ANNUAL REPORT 2018
TRANSPORTATION RESEARCH GROUP

Prof John Preston, Head, Transportation Research Group, Department of Civil, Maritime and Environmental Engineering, School of Engineering, Faculty of Engineering and Physical Sciences, University of Southampton, Boldrewood Innovation Campus, Southampton, SO16 7QF.
Tel: 023 8059 2192; e-mail: jpreston@soton.ac.uk;
web: www.trg.soton.ac.uk

CONTENTS

1. OVERVIEW

The Transportation Research Group (TRG) was established at the University of Southampton in 1967 and has operated continuously since then.

In August 2018 the University underwent a reorganisation. TRG now sits within the Department of Civil, Maritime and Environmental Engineering the (DoCMEE) which is part of the School of Engineering (SoE) and, in turn, Faculty of Engineering and Physical Sciences (FEPS). TRG is located at the University's Boldrewood Innovation Campus where the £46 million National Infrastructure Laboratory is currently under construction, to be completed in the spring of 2019 (see below).

Artist's Impression of the National Infrastructure Laboratory at Boldrewood

This report covers the research activities within TRG during the calendar year 2018.

TRG academic staff members during 2018 were:

- John Preston, Professor of Rail Transport and Head of TRG
- Neville Stanton, Professor of Human Factors in Transport
- Tom Cherrett, Professor of Logistics and Transport Planning
- Mike McDonald, Emeritus Professor of Transportation Engineering
- Ben Waterson, Lecturer specialising in modelling and simulation
- Simon Blainey, Lecturer, specialising in rail transport and modelling.
- Ioannis Kaparias, Lecturer in transportation engineering.
- Katie Plant became Lecturer in Human Factors Engineering in January 2018.
- Shahram Heydari, previously of Imperial College London, joined us in September 2018 as Lecturer in Transportation.

Research Staff in TRG throughout 2018 included Dr John Armstrong, Dr Craig Allison, James Brown, Dr Milan Lovric, Adrian Hickford, Fraser McLeod, Dr James Pritchard, Dr Kirsten Revell, Dr Aaron Roberts, Dr Alan Wong, Dr Vicky Banks, Rich McIlroy and Dr Matt Grote. During the year we welcomed Marcus Young, Dr Yiyang Chen, Dr Jisun Kim and Leonie Webster and said farewell to Dr Bani Anvari, Dr Forough Goudarzi and Dr Bo Gao.

Their research activities are summarised in later paragraphs. **Technical Staff** supporting TRG include Karen Ghali, Daniel Fay, Kiome Pope, Peter Moore and Chris Fenton, with Sarah Twist arriving during the year. Melanie Hallford continued in her role as **Senior Administrator** for the Group, aided by Kelly Carter, with Joy Richardson as administrator for Human Factors projects.

We have a number of Visiting Professors and Research Fellows who contribute significantly to the Group. These include Professor Jianping Wu, Tsinghua University; Professor Pengjun Zheng (Dean of the Faculty of Maritime and Transportation Engineering) at Ningbo University in China; Professor Alan Stevens (formerly of TRL); Professor Julian Hine of Ulster University; Professor Mike Browne (Professor of

Industrial and Financial Management & Logistics), University of Gothenburg; Professor Johan Woxenius (Professor of Industrial and Financial Management & Logistics), University of Gothenburg; Professor David Jeffery; Dr John Walker; Dr Terence Bendixson, Dr John Schoon, Dr Simon Box, Dr Shahjahan Miah, Professor Paul Salmon, Professor Guy Walker, Iain MacGregor and Dr Birendra Shrestha. Visitors from Korea included Elizabeth Jeong, Sangok Lee and Junhong Park and Henrik Johansson from Sweden.

We also had over 30 students attached to the Group undertaking PhD or EngD (Engineering Doctorate) research in transport. In 2018, PhD degrees were awarded to Justin Saward, Katie Parnell, Wonman Oh and Yiwei Guo.

Postgraduate teaching continues to be an integral part of TRG activities, particularly the MSc in Transportation Planning and Engineering. Three pathways through the course were offered for the first time in the 2018-19 academic year, offering students a choice of specialising in Infrastructure, Behaviour or Operations. Some 20 new students enrolled in September 2018, both full-time and part-time.

Overall, we have maintained a healthy portfolio of research in 2018. By the end of the year, our research grants and contracts had a total value of over £10 million, with over £4 million of this from EPSRC.

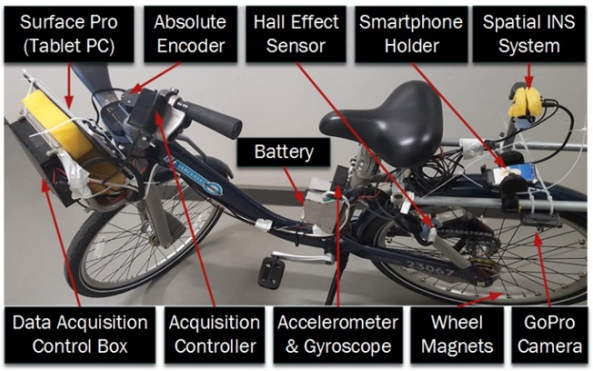
TRG facilities include:

- SUDS (Southampton University Driving Simulator), located in Building 176 at Boldrewood and equipped with a Land Rover Discovery (see below).

The Southampton University Driving Simulator (Mark 2)

- The TRG Instrumented Vehicle (IV2) for on-road trials and new garage facility in Building 185 of Boldrewood. It is anticipated that IV2 will be replaced in 2019, following a successful bid to the University's Research Equipment at Southampton: Delivering Innovation to the Next Generation (RESOUNDING) Fund.

The TRG Instrumented Vehicle (IV) and instrumented bicycle (iBike) for on-road trials, are hosted in the garage facility in Building 185 of Boldrewood. Funds have been awarded to update the IV.



The TRG Instrumented Bike

- Our transport data analysis facility, located in Building 176, Boldrewood.

- ComTET – A command teamwork experimental test bed for submarine control rooms, located in Building 21, Highfield.

The ComTET Submarine Control Room Simulator

Outreach

In 2018, TRG was again active in delivering high impact public engagement and outreach events and activities, under the coordination of Dr Alan Wong. This included:

- providing sustainable research activities to engage the public at the South Downs Green Fair, and the Human Worlds Festival;
- running Researchers' Cafés sessions for the University, which highlighted the research being conducted by early-career researchers and postgraduate students;
- continuing to develop the Southampton Future Cities Community Engagement Hub, involving cross-discipline research groups from the University as well as the central Public Engagement with Research Unit, for which a series of outreach events and activities were conducted, to create more vibrant and people-friendly neighbourhoods in Southampton, which encouraged active travel and reduced car dependency. The events included activities for the opening of the new John Hansard Gallery in Studio 144, National Clean Air Day on 20 June, and the HSBC Southampton Let's Ride Festival, which was attended by over 9,000 people.
- Our other outreach activities include demonstrations based on games for Metamorphosis (or the creation of child-friendly neighbourhoods – Section 3.6) and Model Train sets.

TRG's Model Train Set

Craig Rafter (PhD student) has developed a computer game for outreach called "Junction Jam" that allows players to try and control a set of traffic lights. The game won an award for best new activity in its first year and has been demonstrated at the Science and Engineering Festival, and various roadshow events in partnership with the Next Generation Computation CDT. The code for the game is open-source and available here: https://github.com/cbrafter/CrowdTLL.

2. EXTERNAL ACTIVITIES

The following sections summarise the range of external activities undertaken by TRG Academic Staff members in 2018:

John Preston:

- Member of the EPSRC Peer Review College.
- External examiner for Masters level courses at Cardiff and Leeds Universities.
- Co-Chair (with Professor Ingo Hansen of the Technical University of Delft) of the World Conference on Transport Research Society's (WCTR) Rail Special Interest Group.
- Committee Member of the International Association of Rail Operations Research (IAROR) and the International Conference on Competition and Ownership in Land Passenger Transport.
- Member of the Future Traffic Regulation Optimisation (FuTRO) Project Control Board and the Vehicle/Train Control and Communications Systems Interface Committee.
- Editorial Board Member: Journal of Transport Policy.

Neville Stanton:

- Associate Editor, IEEE Transaction on Human-Machine Systems.
- Member, Editorial Board, Ergonomics.
- Member, Editorial Board, Theoretical Issues in Ergonomics Science.
- Book series editor of "Transportation Human Factors" with CRC Press.
- External examiner for Bachelor and Master level degrees in Occupational Health and Safety at the National University of Ireland, Galway.
- Chair of the Honourable Company of Air Pilots and the Air Pilots Trust Annual Aviation Safety prize.
- Chartered Engineer with the Institute of Engineering and Technology.
- Chartered Psychologist with the British Psychological Society.
- Chartered Ergonomist with the Institute of Ergonomics and Human Factors.
- External expert advisor for Australian Research Council funded rail level crossing project, University of Sunshine Coast, Queensland, Australia.

Tom Cherrett:

- Member of the U.S. Transportation Research Board's, Standing Committee on Urban Freight Transportation (AT025).
- Member of the Editorial Board (Proceedings of the ICE: Transport Journal).
- Member of the Logistics Research Network (LRN) committee.
- Member of IET's (The Institution of Engineering and Technology) Transport Policy Panel.
- External Examiner, MSc Transportation Planning and Engineering course at Newcastle University (2015-2019).
- External Examiner; UG Logistics and Operations Management courses at Cardiff University (2017-2021).

Ben Waterson:

- Member of the Editorial Board for the Institution of Civil Engineers: Transport Journal.

Simon Blainey:

- Secretary of the Royal Geographical Society's Transport Geography Research Group.
- Member of the Governance Board for the Data Analytics Facility for National Infrastructure (DAFNI.)

- Member of the EPSRC Associate Peer Review College.
- External Examiner for MSc, BSc, DipHE and CertHE courses in Railway Operations Management, Glasgow Caledonian University.

Ioannis Kaparias:

- Honorary Lecturer at the Department of Civil and Environmental Engineering of Imperial College London.
- Independent expert for the European Commission on research and innovation activities, acting as an evaluator of proposals submitted to the Horizon 2020 programme.
- External PhD examiner, University College London.
- Commissioned by Connect Plus Services to carry out a follow-up independent technical review of the M25 mobile-phone-based travel time monitoring system.
- Elected member of the Executive Committee of the UK Universities' Transport Study Group (UTSG), acting as Honorary Treasurer.
- Member of the US Transportation Research Board's Standing Committee on User Information Systems (AND20).
- Deputy Editor-in-Chief of the IET Intelligent Transport Systems journal (Institution of Engineering and Technology).
- Member of the scientific committee of the 7th Symposium of the European Association for Research in Transportation (hEART 2018), 5-7 September 2018, Athens, Greece.

Katie Plant:

- Associate member of the Chartered Institute of Ergonomics and Human Factors (CIEHF).
- Technical committee member for the Sixth International Conference on Human Factors in Aviation Transportation, 23-26th July, 2018, Orlando, USA.
- External Examiner for PhD theses for University of Sunshine Coast, Australia and Ohio State University, America.

Shahram Heydari:

- Member of the editorial board of Analytical Methods in Accident Research.
- Collaborative member of the Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT)
- Member of the Network of Excellence in Air Quality at Imperial College London.

3. RESEARCH

TRG research fits within a view of transport as a socio-technical system capable of delivering sustainable outcomes, but also with the potential for unsustainable outcomes if the interactions between transport technology and society are not adequately addressed. We are particularly interested in how society shapes, and is shaped by, technological developments in transport. This requires an interdisciplinary approach involving the engineering and physical sciences, along with the social sciences and humanities. In particular, we bring together traffic engineering, transport economics and human factors. TRG's work is multi-modal and covers both passenger and freight transport, whilst also examining the extent to which information technology may act as a complement or a substitute for transport.

A focus of our research remains on Intelligent Transport Systems, with a growing portfolio of studies on Human Factors in Transport. We also undertake research on a number of other interrelated themes, including energy and environment, freight and logistics, future technologies, rail and transport economics and policy.

The remainder of this report summarises TRG research activities ongoing in 2018 within different topic areas. Research titles listed in **blue** represent contract (funded) research, whilst those in **green** are studies by Postgraduate Research students (PhD, iPhD or EngD).

3.1 Traffic Operations and Safety Management

STARS: Socio Technical Approach to Road Safety. NIHR Global Research Group on Global Road Safety

(National Institute for Health Research, August 2017 to July 2020) Dr R.C. McIlroy**.** *Contract Holders;* Prof N. A. Stanton, Dr K.L. Plant, Prof J.M. Preston, Prof. C. Deakin (Medicine), Prof P. Roderick (Medicine).

Low- and Middle-Income Countries (LMICs) see more than twice as many road traffic fatalities (per head of population) compared to high-income countries. Whilst these countries represent 82% of the global population, they are home to only 54% of the world's registered motor vehicles. The overall goal of our Global Health Research Group (GHRG) is to reduce the number and severity of road accidents in LMICs through our underpinning philosophy of "local solutions for local problems".

The GHRG has the University of Southampton collaborating with a least developed country (Bangladesh, via Bangladesh University of Engineering and Technology), a low-income country (Kenya, via Strathmore University), a lower-middle income country (Vietnam, via National University of Civil Engineering), and an upper-middle income country (China, via Tsinghua University).

During the first year of the project three research streams have been undertaken: (1) conducting a large cross-cultural comparison survey to explore attitudes to road safety and risk perception; (2) Applying Accimaps as a systems-based accident analysis method for three high risk accident hot spot sites in each country, and using the findings to develop

systems-based safety recommendations; and (3) conducting a naturalistic 'think aloud' study with country-specific road users (e.g. moped riders in Vietnam, cyclists in the UK) in order to understand decision making processes from the perspective of road users.

Road Safety in Low Income Countries (IMC Worldwide Limited on behalf of the Department for International Development, November 2018 to July 2019). *Contract holder:* Dr S. Heydari.

This project will undertake a systematic review and produce a state of knowledge paper on road safety in low income countries. Particular focus will be placed on underreporting, limited data conditions, unobserved heterogeneity, emerging technologies and new forms of data, novel approaches, expected increases in traffic volumes, dumping of old vehicles and advanced vehicle safety features. This work is being undertaken as part of the High Volume Transport applied research programme. It involves a collaboration with the Johns Hopkins International Injury Research Unit.

Development of a Travel Time Prediction Model Considering Road Geometry in a Motorway Tunnel Section (funded by the Korean Government, PhD Studentship from September 2016), Sungbae Yoon. *Supervisors:* Prof J.M. Preston, Dr I. Kaparias.

Travel time prediction depending on traffic flow would be one of the most important elements at the stage of traffic demand forecasting. However, the current trip assignment model in South Korea assumes that all planned roads have level terrain even though 8.7% of Korean motorway is made up of tunnels. In other words, the current model that does not consider road geometry, including tunnels could lead to inaccurate travel time predictions.

The aim of this study is, therefore, to improve travel time prediction model reflecting road geometry with a tunnel, which is one of the most common configurations in South Korea. As a result, this study has the detailed objectives as below:

- To identify the correlation between traffic and road geometric features.
- To develop a new travel time prediction model in a tunnel section.
- To verify the applicability of the newly developed model to various cases.

Traffic data from ITS and road geometric data from the management system are being combined for its development. Statistical regression method for modelling will be used.

Improving Automatic Incident Detection Algorithms (ESPRC and Siemens, PhD Studentship, from July 2016). Jonny Evans. *Supervisors:* Dr B.J. Waterson, Prof T.J. Cherrett, *Industrial Sponsor:* Dr Andrew Hamilton (Siemens).

Incidents are events that disrupt the normal flow of traffic, such as vehicle impacts, breakdowns, illegal parking/unloading and emergency roadworks. They cause significant costs to road network users in the form of delay, vehicular damage, air pollution and personal injury.

Automatic Incident Detection algorithms (AIDAs) have been developed to analyse traffic data, and inform users of potential incidents on the road network. However, many AIDAs fail to differentiate between an incident, and recurring congestion (e.g. from major events or rush hour).

This project seeks to improve AIDAs by understanding the context surrounding the traffic data.

A machine learning algorithm will be created that can learn the patterns between the traffic state and context by analysing historical data. An AIDA with this insight will then be able to raise alerts to Transport Operators more quickly and with less false alerts, ultimately aiding in mitigating the consequences of incidents on the road network.

3.2 Energy & Environment

Alternative Fuel Feasibility Assessment (Southampton City Council, from October 2017 to October 2018). Dr M. Grote. *Contract Holder*: Prof T.J. Cherrett.

The aim of the Alternative Fuel Feasibility Assessment project was to support Southampton City Council (SCC) in the development and adoption of an Electric Vehicle Action Plan (EVAP). This was to set out the charging infrastructure requirements to support the uptake of Electric Vehicles (EVs) across the city over the next five years, and to consider options for alternatively fuelled Heavy Duty Vehicles (HDVs) operating in the city.

The project consisted of a set of discrete tasks agreed with SCC according to their priorities. The principal task involved analysis of the provision of residential on-street EV charging infrastructure in urban areas where residents do not have access to off-street parking at home for convenient over-night charging. Provision of such infrastructure removes a recognised barrier to EV uptake. A practical method was developed for Local Authorities to identify suitable locations for the initial installation of charge points. The method was based on simple Geographic Information System (GIS) analysis of routinely available census and parking data to identify the spatial overlaps between areas where residents are most likely to be EV users and areas with a high reliance on residential on-street parking. The method has been implemented in practice to determine a charging infrastructure installation strategy for Southampton, where 129 streets were recommended as suitable locations.

Other tasks included: calculation of baseline figures for the number of EVs using Southampton's road network to provide a basis for undertaking future, repeat assessments of the situation; development of a methodology for monitoring Southampton's charge point network to provide a guide for future investment in network expansion; analysis of the scope for electrification of the Light Goods Vehicle fleet operating in Southampton; and assessment of the infrastructure requirements and procurement options for alternatively fuelled (e.g. natural gas or hydrogen) HDVs within the Council's fleet, with provision for other key organisations and fleet operators (e.g. the city's bus operators) where opportunities for collaboration arise.

Centre for Sustainable Travel Choices (DfT Access Fund, through SCC in conjunction with British Cycling, Cycling UK, Hampshire County Council and Sustrans, from April 2017 to March 2020). Dr A. Wong, A. Hickford, K. Ghali; *Contract Holder*: Prof J.M. Preston.

The Centre is a partnership that aims to promote local sustainable and active travel, whilst suppressing private car use. This project continues the collaborative

work initiated originally through the Local Sustainable Transport Fund. TRG is leading on the monitoring and evaluation of physical interventions and travel behaviour change as part of Southampton and Hampshire Councils' 'cycling ambition' plan for promoting active travel, in particular cycling, into local towns, schools, colleges and workplaces. This is with the aim of developing a sustainable travel culture that enriches lives, provides realistic travel choices, and tackles the pressing air quality problem in the Southampton region. The major schemes planned include the development of wholly or partly segregated cycling 'Freeways', running from the centre of Southampton northwards towards Eastleigh and Chandlers Ford, westwards towards Redbridge and Totton, and eastwards towards Botley and Hedge End. This is part of a wider 10-year cycling strategy (from 2017) to develop a Southampton Cycle Network that also includes cycling 'Cityways' linking other parts of town. A key activity in 2018 involved the monitoring and evaluation of Get Cycle Savvy (March/April) and Cycle September Campaign. These were promotional activities run by Southampton City Council and were designed to encourage cycling.

3.3 Freight & Logistics

Freight Traffic Control 2050 (Transforming the Energy Demands of Last-mile Urban Freight through Collaborative Logistics) (EPSRC, from 2016 to 2019). F.N. McLeod, K. Ghali. *Contract Holder:* Prof T.J. Cherrett.

With van traffic predicted to increase by 20% in London by 2030, and slow uptake of electric or alternatively-fuelled goods vehicles, more radical strategies are needed to reduce the numbers and impacts of freight vehicles in our cities. Working with some major parcel carriers in London, this project is examining the potential for closer operational collaboration between carriers to reduce urban traffic and energy demand. This is expected to be done whilst maintaining customer service levels, and evaluating to what extent such relationships can develop naturally within a commercial setting or whether a third-party 'Freight Traffic Controller' would be needed to ensure equitable distribution of demand across a city. A further aspect of collaboration being trialled is the concept of 'portering', whereby the parcel carrier delivers bags of parcels to roadside porters who make the final deliveries. This would replace the existing practice where the carrier's vehicle is typically parked for 70% of the time while the carrier is walking to, and spending time at, delivery points. Portering would make more efficient use of vehicles and would release valuable kerbside space.

CITYLAB (EU Horizon 2020, from 2015 to 2018). F.N. McLeod. *Contract Holder:* Prof T.J. Cherrett.

The CITYLAB project has adopted living lab methods (joint stakeholder co-operation and innovation) to test various freight initiatives in the cities of Amsterdam, Brussels, London, Paris, Oslo, Rome and Southampton. In Southampton, the overriding objective has been to improve air quality along key transport corridors. Focus has been on large municipal organisations such as Southampton General Hospital, Southampton City Council and Southampton's two universities to investigate opportunities for joint procurement and consolidation of goods to reduce environmental impacts. The Southampton Sustainable Distribution

Centre at Nursling, operated by project partner Meachers Global Logistics, has offered a consolidation service, with take up from the hospital for temporary storage and transportation of automated dispensing units and current planning for consolidation of pharmacy goods transport. Consolidations of items delivered to student halls of residence were investigated in case studies although not implemented. Citylab partner Southampton City Council is actively contributing to air quality concerns by putting in place a plan to switch a significant proportion of its own-operated vehicle fleet to electric vehicles, and the first six vehicles arrived in January 2018.

Improving the Productivity of Rural Farmers: Understanding the Scope for Collective Supply Chain Management in Thailand (PGR student, from October 2017) Korawit Fakkhong. *Supervisors*: Prof T.J. Cherrett, Prof J.M. Preston.

The transportation sector plays a vital role in supply chain management by enabling products to be situated in the right place at the right time to meet ever more stringent customer requirements. This is no more prevalent than in Thailand's food industry which is substantially export-dependent, representing one of the main contributors to the country's income. It has recently faced considerable competition from other regional markets with local food producers suffering due to perceived inefficiencies in the local supply chain.

This research aims to investigate the opportunities for improving the logistics of food supply from rural farmers in Thailand into the main export routes and how market opportunities can be increased as a result. Integrated agro-industrial parks and collaboration models will be used to investigate how different transportation and distribution approaches could improve overall logistics performance, as well as businesses opportunities for rural farming communities.

Demand Forecast and Capacity Appraisal of the United Kingdom Lift-on Lift-off Container Ports System **(**SMMI PhD studentship from January 2016). Manuel Buitrago. Supervisors: Prof J.M. Preston, Prof T. Bektas (Management).

The maritime sector is of the utmost importance for the United Kingdom's economy. Great Britain, an island, has limited options for the use of sea-borne transport for most of the freight commodities. Air freight is mainly used for high-value and time-sensitive products and the Channel Tunnel is limited by capacity constraints. For bulk and containerised commodities, which usually present a lower value density and higher volume, maritime transport is the only feasible option. As a result, up to 96% of the volume of all UK import/export trade flows use the UK ports. Roll-on roll-off (ro-ro) and lift-on lift-off (lo-lo) container terminals are essential to accommodate container flows. Besides, amongst lo-lo terminals, the UK also needs a certain deep-water capacity to be able to cater for ultra large container ships (ULCS) that are deployed to the main maritime route that links the Far East with Northern Europe. Ensuring the availability of enough spare deep-water capacity has become even more important on the eve of Brexit.

Apart from enabling the trading capability of the nation, the ports are crucial for the UK's economy in, at least, two other important ways. Efficient ports increase the competitiveness of the UK economy, reducing dwell times and facilitating smooth trade. Secondly, ports generate

important spillover effects. These include value generation, creation of jobs and the formation of clusters and industrial poles.

The UK container port system has experienced profound change since the 1980s. The system underwent a change in two dimensions. Firstly, the major container ports were privatised under the Thatcher administration. Currently, all major UK container ports are privately-owned. Secondly, the container port is concentrated in just three major ports of the Southeastern coast of the UK, which handle more than 70% of the total yearly throughput.

This research project develops new models to assess capacity and demand for the lift-on lift-off container seaports in the United Kingdom. Firstly, the evolution UK container port system has been analysed. Secondly, the system capacity has been analytically appraised using a system of systems approach. An aggregate forecast of the demand for lo-lo container traffic of the United Kingdom system of container ports has been calculated up to the year 2050, using econometric models that incorporate economic growth and the cost of energy as predictors. Several scenarios have been incorporated to reflect the uncertainty and the potential disruption caused by the UK withdrawal from the European Union. Finally, the demand is allocated to the individual UK containers ports by means of a Lotka-Volterra competition model.

This research presents insights to decision-makers to base port policy on evidence and informs crucial strategic investment decisions for government and industry alike. Overall it provides a rationale to decide where and when to invest on capacity expansion. Finally, it would be possible to use the results to signpost risks to the port system, in terms of congestion, loss of traffic and vulnerability of the port infrastructure network.

3.4 Future Technologies

Green Adaptive Control for Future Interconnected Vehicles (G-ACTIVE) (EPSRC from March 2016 to February 2019). Dr C. Allison, *Contract Holders:* Prof N.A. Stanton.

The project targets a significant reduction in fuel consumption, CO_2 and NOx emissions in passenger and light duty road vehicles. This will be achieved by implementing new Energy Management control systems that are inclusive, predictive and adaptive. This has been investigated through the application and development of car following models and human factor methods.

Incorporating More Connected Vehicle Information into Urban Signal Control Managements (PhD from January 2018). Zongyuan Wu. Supervisors: Dr B.J. Waterson, Dr B. Anvari.

This project aims to understand the benefits of adopting comprehensive information obtained from connected vehicles in control strategies. In particular, the impact of considering vehicles different from each other on traffic control is investigated here. The report reviews existing urban signal control strategies, points out their drawbacks and highlights that they fail to realize that vehicles are different. The project will try to identify which methods for recognising individual vehicle information data are useful for adaptive urban signal control using connected vehicle technology. A new adaptive signal control model will be developed, which

will incorporate more individual vehicle information with typical connected vehicle data. The research will then investigate how the presence of information about each vehicle will impact the operation of adaptive signal controls using CV technology and identify which kind of factors significantly affected their performances. The end of the research will support the adaptive signal control strategies to respond to different traffic situations on the basis of better understanding of additional information.

Addressing the New Reality of Vehicle Automation in Highway Design (sponsored by the EPSRC Sustainable Infrastructure Systems CDT, iPhD studentship from September 2017). Hameed Jehanfo. *Supervisors:* Dr I. Kaparias, Prof J.M Preston.

Since the first mass-produced cars entered the open market in the early 20th Century, transport technology has developed considerably. Whereas early vehicles had zero automation, there are now vehicles fitted with equipment to carry out automatic braking, lane-keeping and speed-control.

In the last decade, there has been a drive towards automating more, and eventually all, driving tasks. Several trials and research studies have taken place around introducing Connected and Autonomous Vehicles (CAVs) onto public roads. This, coupled with progress made in developing and testing technologies, has engendered confidence in policy-makers to accept the imminence of this transport revolution. In his 2017 Autumn Budget, the UK Chancellor of the Exchequer announced that self-driving vehicles will be allowed on British roads by 2021.

Although current highway standards still rely on 100% driver input, CAVs will reduce or exclude human control of driving tasks. This shifts the dynamics of road engineering principles, which draw on driver psychology and morphology. Introducing CAVs will impact on fundamental highway parameters such as visibility, headways and reaction times. A review of design standards is overdue as a result of partial automation on our roads now. With full automation on the horizon, this research will assess the potential for revising design standards for various degrees of vehicle automation.

Designing Public Transport Travel Information that Meets the Travellers' Information Needs, According to the Fourth Rule of Citizenship (sponsored by EPSRC and Southampton City Council, EngD studentship from October 2013,) Amanda Haylett. *Supervisors:* Prof T.J. Cherrett, Dr G. Wills (Electronics and Computer Science).

In 1977, The National Consumer Council expressed that among the rules of citizenship, information provision must conform to two fundamental principles; (1) continuous access to information to assist in the decision making process and (2) the necessary support and advice that can convert that information into effective action. In line with this particular rule of citizenship, the aim of this research is to stipulate the best approach for satisfying this fourth rule. To do this the research will break down what travel information is, how it has developed in light of rapid technological advancement in delivery. Moreover, it will draw conclusions on how well we are meeting this fourth rule of citizenship through present day travel information provision techniques such as journey planners. The outcome of this research will be the production of specific travel information delivery standards to both ratify present day solutions, and

improve future information delivery strategies.

Electric Vehicle Drivers and their Use of Digital Media (part-time PhD, from December 2013). Farah Alkhalisi. *Supervisors*: Dr B.J. Waterson, Prof T.J. Cherrett.

Promoting the use of renewable-source fuels has greater potential to reduce transport-related carbon emissions in the short to medium term than changed traveller behaviour, especially given doubts that Western Europe has reached 'peak car'. Although electric vehicles (EVs) currently account for around 1% of new cars sold in the UK, they are intended to play a key role in meeting the objectives of the 2008 Climate Change Act. Strategies to counter barriers – both technical and cultural - to EV purchase or adoption are therefore clearly necessary.

Transport users, cyclists and walkers are increasingly using digital technologies such as social media platforms, smartphone apps and crowd-sourced databases to overcome infrastructural shortfalls; for car-sharing; and for intermodal transport. Little is known, however, about the extent to which EV drivers could be similarly using digital resources related to, for example, location of public charging points; scheduling and remote monitoring of their cars' charging; or technical data and information-sharing. This research therefore attempts to understand the relationships between electric vehicle drivers and digital media.

Mitigating Range Anxiety and Reducing Energy Consumption in Drivers of Electric Vehicles (iPhD student from October 2015). Richard Deacon. *Supervisors*: Prof J.M. Preston, Prof T.J. Cherrett.

Range anxiety, or a driver's lack of confidence in an electric vehicle's ability to complete a specified journey, is considered to be the primary barrier to the purchase of battery electric vehicles (BEVs). However, most new BEVs have a range of 100 miles, whilst the average UK driver travels just 25 miles per day (National Travel Survey 2013). In order to reassure the motoring public, the driver requires accurate and user friendly feedback so as to be able to maximise the economy of the BEV, maximise range and boost user confidence. A series of studies are planned in the Southampton University Driving Simulator (SUDS) that will investigate a variety of different information presentation methods and their effects on driving performance. The project aims to test the effects of new driver interfaces that will be developed with the aims of reducing range anxiety and minimising energy consumption. It is expected that this project will help recognise the potential of BEVs in the development of Sustainable Infrastructure Systems.

Optimising Wireless Electric Vehicle Charging Locations (iPhD student from October 2015). Luke Hutchinson. *Supervisors*: Dr B.J. Waterson, Dr B. Anvari. *Industrial Sponsor*: Transport Research Laboratory.

Wireless Power Transfer offers a viable means of charging Electric Vehicles (EV) whilst in a dynamic state, mitigating issues concerning vehicle range, the size of on-board energy storage and the network distribution of static based charging systems. Such charge while driving technology has the capability to accelerate EV market penetration through increasing user convenience, reducing EV costs and increasing driving range indefinitely, dependent upon sufficient

charging infrastructure. Yet, the detailed vehicle interactions of both users and non-users of a dynamic charging system has received little analysis.

This research therefore seeks to create a modelling framework that - given the inputs of a network, driver requirements and the infrastructure capabilities - can attempt to optimise the distribution of both wireless charging systems and plug-in charging stations within the network. The project also intends to identify the potential of the dynamic charging situation, how it could be implemented into the existing charging infrastructure, and the issues that could be encountered during deployment. The interaction environment between the driver, vehicle and infrastructure has been identified as the key component of the system and achievable energy transfer efficiencies are dependent upon such aspects. Further exploration of these factors, both as individual entities and as a wider concept, will be undertaken to assess methods that can be applied, considering the global aim of maximising transfer efficiency.

Integrating Connected Vehicles into the Transport Network (EPSRC CDT in NGCM Studentship from September 2015) Craig B. Rafter *Supervisors*: Dr T.J. Cherrett, Dr B. Anvari. *Industrial Sponsor*: Transport Research Laboratory.

The increase in traffic volumes resulting from population growth makes network delay and capacity optimization challenging. However, the introduction of connected vehicles in intelligent transport systems presents unique opportunities for improving traffic flow and reducing delays in urban areas. With connected and autonomous vehicles set to begin commercial deployment in 2020, investigating how transportation infrastructure can sustainably support high numbers of connected vehicles in the network is imperative.

Existing transportation infrastructure is designed around non-automated vehicles. This includes not just the road-space, but also the many thousands of traffic sensors, the control infrastructure (traffic lights, variable speed limits). This research investigates strategies to redesign traffic signal control infrastructure to support connected vehicles and deliver improvements in sustainability.

This research considers scenarios ranging from low to high numbers of connected vehicles in the transportation network using computational modelling, and experiments on simulated and instrumented vehicles. Ultimately, the outcome of this research will be innovative new designs to transportation infrastructure - with a strong evidence base - that will support connected vehicles to maximize sustainability in the transport network.

Transport and the Grid: Integrating the Charging of Electric Vehicles (EPSRC DTC EngD Studentship, from September 2013). Steve Broderick *Supervisors*: Dr B. Waterson, Dr A. Chipperfield. *Industrial Sponsor*: Scottish and Southern Energy.

The rapid integration of Electric Vehicles (EVs) (substituting cars in the transport system) raises significant questions as to the means and manner by which they charge. The concern regards the UK domestic Low Voltage (LV) network. The network was not designed to support transport load – which, with home charging, it now must do. Some networks are already known to be incapable of supplying EV populations beyond several 10’s of percent.

Modern Electric Vehicles have many control options, yet a holistic simulation of large populations connected to the LV system is not presently available.

A goal of this study is to construct a realistic simulation tool, modelling EV and other electrical dynamics (primarily the supply of pre-existing electrical loads). The EV model includes EV characteristics and battery state, travelled distances and timings, driver charging connection habits and expectations of future trips.

The work is focussed on a real-world UK LV network and explores the capabilities/ constraints on the system. Charging control options and methods will be assessed, so to best satisfy conflicting load demands.

The output of the study will include a simulation tool, key learning points and an assessment of options to manage the electrical network, given a growing EV population.

The work has relevance for countries which use a substation-fed LV (230 V) domestic power system and allow EV charging at home. This includes most of Europe, India and other countries.

3.5 Rail

T2F: Track to the Future – Economic and Environmental Modelling (EPSRC Programme Grant from June 2015 to May 2020). Dr J. Armstrong, M.A. Young. *Contract Holders*: Prof J.M. Preston, Dr S.P. Blainey.

This programme grant follows on from the Track21 project (2011-2015), and involves addressing additional research questions with the aim of delivering improved railway infrastructure performance, as well as further research based on some of the key outputs from Track21. As train frequencies and speeds continue to increase over time, railway track is being more intensively used, which leads, in turn, to increased maintenance requirements. Combined with the urgent need to reduce the railway system's costs and environmental impacts this places great pressure on railway infrastructure operators. Alongside this, it will also be necessary to mitigate the impacts of climate change on railway track systems, with coastal railways potentially particularly vulnerable in this regard.

In order to help the rail industry tackle these challenges relating to track maintenance and performance, T2F is addressing three key research challenges. The first is to develop low maintenance and long life track systems with optimised use of materials. The second is to design crossings and transitions so as to optimise vehicle behaviour and consequently maximise the service life of trains, and the third is to develop an integrated approach to the design of low-noise and low-vibration track. TRG's contribution to the project involves the calculation of the economic and environmental impacts of such interventions. This involves working in partnership with Network Rail (with whom the University of Southampton has a Strategic Partnership), and with other T2F researchers at the universities of Southampton, Birmingham, Nottingham and Huddersfield. Work so far has focused on life cycle cost and carbon modelling of the installation of under-sleeper pads and the use of fibre-reinforced ballast and on comparing ballasted and non-ballasted track systems. TRG are currently developing (in partnership with the Institute for Sound and Vibration Research) a more accurate

and spatially detailed socio-economic assessment of changes in noise and vibration from railway track systems using GIS to combine and process a range of datasets. A generalised socio-economic assessment methodology for track system interventions based on data ontologies is also being developed in conjunction with researchers at the University of Birmingham.

Improving Customer Experience While Ensuring Data Privacy ('DICE')

(EPSRC, September 2016 to February 2020). Dr J. Pritchard. *Contract Holder:* Dr S.P. Blainey, jointly with University of Surrey, Loughborough University, and Royal Holloway University of London.

This project is investigating the trade-offs rail passengers might face between data privacy and improvements to the customer experience. Particular attention is paid to passengers with special journey requirements and to future ticketing systems. Research areas include: the development of an effective trust framework to enable customer control over data privacy; the development of data aggregation techniques which aid the provision of an improved customer experience without compromising data anonymisation; testing the applicability of these frameworks and techniques to potential future ticketing solutions; developing use case scenarios for systems to improve the rail customer experience; and assessing the demand and environmental impacts of providing an improved customer experience enabled by these systems.

The current focus, working mainly with the team from Loughborough, is on analysing a set of customer complaints in order to ascertain the factors which can lead to a degraded customer experience, and understand how individual context can make a difference. This will help us to understand where knowing something about the passengers could help rail operators improve the customer experience. This will help build up a picture of where the potential trade-offs between data privacy and customer experience might lie.

Understanding Passenger Loadings and Providing Better Information

(Govia Thameslink Railway (GTR), November 2016 – December 2018). Dr J. Pritchard, Dr K.M.A. Revell. *Contract Holder:* Prof J.M. Preston

This project builds on the earlier RRUKA funded work looking at the use of passenger loading data to influence behaviour and mitigate crowding. It is funded as part of Future Rail's TOC'15 initiative.

On the basis that providing better crowding data to passengers seems desirable, the first aim is to identify the most suitable data sources for counting passenger numbers. A range of data sources have been obtained, which vary in terms of accuracy, cost and other practical limitations (for example, not all sources can be read in real-time), and work is ongoing to assess their relative merits. It may be that an optimal solution is found by using some combination of the available data sources.

The second aim is to develop the methods used to accurately predict passenger loadings from the data available, developing algorithms and working with GTR's appointed developer to ensure that they can be implemented.

The final aim is to determine how best crowding information should be presented to the travelling public and to implement a

small-scale trial in order to further assess the benefits.

A set of manual counts were commissioned by GTR in order to be able to calibrate a set of models. Regression models have been developed to estimate the number of people currently on a train from a number of factors, including the recorded weight of the carriages.

Software has been written in Python and initial models have been developed which now predict passenger loadings in real-time and offer forecasts for the month ahead. This software forms part of a whole system which is currently being trialled, and work is ongoing to improve the outputs.

Human factors methods are being used to design tools to provide better information to operational staff and customers using user-centred principles. Work on customer tools has also considered the extent to which information will be used through an on-line experiment that has permitted the development of an ordinal regression model.

Predicting and Mitigating Small Fluctuations in Station Dwell Times

(RSSB from April 2018 to March 2019). Dr J. Pritchard, Dr B.J. Waterson and staff from GeoData Institute. *Contract Holder:* Dr S.P. Blainey.

This joint project between TRG and the University's GeoData Institute will develop models which are capable of making real time predictions of expected variations in railway station dwell time, along with an interface capable of communicating these variations to railway operating staff so that they can implement appropriate mitigation measures. Variations in station dwell times can have a significant effect on network capacity, with previous analysis of dwell time variations indicating that even small delays can adversely affect overall network performance. The lack of information and understanding of these variations makes it difficult to implement effective mitigation measures to reduce the occurrence and impact of such delays. This project will address this problem by developing a model explaining the causes of small fluctuations in station dwell time based on a range of datasets, and exploring the use of this model to forecast future fluctuations in station dwell time, in real time. The research will focus particularly on dwell time variations of less than three minutes duration at station stops, as this is where current knowledge is most lacking. However, the tools developed during the project could also potentially provide insights into longer delays. The project involves working in partnership with South Western Railway, who are supplying key datasets for the project and acting as a testbed for implementation of the models.

An Automated Demand Forecasting Model For New Local Railway Stations

(EPSRC IAA from July 2018 to December 2019). M.A. Young. *Contract Holder*: Dr S.P. Blainey.

The considerable growth in passenger rail use in the UK in recent years has been accompanied by a large number of schemes to construct new stations and railway lines. However, analysis has shown that the accuracy of the forecasting tools conventionally used to assess such schemes leaves a lot to be desired. Recent PhD research has developed integrated railway station choice and demand models capable of producing forecasts of passenger numbers at new station locations

anywhere in Great Britain, and of estimating the levels of demand abstraction at nearby existing stations. This project will develop a software tool based on this research which will be hosted at the Data Analytics Facility for National Infrastructure (DAFNI), and made available to transport planners working for industry and government stakeholders. This tool will provide forecasts of the demand impacts of new railway stations sited at any location in Great Britain, suitable for use in the business case appraisal process for such stations. It will also establish procedures and processes for maintaining an historic archive of transport-related datasets (such as transit timetables and fares) on the DAFNI National Infrastructure Database (NID).

Modelling Railway Station Choice Using Geographical Information Systems (GIS) (PhD studentship, from October 2014). Marcus Young. *Supervisors:* Dr S.P. Blainey, Prof J.M. Preston.

This project sought to improve the aggregate models that are typically used to forecast demand for new local railway stations in the UK, by incorporating more realistic representations of station catchments. These models have previously assumed that the choice of station is a deterministic process, for example station catchments are often defined by assigning each zone (such as census output area) to its nearest station. Using origin-destination survey data from Scotland and Wales, station choice models were developed that, given a set of alternative stations for each unit postcode, could predict the probability of each station being chosen, thus defining probabilistic station catchments at a high spatial resolution. Trip end models were then calibrated using a dataset of all local railway stations in mainland GB. The models with probabilistic catchments performed better and gave greater weight to the population variable, indicating that they can better account for differences in station usage that are explained by station catchments and their generation potential. Therefore, they should be more robust and transferable, and better suited for use as a national predictive model. The models were applied to predict demand at several recently opened stations, including the new Borders Railway line. The model with probabilistic catchments produced more accurate forecasts which, in many instances, were better than the official forecasts produced when the schemes were appraised.

A Comparative Assessment of Intercity Transport Technologies: A Saudi Arabian Case Study (PhD from September 2016). Hamad Almujibah. *Supervisors:* Prof J.M. Preston, Dr S.P. Blainey.

With increasing urbanisation worldwide, the passenger demand for inter-urban travel has grown and the development of new transport technologies is needed, such as High-Speed Rail (HSR), Magnetic Levitation (Maglev), and Hyperloop. This thesis describes the development of the comparative assessment of these three intercity transport technologies, in terms of their service characteristics. In this case, the comparative assessment is made up of four models. The first model is the Spreadsheet Total Cost Model (STCM), which focuses in calculating the social and financial costs according to the vehicle characteristics and unit costs for each of the transport technologies studied, including operator cost, user cost, and external cost. Secondly, a Demand Forecast Model (DFM) is needed to forecast travel demand of HSR

flows. This model includes different parameters such as population along the corridor, GDP per capita, generalised journey time, percentage of unemployment, and number of years since opening lines. The third model is a Stated Preference Model (SPM) to examine the choice of Hyperloop over all other transport modes to gain an understanding of how the decision can be made when faced with a number of transport alternatives. The fourth model is the Elasticity Demand Model (EDM) to determine the existing mode flows, in terms of generalised journey travel time, including conventional rail, aircraft, automobile, and bus. The comparative assessment is applied on the Riyadh-Dammam corridor, Saudi Arabia to determine the most suitable transport mode, in terms of level of service, total social and operator costs, and forecast passenger demand level.

Improving Pre-trip Information About Transfer-involved Rail Journeys (PhD from October 2013). Yiwei Guo. *Supervisors*: Prof J.M. Preston, Dr S.P. Blainey. Awarded 2018.

With the development of information and communications technology, rail passengers' experience of punctuality and reliability relies increasingly on the quantity and quality of the available passenger information.

Although passenger information is viewed as an important influencing factor on customer experience and rail patronage, the quality of the pre-trip information about certain transfer-involved, delay-sensitive routes (called Critical Routes) is often disregarded due to the limitations of current technologies. On the one hand, the accuracy of pre-trip timetable information is prone to train delays and cancellations. On the other hand, real-time disruption alerts contribute little to the pre-planning of the transfer activities involved in a given journey and the relevant activities before and after the journey.

This research explored the possibility of enhancing the management of delays by improving the pre-trip information about transfer-involved journeys. A set of novel timetable-information algorithms and passenger-centric analytical methods were developed to provide technical solutions and to quantify the expected gains from these novel solutions. Empirical evidence from a number of identified Critical Routes (containing critical transfer-involved journeys) in British railways reveals the efficiency and effectiveness of the proposed methodology.

Streamlined Train Travel: Assessing and Reducing Door-To-Door Journey Times Associated with New Rail Infrastructure (funded by the Turkish Government, PhD Studentship from September 2018) Emine Tugba Yazici. *Supervisors:* Dr S.P. Blainey and Dr J. Pritchard.

There are many reasons for investment in high-speed rail (HSR), such as increasing transport capacity, enhancing network, supporting mode shift from air travel to HSR, but often one of the primary reasons for promoting HSR investment is a reduction in journey time. While HSR services are usually able to achieve a reduction in on-board time between major centres, not all HSR services are necessarily successful in achieving reductions in door-to-door journey time. Therefore, this research reviews high-speed rail routes and their stations around the world to investigate factors affecting the door-to-door journey time such as station connectivity, accessibility,

location, HSR route alignment and service operation. Then, with the assessment of the existing applications, for the future HSR construction, a guideline will be provided to help transport planners on the provision of HSR services in a way which maximises the potential journey time benefits.

A Reform Assessment to Optimise the Railway Organisation in Saudi Arabia

(PhD from April 2018). Sultan AlSaedi. Supervisors: Prof J.M. Preston, Dr S.P. Blainey.

The research project aims to determine the optimal size and organisation of rail services in a medium-sized country, such as Saudi Arabia, where the network has not been fully developed. As different railway organisational forms have been developed across the globe, such as vertical and/or horizontal separation, the research project will examine different forms, including the current structure. To achieve such organisational optimisation, the research project will deliver an assessment of the technical and financial performance and customer satisfaction through quantitative and qualitative analyses. The technical performance will be analysed through an estimation of the technical efficiency in order to minimise required inputs or maximise produced outputs in the production technology. Regarding the financial performance, the research project will only focus on the analysis of the cost efficiency, and cost minimisation will be estimated through this analysis. Based on the technical and cost efficiency, the allocative efficiency will be measured. For customer satisfaction, the assessment will be conducted based on the concept of consumer sovereignty. Therefore, the contribution of this research project is to identify which organisation form can maximise the production technology, minimise the railway cost and improve customer satisfaction.

A Whole Life Carbon Model for Railway Track System Interventions

(EPSRC and Network Rail Sustainable Infrastructure Systems iPhD from January 2018). Georgios Rempelos. *Supervisors:* Prof J.M. Preston, Dr S.P. Blainey.

The UK's rail network consists of approximately 20,800 miles of track and estimates suggest that the volume of maintenance and renewal required results in approximately 430,000 to 934,000 t CO_2 per annum. This project aims to develop a cost and carbon emissions model for railway track systems, covering the whole life of the infrastructure. The model will be capable of modelling the impacts of a wide range of track system interventions, including the full range of engineering solutions developed during the Track21/Track to the Future (T2F) research programmes. In essence, this project aims to produce a framework which will work as an analytical tool to better understand the carbon footprint of today's rail industry and, subsequently, assist the decision-making process on both minimising CO_2 and realising sizeable financial/social benefits. The results from this work are purposed to be fed into a wider Cost Benefit Analysis (CBA) framework, in order to objectively assess different track interventions qualitatively and quantitatively at a macro level and subsequently assist stakeholder decision-making.

Presently, the project is focussed on individual carbon foot-printing studies based largely on existing embodied carbon factor databases such as the '*Bath Inventory of Carbon and Energy*' and the '*Rail Carbon Tool*' by Rail Safety and Standards Board (RSSB). The

downside of these databases lie primarily on the coarse representation of data and the heavy reliance on carbon dioxide to quantify the environmental externalities of different track designs. It is thus desirable to move towards a full Life Cycle Analysis (LCA). This target revolves around the notion of developing a dynamic framework that is able to quantify a wide range of externalities (aside of CO_2) at a mid- or end-point level. This study will require data of fine-granularity for all the individual processes (sourced through Delphi surveys and Network Rail databases) involved within the life cycle of the underlying system under investigation.

Aside of the environmental externalities of the rail infrastructure, the project will attempt to provide a link between both cost and carbon, examining prospective trade-offs between the upfront and the on-going financial and environmental externalities throughout the useful life of these structures. Of particular interest are potential performance comparisons between ballast-less technologies (slab track) and the optimised ballasted track with interventions developed during Track21/T2F. The project will attempt to divert from the standardised CBA approach and look into alternative frameworks such as Multi-criteria decision analysis (MCA) or outranking methods. Work so far includes a streamlined LCA study with a view to evaluate and compare the lifecycle GHG emissions associated with concrete (G44), steel (W560H), hardwood and softwood sleepers. This work will potentially be extended to include a comparison with more recent composite sleeper technologies (i.e. Fibre-reinforced Foamed Urethane (FFU) sleepers).

The Project Economics and Management of Railways in the Middle East (PhD (Part-time) from October 2018). Fawad Munir. *Supervisors:* Prof J.M. Preston, Dr S.P. Blainey.

The focus of this research is the "Investment choice" of establishing a modern rail, and other transport, networks in the Gulf region. From a recent open source literature (www.meed.com) and media review (Gulf News) it emerges that almost all Gulf Cooperation Council (GCC) authorities are seeking alternatives to state investment in major transport projects. An example of this could be the ambitious yet hugely delayed GCC rail project. It is unclear if, or how, an investment model has been considered in the strategic decision of the GCC rail network, but it seems that any such studies have only been done at a rudimentary level. It is argued by Harry Markowitz that stock investors with sufficient computational resources can be compared with government bodies and client organisations and therefore it is feasible to assume that portfolio theory can either be utilised prior to the investment decision or soon after the feasibility study and decision to go ahead with one or the other project. Therefore, in the context of GCC rail projects, this research will draw parallels with the investment portfolio theory and look at alternative models such as Public Private Partnerships (PPPs).

At first, a comparative and parametric study for existing economic models of long distance railways and/or Metro in modern western countries may be carried out. This will provide a benchmark for comparison with the current GCC practices. Then this study would critically analyse financial studies of GCC region railway projects regarding their investment policy.

The study will provide recommendations, a framework and a model for transport infrastructure investment. This study will be useful for government organisations and other stakeholders for investment choice for a new railway network. Additionally, this research work can also recommend on existing networks in order to establish network wide polices of freight and passenger movement, for a viable business case.

3.6 Transport and Infrastructure Policy

Metamorphosis (EU Horizon 2020, in partnership with SCC, from June 2017 to May 2020). Dr A. Wong. *Contract Holder*: Prof J.M. Preston.

This H2020 project consists of 13 consortium partners, including seven city authorities in the UK and Continental Europe, who are committed to transforming parts of their neighbourhoods from being car orientated to being child-friendly and community-oriented places. The partner cities were chosen to represent a wide variety of demographic and location characteristics, and each works with an academic or enterprise partner to take the lead for a different strand of the project, with the overall aim of improving quality of life, and the physical and mental health of their citizens. The seven cities are (1) Graz, Austria; (2) Meran, Italy; (3) Munich, Germany; (4) Tilburg, Netherlands; (5) Alba Iulia, Romania; (6) Zurich, Switzerland; and (7) Southampton, UK, with TRG taking the lead on the 'user analysis and involvement' work package. Each partner city has plans to implement a series of trials to encourage more 'child friendly neighbourhoods', to show what can be achieved, and build on the availability of shared space, play streets, living laboratories, crystallisation points, and use of other public spaces and associated interventions. This includes encouraging integrated planning that promotes walking and cycling (and sustainable travel generally) instead of using the car. It also develops innovative approaches to local urban design, which engages both children and adults as stakeholders and participants in the development and building process, as well as enabling and simplifying city procedures for the planning and implementation of child friendly neighbourhood measures and activities. TRG has provided a systematic review of interventions and measures that are being applied by the local case studies. In Southampton, interventions in the Old Town and Sholing neighbourhoods that include street closures are being monitored and evaluated.

Metamorphosis Global (IMC Worldwide Limited on behalf of the Department for International Development, in partnership with SCC, from October 2018 to March 2019). Dr S. Miah, Dr A. Wong. *Contract Holders*: Prof J.M. Preston, Dr I. Kaparias.

This project, which is being undertaken in conjunction with the Bangladesh University of Engineering and Technology, looks at the scope for applying the concepts developed in Metamorphosis (see above) to Low Income Countries. In particular, it will examine the prospects for making neighbourhoods around two schools in Bangladesh more child-friendly, through the illustration of practical case studies and the development of a prototype on-line toolkit. This research is being undertaken as part of the High Volume Transport applied research programme in Transport – Technology Research

Innovation for International Development (T-TRIID).

UKCRIC Strand C: Data Analytics Facility for National Infrastructure (DAFNI) (EPSRC from April 2017 to March 2021). *Contract Holder:* Dr S.P. Blainey, jointly with eleven other universities.

DAFNI is a major UK facility which aims to advance infrastructure research. Based at Science and Technology Facility Council (STFC Harwell), DAFNI will host national infrastructure datasets and provide a complex system science driven platform for modelling, simulation and visualisation. These capabilities will be underpinned by the high throughput data interconnectivity and integrated high performance computing facilities required for multi-scale infrastructure system modelling, linked with a unique national infrastructure database. DAFNI will be implemented and tested over the four year period from 2017 to 2021, enabling significant new advances in infrastructure research and facilitating access to tools and methods capable of addressing real-world challenges at a range of scales. It will therefore provide world-leading capability to support UK research, business and government in infrastructure systems analysis, modelling, simulation and visualisation. The University of Southampton is one of 12 partner institutions overseeing the delivery and management of the programme, with the university's input being provided by representatives from TRG.

Multiscale Infrastructure Systems Analytics (MISTRAL) (EPSRC Programme Grant from January 2016 to June 2020). Dr M. Lovric, A.J. Hickford. *Contract Holders:* Prof J.M. Preston, Dr S.P. Blainey, Prof R. Nicholls (Energy and Climate Change), jointly with six other universities and industrial and government partners.

MISTRAL is phase 2 of the Infrastructure Transitions Research Consortium (ITRC), expanding the scale and reach of the NISMOD (National Infrastructure Model) system. ITRC's vision is for complex infrastructure decisions to be guided by systems analysis. Using the pioneering tools developed by the ITRC team, decision-makers are able to visualise and assess how all of their infrastructure systems are performing, help to pinpoint vulnerabilities and quantify the risks of failure. The tools are capable of performing 'what-if' analysis of proposed investments and exploring the effects of future uncertainties, such as population growth, new technologies and climate change. A key feature of the ITRC projects has been a high level of engagement with industry and government, and the modelling tools produced as part of ITRC and MISTRAL have been used by the National Infrastructure Commission to inform their National Needs Assessment.

Work at TRG is focusing on enhancing the transport models developed during ITRC phase 1 and developing novel transport models. This centres on building an integrated framework covering capacity, demand and risk, and incorporating a network-based representation of the British transport system. The scope of the model will also be extended to cover key international linkages. Tasks include generating a base year OD matrix for Great Britain, parameterising transport interventions and policies for inclusion in the model using the best available evidence, constructing a flexible network-based national transport model, and integrating

risk and resilience modelling into the wider framework.

TRG staff members are also involved in other MISTRAL work, together with researchers from the University of Oxford, and in collaboration with the United Nations Office for Project Services (UNOPS). This aims to adapt and apply the systems-of-systems infrastructure assessment capabilities and analysis tools for the application of evidence-based decision making in other international contexts. This includes developing countries, regions undergoing post-conflict or post-disaster recovery, and rapidly developing city-states. The initial focus was a 'fast-track' assessment of the infrastructure needs of Palestine, and a second assessment is now being undertaken for Curacao.

ACHILLES (Assessment, Costing and Enhancement of Long-Life, Long-Linear Assets) (EPSRC Programme Grant, July 2018 to December 2022). *Contract Holder:* Prof J.M. Preston.

ACHILLES is led by Newcastle University and also includes universities at Bath, Durham, Leeds and Loughborough, as well as the British Geological Survey. TRG will be working closely with the Infrastructure Group at the University of Southampton. ACHILLES is focussed on long-linear assets that are critical to the delivery of services over long distances such as road and rail embankments and cuttings, pipeline bedding and flood protection structures. TRG's work will provide economic forecasting and decision support at the network level. More specifically, a model of Whole Life Costs of interventions will be developed and the social costs of service disruptions examined. Risks and uncertainty will be considered using Monte Carlo Simulation within a Bayesian hierarchical structure. A fast track analysis of road and rail infrastructure on the London – Bristol corridor is being undertaken.

Comparative Economic Assessment of Urban Transport Infrastructure Options in Developing Countries (PhD Studentship, from April 2017, funded by the Vietnamese Government and Faculty of Engineering and the Environment), Minh Tam Vu. *Supervisors:* Prof J.M. Preston, Dr S.P. Blainey.

Powered two wheelers (PTWs) are dominant in mixed traffic environments in developing countries and in particular in East Asia. Furthermore, their significance increases in urban areas, which poses a challenge to planning authorities and policy makers. A popular solution is to invest in urban public transport (PT) schemes such as Bus Rapid Transit (BRT), Urban Rail Transit (URT) and Monorail. However, many investments in PT have been ineffective. Additionally, there seems to be very little evidence on evaluation methods of motorcycles, cars and public transport to analyse feasibility of a new PT mode. Hence, the main aims of this thesis are to (i) Analyse the feasibility of new PT technologies in mixed traffic environments with a dominance of PTWs; and (ii) Identify the most cost-effective mixed transport system.

To achieve these aims, the research develops a comparative economic assessment for comparing public transport technologies and private transport for a local transport corridor. Comparisons among the existing conventional bus service, cars, motorcycles and a new innovative PT technology (such as BRT, URT or Monorail) are assessed using social cost

models, incremental multinomial logit models, incremental elasticity analysis and microscopic simulation models. These models can consider demand effects (such as trip generation and modal shift), congestion and environmental effects, as well as present these effects on the existing mixed traffic conditions.

Integrated Vulnerability Assessment of Transport Networks in Seoul Capital Area, South Korea. (funded by the Korean Government, PhD Studentship from September 2014) Wonman Oh. *Supervisors:* Prof J.M. Preston, Dr S.P. Blainey. Awarded 2018.

Transport networks can be unavailable suddenly due to diverse causes like natural disasters or intended attacks, even though transport networks are ubiquitous infrastructures in a modern society. Malfunctioning transport networks may produce considerable travel costs from the perspective of the whole society as well as an individual traveller. The primary purpose of this research was to assess the vulnerability of public transport networks with integrated analysis between railway systems and road networks in the Seoul Capital Area (SCA), Korea. Stated intentions concerning mode and route choice in the event of a disrupted Seoul Metropolitan Railway Systems (SMRS) were determined through an online survey. The impact of the disruptive event on the SMRS was identified using a TransCAD model that takes into account both the SMRS and the adjacent road networks. Based on in-depth interviews, this research also suggested management strategies to increase resilience of the transport networks in the SCA and to recommend a guideline to travellers in disrupted situations.

Future Funding for Highways (part-time PhD from January 2014) Katherine Tegerdine. *Supervisors*: Prof N.B. Hounsell, Dr S.P. Blainey.

The overall aim of this research is to devise and recommend one or more practical and acceptable methods for funding road transport in the UK, in the short/medium term future, given progress towards intelligent mobility and a low carbon transport system. More specific objectives to achieve this aim are to:

1. Evaluate road transport scenarios up to 2050, reflecting all important trends in traffic growth, vehicle composition and characteristics, infrastructure changes, technological developments, legislation, societal changes and so on;
2. Analyse and understand the cost and revenue implications of these road transport scenarios on Governments and road users;
3. Explore and develop new ways of funding transport infrastructure, including new ways of raising the revenue required to fund the scenarios presented, whilst identifying the impacts of this on all concerned;
4. Make recommendations to Governments on transport infrastructure funding requirements and revenue raising options and implications, on the basis of this research.

Objectives 1 and 2 have been completed, with research currently focussing on objective 3.

A Dynamic Analysis of the Economic Impacts of a Major Port on its City, South Korea (funded by the Korean Government, PhD studentship, from September 2015) Jongjoon Song.

Supervisors: Prof J.M Preston, Dr S.P. Blainey.

This research aims to get a better understanding of the dynamic changes over time in terms of the economic impacts of the port industry, especially major container ports in South Korea. To be specific, this study focuses on the changes in the economic impact of ports over time with particular reference to the regional economy. This research reviews the development history of four major ports in South Korea: Busan, Incheon, Gwangyang and Ulsan, focused on their spatial enlargement and functional progress. Based on an understanding of the development process, it analyses the changes of gross value-added (GVA) per worker in transportation from 1990 to 2015 from the regional accounts. This is done through applying shift-share analysis which has strengths in being able to understand the changes of a specific industry in a specific region compared to the sectoral changes in the national economy. This empirical analysis enables an understanding of how the economic performance in port-related industries has changed over time with respect to both the national economy and the regional economy. From the results, this research will suggest the major characteristics in terms of the economic contribution of port industry and supply several recommendations for port policy in South Korea.

Modelling Land Use and Transport Evolution in Port Cities (sponsored by the Education Endowment Fund, Republic of Indonesia, PhD studentship, from September 2016) Aditya Tafta Nugraha. *Supervisors:* Dr B.J. Waterson, Dr S.P. Blainey.

With the exception of modern specifically created ‘superports’, most of the world’s major ports are located close to the heart of urban areas (indeed the growth of the surrounding city is often a result of the port location). While such proximity to an urban area enables the plentiful supply of workers and accommodation facilities for travellers through the port, it also provides large challenges to enable ports to handle an increasing throughput of goods and travellers without overloading the already congested urban transport system. This research therefore seeks to review port-city situations around the world, to investigate issues such as constraints on port operations, impacts on urban traffic networks, best practices on port-city transport scheduling, operation, and coordination, as well as the consequences for the economic benefits of port-city prosperity. This project examines the dynamics between port and urban development through cellular-automata (CA) based land use and transport simulation model.

3.7 Human Factors

C:TTIME (BAE Systems from May 2018 to May 2019). L. Webster, S. Twist, D. Fay, K. Pope, C. Fenton, *Contract Holders*: Dr A. Roberts, Prof N.A. Stanton.

The armed forces are required to build Collective Training (CT) capability in a climate of increasing constraints on time, money and resources. This has fuelled a drive to identify and validate innovative training interventions that maximise collective performance. The Defence Human Capability Science and Technology Centre (DHCSTC) issued a statement of requirement to assess ways in which novel methods could be utilised to accelerate and enhance team performance. The Collective Teamwork Training Intervention Measurement and

Evaluation project (C:TTIME) was a program of work designed to address this requirement. To be achieved via identification of a wide range of interventions and measures of teamwork to inform rigorous experimental evaluation of their effectiveness. To date the C:TTIME team have completed a literature review of teamwork measures and intervention which has been accepted as the basis of a 'State of Science' publication with world leading co-authors in a high impact journal in the field of Human Factors. The team have also designed and developed a novel experimental protocol to assess the performance of augmented teams during submarine control room and domain agnostic operations. The work has been appraised by military stakeholders with clear avenues of exploitation having been identified depending on the success of the testing process.

Open Flight Deck (OFD) (Innovate UK from March 2017 – February 2020) Dr V.A. Banks, Dr K. Parnell. *Contract Holders:* Prof N.A. Stanton, Dr K.L. Plant.

Next generation civil aircraft require a step change in the capability of the flight deck to deliver new operational scenarios in a more transparent way. Flight deck technology will need to incorporate the latest developments in computing platform, Human-Machine Interface (HMI), crew aids and pilot interaction technologies. The aim of the Open Flight Deck project is to develop an open, accessible and standardised avionic platform for the flight deck which can support the introduction of such technologies, new software applications and peripheral devices. With the flight crew remaining central to aircraft operations, the project also seeks to develop new crew aids that can both optimise crew workload but also improve situational awareness to extend safe aircraft operations. Further it also seeks to integrate new and existing applications to add functionality, simplify the flight deck, reduce error potential and harness big data opportunities. Working with GE Aviation, BAE Systems, Rolls Royce and Coventry University, Human Factors expertise is provided in the design and evaluation of these future flight deck innovations.

TASCC (Towards Autonomy - Smart and Connected Control): Human Interaction: Designing Autonomy in Vehicles (HI:DAV) (Jaguar Land Rover (JLR)/ EPSRC, April 2016 to April 2020). Dr K.M.A. Revell, James Brown**.** *Contract Holder:* Prof N.A. Stanton

Cars that can drive themselves have been predicted for some time, but they are nearly with us. Highly automated vehicles are likely to be on public roads within the next ten years. The largest gap in our understanding of vehicle automation is how drivers will react to this new technology and how best to design the driver-automation interaction. This project will answer these questions by using Human Factors methodologies to model driver behaviour for level 3 semi-autonomous vehicles. It will study a wide range of drivers with different driving experience in simulators, on test-tracks and in road going vehicles.

During the course of the research the Universities of Cambridge and Southampton will be working closely with JLR engineers to ensure that the UK remains at the forefront of technological innovation in vehicle automation. Questions will be answered about how drivers will react to this new technology and how best to design the driver-automation interaction. The success of vehicle automation design will be reliant

on designing appropriate interactions and interfaces that support the driver. Our research will be essential to that success.

ComTET2 (BAE Systems from 2017-2020). D. Fay, K. Pope, C. Fenton, P. Moore. *Contract Holders:* Prof N. A. Stanton, Dr A. Roberts.

Due to the success of ComTET1, funding for a further three year program of work was attained. The team will continue to provide evidence based recommendations from well-controlled experimental studies to demonstrate the benefits and pitfalls of new team structures, allocation of system functions, ways of working, communication media, interfaces, job aids and work design. The ComTET2 team will also undertake new avenues of work including investigation of optimal deployment, operation and utilisation of data derived from unmanned underwater vehicles by command teams.

Applying a Sociotechnical Systems Approach to Improve Cycling Road Safety and Increase Cycling Participation (funded by Southampton University, from October 2018), Matthew Webster. *Supervisors:* Dr K.L. Plant, Prof N.A. Stanton.

Cycling provides many benefits, such as increased physical health, a positive contribution to the economy and reduction in air pollution. Despite this, cycling still is involved in a constant battle to be seen as a positive activity amongst the media and non-cyclists and cyclists too. On top of this, a huge gender divide with the majority of cyclists being male creates a struggle to ensure that infrastructure is inclusive towards women. Furthermore, the low participation levels of younger children riding a bike to and from school within the UK is considerably small when compared to the Netherlands (2.5% vs 30%). Finally, the number of cycling accidents throughout Britain is worryingly high being around 18,477 in 2016, this number made up around 8% of all modal accidents within the UK which, when comparing the number of cyclists against vehicles, highlights a need for change.

This research begins to tackle cycling by treating it as a system and taking a sociotechnical approach, by researching into social (News, Social media, Neighbourhoods, Peoples views), technical (legislation, economic, accessibility), hardware (Signs, potholes, roads, cycle lanes, theft/safety) and organisational (Government, Council, Schools, Emergency Services) features of cycling to create a safer cycling Britain and increase participation across all levels of cycling, ages, and gender.

In time this research hopes to join forces with other organisations such as British cycling, local governments and high-profile company's and public figures involved within cycling to allow a stronger reach and implementation of interventions to be tested and improved to allow them to be as effective as possible and provide a strong set of recommendations that can ultimately be used and applied within the UK.

Ready to Take Back Control – Assessing the Optimal Way to Monitor Driver States Using a Variety of Cognitive and Psycho-physiological Methods (funded by Jaguar Land Rover, PhD studentship from October 2017) Sylwia Kaduk. *Supervisors:* Prof N.A. Stanton, Dr A. Roberts.

A new generation of half-automated vehicles will allow automated driving in some circumstances, for example on certain highways. New technologies could

increase safety and the efficiency of transport, but might also create some challenges. One of the challenges is the moment of transition from automated to manual driving. Some physical and mental states of the driver at this moment might highly jeopardise safety. This research is part of the HI:DAV project that explores human factors in transition from automated to human driving in automated vehicles. It is investigating the possibility of using various psychophysiological measures to detect drivers' states that could be potentially dangerous for safety of take-over and further driving. Issues identified from the literature include sleep, sleep inertia, drowsiness, sleepiness, fatigue, mental workload, inattention, lack of situation awareness, stress, anger, motion sickness, bad health state and behavioural distractions. The most reliable methods of detecting these states will be established. Example of measures that might be used are electroencephalography (EEG), electrocardiography (ECG) and acoustic voice analysis.

Handover Interactions and Interfaces in Autonomous Vehicle Design: How can Handover Assistants be Usable, Sufficiently Raise Situation Awareness, and Appropriately Calibrate User-trust? (funded by Jaguar Land Rover as part of the TASCC: Hi:DAV project, PhD studentship, from January 2017) Jediah Clark. *Supervisors:* Prof N.A. Stanton, Dr K.M.A. Revell.

In automated vehicles that require a human driver to be present, the transition of control (whether planned or unplanned) marks a profound vulnerability in the driving-system. As drivers remain 'out-of-the-loop' for an extended period, issues such as loss of 'situation awareness' may occur. Handover assistants have been proposed as a solution to such issues. However, how and what to present to the driver during these transitions remains unclear, and issues such as safety, usability and user-trust must be considered. This project attempts to address these issues through iteratively generating design concepts and testing them experimentally. By doing so, it is hoped that well-considered and refined designs can be provided as a result of this research."

Optimising Steering Wheel Based Controls in Motorsport (PhD (part-time) from October 2017). James W H Brown. *Supervisors:* Prof N.A. Stanton, Dr K.M.A. Revell.

The interfaces of cars within the higher echelons of motorsport are highly complex as a result of the need to be able to maximise performance. However, there are multiple known instances of driver errors occurring, costing them time and, in some cases, loss of control of the vehicle, due to interface design issues. Motorsport is both high-risk and high-cost and drivers are frequently exposed to high cognitive and physical workloads. This combination of factors represents a significant challenge in terms of interface design. Identifying and prioritising the primary usability aspects relevant to racing drivers aids the definition of the unique problem domain. The subsequent application of Human Factors methods to the specific area of steering wheel based controls aims to optimise control locations, attributes and layouts. This project hopes to generate a hybridised methodology for the creation of idealised interface designs within motorsport. The production of prototype steering wheels based on the methodology's outputs allows experimental testing and validation. The project output should additionally provide insight into the

generic design of complex interfaces in high risk/high cognitive load scenarios.

A Sociotechnical Systems Approach to Driver Distraction (sponsored by EPSRC and Jaguar Land Rover, EngD studentship from October 2013). Katie J. Parnell. *Supervisors:* Prof N.A. Stanton, Dr K.L. Plant, R. Whitford (Jaguar Land Rover). Awarded 2018.

The impact of driver distraction on road safety has been a focus of Human Factors research for over half a century. Over this time, developments in technology have served to increase the impact of driver distraction. Mobile phones have attracted much attention within the field, however other technological tasks that are brought into the vehicle by the driver, as well as those that are built in to the vehicle by manufacturers, also negatively affect the driver's safe monitoring of the road environment. Traditional methods employed to manage the issue have been critiqued for being too focused on the individual. It is argued that the focus should be on the role of the wider sociotechnical system within which the behaviour occurs. This project sought to explore the issue of driver distraction from technological devices by taking a sociotechnical systems approach.

Latent Error Detection & Recovery in UK Naval Aircraft Maintenance (funded by the Royal Navy, PhD from October 2013). Commander Justin Saward. *Supervisors:* Prof N.A. Stanton, Prof J.M. Preston. Awarded 2018

System-induced human error is the most significant factor in aircraft accidents, for which errors are both inevitable and a frequent occurrence. Human error is a by-product of performance variability caused by system failures, for which undetected error becomes a latent error that can impact system safety and therefore contribute to a future undesired outcome. The phenomenon of Individual Latent Error Detection (I-LED) was proposed. I-LED refers to the detection of workplace latent errors at some point post-task completion through the recollection of past activity by the individual who suffered the error. An extensive literature review showed the phenomenon to be a novel concept, indicating a clear gap in knowledge requiring research to explore the nature and extent of I-LED events. A multi-process theory was developed and combined with the system's perspective to provide a theoretical framework upon which to conduct real-world observations of I-LED events in cohorts of naval air engineers. Collected data indicated time, location and other system cues triggered I-LED events, for which the deliberate review of past activity within a time window of two hours of the error occurring and whilst remaining in the same sociotechnical environment to that which the error occurred appeared most effective. Several practicable interventions were designed and tested, from which the overall benefit of integrating the I-LED phenomenon as an additional safety control within an organisation's safety system was assessed. This research was completed in September 2017 and shown to contribute to knowledge on workplace safety by applying systems thinking to understand the nature and extent of I-LED and its benefit to safety resilience in naval aircraft maintenance. I-LED research arguably offers a step-change in safety thinking by offering a level of resilience within the workplace that has not previously been accounted for in organisational safety strategies.

Application of the Perceptual Cycle Model and Schema Theory to

Automobile Driving Behaviour (PhD studentship from June 2017) Jamal Kinsella. *Supervisors* Dr K.L. Plant, Prof N.A. Stanton.

Specific automobile driving behaviours, such as speeding behaviours and non-compliance with road signs, are believed to contribute to driving collisions, one of the leading causes of death worldwide. According to Neisser's Perceptual Cycle Model, human decision-making is influenced by our schema (anticipations developed through experience and activated in specific contexts) which, in the case of driving, will be informed by training and personal experiences with roads, cars and driving in general. Through applying this model researchers have found an explanation for the differences in specific driving behaviours found in different demographic groups of drivers. The aim of this project is to apply verbal protocol methods to elicit and infer schema to investigate differences in driving behaviour across different demographic groups, with implications for improving the training and systems designed to encourage safe driving behaviour.

Alternative Safety Management Techniques for Air Traffic Management (funded by NATS, PhD from September 2017). Craig Foster. *Supervisors:* Dr K.L. Plant, Prof N.A. Stanton.

Air Traffic Management (ATM) exists to support the safe and expeditious flow of aircraft through the world's airspace. However, safety in ATM presents unique challenges due to it being a complex and highly coupled socio-technical system of systems. Despite this, ATM has achieved an ultra-safe level of performance. However, ATM is undergoing unprecedented change and a number of new challenges face the industry. New regulations and regulators, new technologies, changing roles for the human, the desire to reduce the environmental impact of air travel and a demand for further cost efficiencies and commercialisation could all affect the ATM industry's commitment to safety. Against this backdrop, ATM needs to ensure that how safety is understood and managed remains appropriate and safety data continues to deliver information about how safe the operation is and provide an alert to changing risks to inform action. This PhD examines the challenges that arise from the way safety is currently thought about in ATM and considers recent advances in safety science as providing an alternative approach which focusses on successfully harnessing the adaptations present within complex socio-technical systems. A review of the safety literature identifies a need to further elaborate how organisations are to practically apply these emerging ideas within the context of an industry which is characterised by standardisation, procedures and regulation.

Whilst the introduction of new technology presents challenges to safety it also presents an opportunity to marry this alternative safety management approach with the use of data generated from the delivery of the ATM service to better understand the adaptations that produce safety. The PhD is expected to explore and contribute to research in this area and bridge the gap between grounded safety theory for complex socio-technical systems and novel techniques for understanding data generated by humans adapting whilst doing work in safety-related domains.

CORSIA - A Carbon Offsetting And Reduction Scheme For International Aviation (PhD from September 2017) Liu

Tianyi. *Supervisors*: Dr S.P. Blainey, Dr K.L. Plant.

CORSIA is a global market based measure scheme developed by the International Civil Aviation Organisation (ICAO) to address the annual increase in total CO_2 emissions from international civil aviation. Overall, CORSIA aims to achieve the aspirational goal of being carbon natural growth from 2020. According to ICAO's assembly resolution A39-3, CORSIA is structured into three different phases, namely the "pilot phase" (2021-2023), "first phase" (2024-2026) and "second phase" (2027-2035).

The primary objective of this research is to evaluate how CORSIA will impact the major UK/Chinese airlines from 2021. In addition, this research will also explore the potential cost-control strategies in the post-implementation phases that can be leveraged to gain competitive advantage by major international airlines.

Maritime Command and Control Human-Machine Interaction (sponsored by DSTL and BAE Systems, PhD (part-time) from 2014). Daniel Fay. *Supervisors:* Prof. N.A. Stanton, Dr A. Roberts.

Future maritime control rooms will be tasked with handling increased data with potentially less crew. User interfaces have evolved to meet current requirements, but this iterative process has propagated legacy design paradigms that may be unsuitable for future requirements. A new design paradigm for user interfaces may be required to maintain effective performance. Ecological Interface Design (EID) is being explored as a theory based approach to design new interfaces. Novel user interfaces will be designed and tested to assess their applicability for future maritime command and control.

Dynamic Risk Assessment: A Systematic Review (Funded by the Royal Navy, PhD from January 2018) Mark Sanderson. Supervisors: Prof N.A. Stanton, Dr K.L. Plant

Dynamic Risk Assessment (DRA) is synonymous with decision making under changing conditions in order to maintain a safe working environment. It is a concept typically used in industries such as aviation, oil and gas exploration, health care and the emergency services. More recent work has broadened into outdoor adventure activities and military leadership. However, it is argued that DRA has far wider utility and should be considered a key aspect of any safety management system.

Commencing with a systematic review, the initial aim of this study is to determine the key factors of DRA in a safety context. Although in its infancy, the study already finds there to be several recurring themes including Situational Awareness (SA), resource constraints, complexity, loss of control, uncertainty and environmental influences.

Once complete, the data will be used to develop a network model and illustrate the contribution of each element by weighting them based on their frequency of occurrence. This will be achieved for individual factors as well as the inter-connections to present DRA in an entirely new way. This should enhance contemporary understanding and improve safety performance where work is conducted at the sharp end.

Subsequent research will use a case study of a recent military accident to validate this model. Beyond this the work

may bridge into established fields such as Distributed Situational Awareness (DSA), Naturalistic Decision Making (NDM), error and violation, risk perception, risk assessment and safety management.

4. TRANSPORTATION RESEARCH GROUP PUBLICATIONS

2018

1. Adshead, D, Fuldauer, L, Thacker, S, Hickford, A, Rouhet, G, Muller, WS, Hall, J & Nicholls, R 2018, *Evidence-Based Infrastructure: Curacao.: National infrastructure systems modelling to support sustainable and resilient infrastructure development*. United Nations Office for Project Services, Copenhagen, Denmark.
2. Alkhalisi, F & Waterson, B 2018, 'Digital media: A pathway technology in the electromobility transition?' Paper presented at 50th Annual Conference of the Universities' Transport Study Group, London, United Kingdom, 3/01/18 - 5/01/18
3. Allen, J, Piecyk, M, Piotrowska, M, Mcleod, F, Cherrett, T, Nguyen, T, Bektas, T, Bates, O, Friday, A, Wise, S & Austwick, M 2018, 'Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: the case of London' *Transportation Research Part D: Transport and Environment*. DOI: 10.1016/j.trd.2017.07.020
4. Allen, J, Bektas, T, Cherrett, T, Bates, O, Friday, A, Mcleod, F, Piecyk, M, Piotrowska, M, Nguyen, T & Wise, S 2018, 'The scope for pavement porters: addressing the challenges of last-mile parcel delivery in London' *Transportation Research Record: Journal of the Transportation Research Board*, pp. 1-13. DOI: 10.1177/0361198118794535
5. Allison, C, Parnell, K, Brown, J & Stanton, N 2018, Modeling the real world using STISIM drive® simulation software: a study contrasting high and low locality simulations. in *Advances in Intelligent Systems and Computing: Advances in Human Aspects of Transportation. AHFE 2017.* vol. 597, Advances in Intelligent Systems and Computing, vol. 597, pp. 906-915. DOI: 10.1007/978-3-319-60441-1_87
6. Allison, C, Stanton, N, Fleming, J, Yan, X, Goudarzi, F & Lot, R 2018, 'Inception, ideation and implementation: developing interfaces to improve drivers' fuel efficiency' Paper presented at Charted Institute of Ergonomics & Human Factors Ergonomics and Human Factors, Birmingham, United Kingdom, 23/04/18 - 25/04/18, pp. 1-8.
7. Allison, C & Stanton, N 2018, 'Eco-driving: A review of the behavioural approach to personal emission reduction' *Theoretical Issues in Ergonomics Science*.
8. Allison, CK & Stanton, NA, Using cognitive work analysis to inform policy recommendations to support fuel-efficient driving. in *Advances in Human Aspects of Transportation - Proceedings of the AHFE 2018 International Conference on Human Factors in Transportation, 2018.* vol. 786, Advances in Intelligent Systems and Computing, vol. 786, Springer-Verlag, pp. 376-385, AHFE International Conference on Human Factors in Transportation, 2018, [state] FL, United States, 21-25 July. DOI: 10.1007/978-3-319-93885-1_34
9. Almujibah, HR & Preston, J 2018, 'The total social costs of constructing and operating a maglev line using a case study of the riyadh-dammam corridor, Saudi Arabia' *Transportation Systems and Technology*, vol 4, no. 3, Suppl. 1, pp. 298-327. DOI: 10.17816/transsyst201843s1298-327
10. Alvarez Borges, FJ, Clayton, CRI, Richards, DJ & Madhusudhan, BN 2018, The effect of the remoulded void ratio on unit shaft friction in small-displacement piles in chalk. in J Lawrence, M Preene, U Lawrence & R Buckley (eds), *Engineering in Chalk: Proceedings of the Chalk 2018 Conference.* Institution of Civil Engineers, London, UK, pp. 475-480. DOI: 10.1680/eiccf.64072.475
11. Arend, MG, Franke, T & Stanton, NA, 'Know-how or know-why? The role of hybrid electric vehicle drivers' acquisition of eco-driving knowledge for eco-driving success' *Applied Ergonomics*, vol 75, pp. 221-229. DOI: 10.1016/j.apergo.2018.10.009
12. Banks, VA, Eriksson, A, O'Donoghue, J & Stanton, NA 2018, 'Is partially automated driving a bad idea? Observations from an on-road study' *Applied Ergonomics*, vol 68, pp. 138-145. DOI: 10.1016/j.apergo.2017.11.010
13. Banks, VA, Stanton, NA, Burnett, G & Hermawati, S 2018, 'Distributed Cognition on the road: Using EAST to explore future road transportation systems' *Applied Ergonomics*, vol 68, pp. 258-266. DOI: 10.1016/j.apergo.2017.11.013
14. Bates, O, Friday, A, Allen, J, Cherrett, T, McLeod, F, Bektas, T, Nguyen, T, Piecyk, M, Piotrowska, M, Wise, S & Davies, N 2018, Transforming last-mile logistics: Opportunities for more sustainable deliveries. in *CHI 2018 - Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems: Engage with CHI.* vol. 2018-April, Association for Computing Machinery, 2018 CHI Conference on Human Factors in Computing Systems, CHI 2018, Montreal, Canada, 21-26 April. DOI: 10.1145/3173574.3174100
15. Bates, O, Friday, A, Allen, J, Mcleod, F, Cherrett, T, Wise, S, Piecyk, M, Piotrowska, M, Bektas, T & Nguyen, T 2018, ICT for sustainable last-mile logistics: data, people and parcels. in B Penzenstadler, S Easterbrook, C Venters & SI Ahmed (eds), *ICT4S2018: 5th International Conference on Information and Communication Technology for Sustainability.* vol. 52, EPiC Series in Computing, vol. 52, Easy Chair, pp. 49-67. DOI: 10.29007/67nl

16. Beanland, V, Grant, E, Read, GJM, Stevens, N, Thomas, M, Lenné, MG, Stanton, NA & Salmon, PM 2018, 'Challenging conventional rural rail level crossing design: Evaluating three new systems thinking-based designs in a driving simulator' *Safety Science*. DOI: 10.1016/j.ssci.2018.03.002 Blainey, S 2018, Passenger rail structure and reform. in J Cowie & S Ison (eds), *Handbook of Transport Economics.* Routeledge, Abingdon, pp. 17-30.
17. Blainey, S 2018, Passenger rail structure and reform. in J Cowie & S Ison (eds), *Handbook of Transport Economics.* Routeledge, Abingdon, pp. 17-30.
18. Blainey, S & Preston, J 2018, 'Predict or prophesy? Issues and trade-offs in modelling long-term transport infrastructure demand and capacity' *Transport Policy*. DOI: 10.1016/j.tranpol.2018.12.001
19. Brown, J, Stanton, N & Revell, K 2018, 'The usability of F1 interfaces' Paper presented at CIEHR (Chartered Institute of Ergonomics and Human Factors) Conference, 21/04/18 - 23/04/18
20. Buitrago, M & Preston, J 2018, Forecasting the throughput of the United Kingdom container ports system up to 2050. in *Forecasting the throughput of the United Kingdom container ports system up to 2050.*
21. Buitrago, M & Preston, J 2018, 'Long-term forecast of the United Kingdom container ports throughput'.
22. Buitrago, M & Preston, J 2018, 'Long-term demand forecast of the United Kingdom lo-lo container traffic' *Case Studies on Transport Policy*.
23. Christoforou, Z, Chandakas, E & Kaparias, I 2018, 'Short-term prediction of on-board passenger volumes in public transport vehicles based on non-exhaustive Automatic Passenger Counting data' Paper presented at 7th Symposium of the European Association for Research in Transportation, Athens, Greece, 5/09/18 - 7/09/18,
24. Brown, J, Stanton, N & Revell, K, A review of the physical, psychological and psychophysiological effects of motorsport on drivers and their potential influences on cockpit interface design. in N Stanton (ed.), *Advances in Human Aspects of Transportation: AHFE 2018.* Advances in Intelligent Systems and Computing, vol. 786, Springer, Cham, pp. 514-522, Applied Human Factors and Ergonomics Conference 2018, Orlando, United States, 21-25 July.
25. Clark, JR, Stanton, NA & Revell, KMA 2018, 'Conditionally and highly automated vehicle handover: a study exploring vocal communication between two drivers' *Transportation Research Part F: Traffic Psychology and Behaviour*, pp. 1-17. DOI: 10.1016/j.trf.2018.06.008
26. Clark, J, Stanton, N & Revell, K, Handover assist in highly automated vehicles: how vocal communication guides visual attention. in *Advances in Human Aspects of Transportation - Proceedings of the AHFE 2018 International Conference on Human Factors in Transportation, 2018.* vol. 786, Advances in Intelligent Systems and Computing, vol. 786, Springer-Verlag, pp. 295-306, AHFE International Conference on Human Factors in Transportation, 2018, [state] FL, United States, 21-25 July. DOI: 10.1007/978-3-319-93885-1_27
27. Coutts, LV, Plant, KL, Smith, M, Bolton, L, Parnell, KJ, Arnold, J & Stanton, NA 2018, 'Future technology on the flight deck: assessing the use of touchscreens in vibration environments' *Ergonomics*, pp. 1-29. DOI: 10.1080/00140139.2018.1552013
28. Evans, JRA, Waterson, B & Hamilton, A 2018, 'Roadcast: an algorithm to forecast this year's road traffic' Paper presented at Transportation Research Board 97th Annual Meeting, Washington, United States, 7/01/18 - 11/01/18, .
29. Faiella, G, Parand, A, Franklin, BD, Chana, P, Cesarelli, M, Stanton, NA & Sevdalis, N 2018, 'Expanding healthcare failure mode and effect analysis: A composite proactive risk analysis approach' *Reliability Engineering and System Safety*, vol 169, pp. 117-126. DOI: 10.1016/j.ress.2017.08.003
30. Fay, D, Stanton, N & Roberts, APJ, Exploring ecological interface design for future ROV capabilities in maritime command and control. in N Stanton (ed.), *Advances in Human Aspects of Transportation: AHFE 2018.* vol. 786, Chapter 24, Advances in Intelligent Systems and Computing, vol. 786, Springer, Cham, pp. 264-273. DOI: 10.1007/978-3-319-93885-1_24
31. Goudarzi, F, Asgari, H & Al-Raweshidy, HS 2018, 'Traffic-aware VANET routing for city environments-A protocol based on ant colony optimization' *IEEE Systems Journal*. DOI: 10.1109/JSYST.2018.2806996
32. Goudarzi, F & Asgari, H 2018, 'Non-cooperative beacon power control for VANETs' *IEEE Transactions on Intelligent Transportation Systems*, pp. 1-6. DOI: 10.1109/TITS.2018.2813258
33. Grote, M, Williams, I, Preston, J & Kemp, S 2018, 'A practical model for predicting road traffic carbon dioxide emissions using inductive loop detector data' *Transportation Research Part D: Transport and Environment*, vol 63, pp. 809-825. DOI: 10.1016/j.trd.2018.06.026
34. Heikoop, DD, de Winter, JCF, van Arem, B & Stanton, NA 2018, 'Effects of mental demands on situation awareness during platooning: A driving simulator study' *Transportation Research Part F: Traffic Psychology and Behaviour*, vol 58, pp. 193-209. DOI: 10.1016/j.trf.2018.04.015

35. Heydari, S, Fu, L, Thakali, L & Joseph, L 2018, 'Benchmarking regions using a heteroskedastic grouped random parameters model with heterogeneity in mean and variance: applications to grade crossing safety analysis' *Analytic Methods in Accident Research*, vol 19, pp. 33-48. DOI: 10.1016/j.amar.2018.06.003
36. Heydari, S 2018, 'A flexible discrete density random parameters model for count data: embracing unobserved heterogeneity in highway safety analysis' *Analytic Methods in Accident Research*, vol 20, pp. 68-80. DOI: 10.1016/j.amar.2018.10.001
37. Heydari, S, Goel, R, da Cruz Gouveia, N, Woodcock, T, Tainio, M & de Nazelle, A 2018, 'A worldwide study of traffic contribution to particulate matter in urban areas using a Bayesian meta-regression approach' Urban Transitions 2018, Barcelona, 25/11/18 - 27/11/18, .
38. Heydari, S, Northover, G, Orjuela, JP & de Nazelle, A 2018, 'A global quantitative synthesis of air pollution exposure in different modes of transport' Urban Transitions 2018, Barcelona, 25/11/18 - 27/11/18, .
39. Hickford, A, Blainey, S, Ortega Hortelano, A & Plant, R 2018, 'Resilience engineering: theory and practice in interdependent infrastructure systems' *Environment Systems and Decisions*, vol 38, no. 3, pp. 278-291. DOI: 10.1007/s10669-018-9707-4
40. Hulme, A, Thompson, J, Plant, KL, Read, GJM, McLean, S, Clacy, A & Salmon, PM 2018, 'Applying systems ergonomics methods in sport: A systematic review' *Applied Ergonomics*. DOI: 10.1016/j.apergo.2018.03.019
41. Hutchinson, L, Waterson, B, Anvari, B & Naberezhnykh, D 2018, 'Potential of wireless power transfer for dynamic charging of electric vehicles' *IET Intelligent Transport Systems*, pp. 1-14. DOI: 10.1049/iet-its.2018.5221
42. Jiang, R, Proprentner, D, Callisti, M, Shollock, B, Hu, XT, Song, YD & Reed, PAS 2018, 'Role of oxygen in enhanced fatigue cracking in a PM Ni-based superalloy: stress assisted grain boundary oxidation or dynamic embrittlment?' *Corrosion Science*, vol 139, pp. 141-154. DOI: 10.1016/j.corsci.2018.05.001
43. Kaparias, I, Gao, Y & Miah, S 2018, 'A study on the effects of highway and traffic characteristics on cyclist behaviour using an instrumented bicycle' Paper presented at 7th Symposium of the European Association for Research in Transportation, Athens, Greece, 5/09/18 - 7/09/18
44. Lovric, M, Blainey, S & Preston, J 2018, 'A conceptual design for a national transport model with cross-sectoral interdependencies' *Transportation Research Procedia*, vol 27, pp. 720-727. DOI: 10.1016/j.trpro.2017.12.150
45. Mamouei, MH, Kaparias, I & Galatioto, F 2018, 'Validation of a system-level fuel economy based control method for autonomous vehicles' Paper presented at 50th Annual Conference of the Universities' Transport Study Group, London, United Kingdom, 3/01/18 - 5/01/18, .
46. Mamouei, MH, Kaparias, I & Halikias, G 2018, 'A framework for user- and system-oriented optimisation of fuel efficiency and traffic flow in Adaptive Cruise Control' *Transportation Research Part C: Emerging Technologies*, vol 92, pp. 27-41. DOI: 10.1016/j.trc.2018.02.002
47. McIlroy, RC, Plant, KL & Stanton, NA, Revealing the complexity of road transport with accimaps. in *Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) - Volume VI: Transport Ergonomics and Human Factors TEHF, Aerospace Human Factors and Ergonomics.* vol. 823, Advances in Intelligent Systems and Computing, vol. 823, Springer Verlag, pp. 80-89, 20th Congress of the International Ergonomics Association, IEA 2018, Florence, Italy, 26-30 August. DOI: 10.1007/978-3-319-96074-6_9
48. McIlroy, RC, Plant, K, Hoque, MS, Wu, J, Kokwaro, GO, Vu, NH & Stanton, N, 'Who is responsible for global road safety? A cross-cultural comparison of Actor Maps' *Accident Analysis and Prevention*, vol 122, pp. 8-18. DOI: 10.1016/j.aap.2018.09.011
49. Merkert, R, Preston, J, Melkersson, M & Link, H 2018, 'Competitive tendering and other forms of contracting-out: institutional design and performance measurement, Workshop 2 report' *Research in Transportation Economics*. DOI: 10.1016/j.retrec.2018.08.002
50. Miah, S, Milonidis, E, Kaparias, I & Karcanias, N 2018, 'A novel fusion algorithm to improve localisation accuracy of an instrumented bicycle' Paper presented at 97th Annual Meeting of the Transportation Research Board, Washington, United States, 7/01/18 - 11/01/18, .
51. Nguyen, T, Bektas, T, Cherrett, T, Mcleod, F, Allen, J, Bates, O, Piotrowska, M, Piecyk, M, Friday, A & Wise, S 2018, 'Optimising parcel deliveries in London using dual-mode routing' *Journal of the Operational Research Society*, pp. 1-13. DOI: 10.1080/01605682.2018.1480906
52. Nilles, M & Kaparias, I 2018, 'Investigating the relation of highway design standards with network-level walkability: the case study of Luxembourg' *International Journal of Transportation Science and Technology*, vol 7, no. 4, pp. 254-263. DOI: 10.1016/j.ijtst.2018.08.001
53. Nugraha, AT, Waterson, B & Blainey, S 2018, 'A modelling framework of land-use and transport interaction to assess co-evolution of port and urban development' Paper presented at 50th Annual Conference of the Universities' Transport Study Group, London, United Kingdom, 3/01/18 - 5/01/18.
54. Ortega, A, Vassallo, JM & Perez-Diaz, J 2018, 'Optimal welfare price for a highway competing with an untolled alternative: the influence of income distribution' *Journal of Infrastructure Systems*. DOI: 10.1061/(ASCE)IS.1943-555X.0000412
55. Ortega Hortelano, A, Blainey, S & Preston, J 2018, 'Installation of under sleeper pads on ballasted railway track: An economic analysis of their potential implementation' *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit*, vol 232, no. 6, pp. 1800-1813. DOI: 10.1177/0954409717748811

56. Ortega Hortelano, A, Blainey, S & Preston, J 2018, 'Assessing whole-life carbon footprint of under sleeper pad installation for ballasted track' *Journal of Transportation Engineering Part A: Systems*, vol 144, no. 12, 04018073, pp. 1-11. DOI: 10.1061/JTEPBS.0000192
57. Ortega Hortelano, A, Almujibah, HR & Preston, J 2018, High speed railway in Saudi Arabia: lessons to be learnt from the Spanish experience. in *International congress on High-speed Rail: Technologies and Long Term Impacts.* pp. 511-529.
58. Parnell, K, Stanton, N & Plant, K 2018, 'Creating the environment for driver distraction: a thematic framework of sociotechnical factors' *Applied Ergonomics*, vol 68, pp. 213-228. DOI: 10.1016/j.apergo.2017.11.014
59. Parnell, KJ, Stanton, NA & Plant, KL 2018, 'What technologies do people engage with while driving and why?' *Accident Analysis and Prevention*, vol 111, pp. 222-237. DOI: 10.1016/j.aap.2017.12.004
60. Parnell, KJ, Stanton, NA & Plant, KL 2018, 'Good intentions: drivers' decisions to engage with technology on the road and in a driving simulator' *Cognition, Technology and Work*, pp. 1-23. DOI: 10.1007/s10111-018-0504-0
61. Politis, I, Langdon, P, Adebayo, D, Bradley, M, Clarkson, PJ, Skrypchuk, L, Mouzakitis, A, Eriksson, A, Brown, JWH, Revell, K & Stanton, N 2018, An evaluation of inclusive dialogue-based interfaces for the takeover of control in autonomous cars. in *IUI 2018 - Proceedings of the 23rd International Conference on Intelligent User Interfaces.* vol. Part F135193, Association for Computing Machinery, pp. 601-606, 23rd ACM International Conference on Intelligent User Interfaces, IUI 2018, Tokyo, Japan, 7-11 March. DOI: 10.1145/3172944.3172990
62. Pope, K, Roberts, A & Stanton, N, Investigating temporal implications of information transition in submarine command teams. in N Stanton (ed.), *Advances in Human Aspects of Transportation - Proceedings of the AHFE 2018 International Conference on Human Factors in Transportation, 2018.* vol. 786, Advances in Intelligent Systems and Computing, vol. 786, Springer-Verlag, pp. 243-253, AHFE International Conference on Human Factors in Transportation, 2018, [state] FL, United States, 21-25 July. DOI: 10.1007/978-3-319-93885-1_22
63. Preston, J 2018, The impact of reform on public transport markets. in J Cowie & S Ison (eds), *The Routledge Handbook of Transport Economics.* Routledge.
64. Preston, J 2018, 'The wheels keep on turning: is the end of rail franchising in Britain in sight?' *Research in Transportation Economics*. DOI: 10.1016/j.retrec.2018.04.005
65. Pritchard, J 2018, Providing improved crowding information to provide benefits for rail passengers and operators. in NA Stanton (ed.), *AHFE 2017. Advances in Intelligent Systems and Computing.* vol. 597, Advances in Intelligent Systems and Computing, vol. 597, Springer Verlag, pp. 973-984. DOI: 10.1007/978-3-319-60441-1_93
66. Pritchard, JA & Preston, J 2018, 'Understanding the contribution of tunnels to the overall energy consumption of and carbon emissions from a railway' *Transportation Research Part D: Transport and Environment*, vol 65, pp. 551-563. DOI: 10.1016/j.trd.2018.09.010
67. Qi, G, Wu, J, Zhou, Y, Du, Y, Jia, Y, Hounsell, N & Stanton, NA 2018, 'Recognizing driving styles based on topic models' *Transportation Research Part D: Transport and Environment*. DOI: 10.1016/j.trd.2018.05.002
68. Rafter, CB, Anvari, B & Box, S 2018, A hybrid traffic responsive intersection control algorithm using global positioning system and inductive loop data: (paper no 18-02779). in *Proceedings of the Transportation Research Board 97th Annual Meeting.* Transportation Research Board 97th Annual Meeting, Washington, United States, 7-11 January.
69. Read, GJM, Stevens, EL, Lenné, MG, Stanton, NA, Walker, GH & Salmon, PM 2018, 'Walking the talk: Comparing pedestrian 'activity as imagined' with 'activity as done'' *Accident Analysis and Prevention*, vol 113, pp. 74-84. DOI: 10.1016/j.aap.2018.01.016
70. Revell, K, Langdon, P, Bradley, M, Politis, I, Brown, J & Stanton, N 2018, User centered ecological interface design (UCEID): a novel method applied to the problem of safe and user-friendly interaction between drivers and autonomous vehicles. in *Intelligent Human Systems Integration - Proceedings of the 1st International Conference on Intelligent Human Systems Integration IHSI 2018: Integrating People and Intelligent Systems.* vol. 722, Advances in Intelligent Systems and Computing, vol. 722, Springer-Verlag, pp. 495-501, 1st International Conference on Intelligent Human Systems Integration: Integrating People and Intelligent Systems, IHSI 2018, Dubai, United Arab Emirates, 7-9 January. DOI: 10.1007/978-3-319-73888-8_77
71. Revell, KMA, Allison, C, Sears, R & Stanton, NA 2018, 'Modelling distributed crewing in commercial aircraft with STAMP for a rapid decompression hazard' *Ergonomics*. DOI: 10.1080/00140139.2018.1514467
72. Rincon Garcia, N, Waterson, B, Cherrett, T & Salazar-Arrieta, F 2018, 'A metaheuristic for the time-dependent vehicle routing problem considering driving hours regulations – an application in city logistics' *Transportation Research Part A: Policy and Practice*. DOI: 10.1016/j.tra.2018.10.033

73. Rincon-Garcia, N, Waterson, BJ & Cherrett, TJ 2018, 'Requirements from vehicle routing software: perspectives from literature, developers and the freight industry' *Transport Reviews*, vol 38, no. 1, pp. 117-138. DOI: 10.1080/01441647.2017.1297869
74. Roberts, APJ, Stanton, NA & Fay, DT 2018, 'Go deeper, go deeper: understanding submarine command and control during the completion of dived tracking operations' *Applied Ergonomics*, vol 69, pp. 162-175. DOI: 10.1016/j.apergo.2018.02.003
75. Roberts, A & Cole, J 2018, 'Naturalistic decision making: taking a (cognitive) step back to take two steps forward in understanding experience based decisions' *Journal of Applied Research in Memory and Cognition*.
76. Roberts, APJ & Stanton, NA 2018, 'Macrocognition in submarine command and control: a comparison of three simulated operational scenarios' *Journal of Applied Research in Memory and Cognition*, pp. 1-14. DOI: 10.1016/j.jarmac.2018.01.006
77. Salmon, P, Read, G, Lenné, MG, Mulvihill, C, Stevens, N, Walker, G, Young, K & Stanton, N 2018, Cognitive work analysis for systems analysis and redesign: Rail level crossings case study. in NA Stanton, PM Salmon, GH Walker & DP Jenkins (eds), *Cognitive Work Analysis : Applications, Extensions and Future Directions.* CRC Press, pp. 271-284.
78. Salmon, PM, Read, GJM, Walker, GH, Goode, N, Grant, E, Dallat, C, Carden, T, Naweed, A & Stanton, NA 2018, 'STAMP goes EAST: Integrating systems ergonomics methods for the analysis of railway level crossing safety management' *Safety Science*. DOI: 10.1016/j.ssci.2018.02.014
79. Saward, JRE & Stanton, NA 2018, 'Individual latent error detection: Simply stop, look and listen' *Safety Science*, vol 101, pp. 305-312. DOI: 10.1016/j.ssci.2017.09.023
80. Schmid, D & Stanton, NA 2018, 'How are laser attacks encountered in commercial aviation? A hazard analysis based on systems theory' *Safety Science*, vol 110, no. Part A, pp. 178-191. DOI: 10.1016/j.ssci.2018.08.012
81. Sowman, J, Box, S, Wong, A, Grote, M, Laila, DS, Gillam, NG, Cruden, A, Preston, J & Fussey, P 2018, 'In-use emissions testing of diesel-driven buses in Southampton: Is selective catalytic reduction as effective as fleet operators think?' *IET Intelligent Transport Systems*, vol 12, no. 6, pp. 521-526. DOI: 10.1049/iet-its.2017.0173
82. Stanton, NA 2018, 'Preface' *Advances in Intelligent Systems and Computing*, vol 597, pp. vii-ix.
83. Stanton, N, Plant, K, Roberts, A, Allison, C & Harvey, C 2018, 'The virtual landing pad: facilitating rotary-wing landing operations in degraded visual environments' *Cognition, Technology & Work*, pp. 1-14. DOI: 10.1007/s10111-018-0467-1
84. Tran, M, Hall, J, Nicholls, R, Hickford, AJ, Chaudry, M & Watson, G 2018, Sustainable Infrastructure. in T Dixon, J Connaughton & S Green (eds), *Sustainable Futures in the Built Environment to 2050: A Foresight Approach to Construction and Development.* Wiley, pp. 117-136.
85. Veerapanane, S, Taylor, A & Kaparias, I 2018, 'A utility-based model for the evaluation of “Mobility as a Service” applications' Paper presented at 97th Annual Meeting of the Transportation Research Board, Washington, United States, 7/01/18 - 11/01/18, .
86. Waterson, B 2018, 'When virtual networks meet physical networks: perils of data mining for real-time transport information' Data Mining : Exploring the Ethical Dilemmas, Southampton, United Kingdom, 14/06/18, .
87. Yoon, S, Preston, J & Kaparias, I 2018, 'Comparative traffic data analysis for a motorway with a tunnel segment' Paper presented at 50th Annual Conference of the Universities' Transport Study Group, London, United Kingdom, 3/01/18 - 5/01/18, .
88. Young, M & Blainey, SP 2018, 'Development of railway station choice models to improve the representation of station catchments in rail demand models' *Transportation Planning and Technology*, vol 41, no. 1, pp. 80-103. DOI: 10.1080/03081060.2018.1403745
89. Young, KL, Lenné, MG, Salmon, PM & Stanton, NA 2018, 'The impact of texting on driver behaviour at rail level crossings' *Accident Analysis and Prevention*, pp. 1-8. DOI: 10.1016/j.aap.2018.05.002