UNIVERSITY OF Southampton

ANNUAL REPORT 2013
TRANSPORTATION RESEARCH GROUP

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1. OVERVIEW

The Transportation Research Group (TRG) was established at the University of Southampton in 1967 and has operated continuously since then. It now sits within the 'Civil, Maritime and Environmental Engineering and Science' Unit (CMEES) which is part of the Faculty of Engineering and the Environment (FEE).

This report covers the research activities within TRG during the period 2013.

TRG academic staff members during 2013 were:

- Nick Hounsell, Professor of Highways and Traffic, and Head of TRG
- John Preston, Professor of Rail Transport and Head of CMEES
- Neville Stanton, Professor of Human Factors in Transport
- Mike McDonald, Emeritus Professor of Transportation Engineering
- Dr Tom Cherrett, Senior Lecturer specialising in freight and logistics
- Dr Ben Waterson, Lecturer specialising in modelling and simulation

Dr Simon Box was appointed a 'New Frontiers Fellow' during this period.

Research Staff in TRG during 2013 included Dr Simon Blainey, Dr John Armstrong, Adrian Hickford, Fraser McLeod, Dr Jinan Piao, Katie Plant, Dr Aaron Roberts and Dr Birendra Shrestha. Their research activities are summarised in later paragraphs. **Technical Staff** supporting TRG included Amish Morjaria and Karen Ghali. Melanie Hallford continued in her role as **Senior Administrator** for the Group.

We are fortunate to 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 David Jeffery; Professor John Wootton; Dr John Walker; Dr Terence Bendixson, Dr John Schoon and Dr Mark Brackstone.

We also had some 20 students attached to the Group undertaking PhD or EngD (Engineering Doctorate) research in transport in 2013. PhD degrees were awarded to Linda Sorensen, Sitti Hassan, Maria Triantafyllou and Talal Almutairi in this reporting period.

Postgraduate teaching continues to be an integral part of TRG activities, particularly the MSc in Transportation Planning and Engineering. This continues to be successful, attracting over 30 new students each year, both full-time and part-time. One trend we have noticed is the increasing proportion of overseas students – reflecting increases in Masters fees for UK/EU students and the difficult economic conditions in some sectors of transport. We are pleased to continue as a partner within the Universities Transport Partnership (www.utp.org).

Overall, we have maintained a healthy portfolio of research in 2013, winning a number of new contracts relating to Intelligent Transport Systems (ITS) and associated social/sustainability issues. Current research activities, which have a total value of ~£4m, are summarised in later paragraphs in this report.

TRG facilities which have been further enhanced in 2013 include:

- SUDS (Southampton University Driving Simulator)
- The TRG Instrumented Vehicle (IV) for on-road trials
- Our well-equipped transport data analysis facility.

We have also acquired a motorcycle simulator and will be setting up ComTET in 2014 – A Command Teamwork Experimental Test Bed for submarine control rooms.

2. EXTERNAL ACTIVITIES

The following sections summarise the range of external activities undertaken by TRG Academic Staff members in 2013:

Nick Hounsell:
- Member of the Committee for the ICE South Transport Group
- Member of the Traffic management and Operations panel of the CIHT's Network and Infrastructure Management Board
- Member of the EPSRC Peer Review College
- Member of ITS EduNet, the European network for education and training in Intelligent Transport systems
- External Examiner for the Transport Masters Course at Napier University
- Academic reviewer of candidates applying for the Transport Planning profession (TPP) qualification
- Expert advisor to Monash University, Melbourne, Australia on a Public Transport priority research project, sponsored by the Australian Research Council (ARC)

John Preston:
- Adviser to the International Transport Forum and Reporter on the Round Table on The Economics of Investment in High-Speed Rail (held in New Delhi, India, 18-19 December 2013)
- Committee member of the International Conference on Competition and Ownership in Land Passenger Transport and Chair of the 13th Conference (held at the University of Oxford 15 – 19 September 2013)
- Member of the Commonwealth Scholarship Commission's Panel of Advisers and the EPSRC Peer Review College
- A member of the Netherlands Institute for Transport Policy Analysis.
- Panel Member REF14 Unit of Assessment 16 (Architecture, Built Environment and Planning).
- Co-Chair of the WCTRS Rail Special Interest Group (with Professor Ingo Hansen of TU Delft) and led sessions at the World Conference on Transport Research (Rio de Janeiro, 15-18 July 2013)
- Member of the EPSRC Peer Review College

Neville Stanton:
- Editor of the peer-review journal Ergonomics
- Member, Editorial Board, Theoretical Issues in Ergonomics Science
- Book series co-editor for Ashgate on 'Human Factors in Defence'.
- Visiting Professor at MIT, Astro and Aero Department
- Key note speaker at the Irish Ergonomics Society Annual Conference
- Member of the Scientific Committee for Naturalistic Decision Making Conference 2013
- Chartered Engineer with the Institute of Engineering and Technology
- External expert advisor for Australian Research Council funded rail level crossing project
- Invited speaker at Monash University, Melbourne, Murdoch University, Perth and University of Sunshine Coast, Queensland, Australia.

Mike McDonald:
- Member of the ERTRAC Working Group on Urban Mobility.
- Trustee of the Rees Jeffreys Road Fund.
- Transport Research Foundation Fellow.
- Pao Yukong Professor at Ningbo University, China.

Tom Cherrett:
- Chairman of the Editorial Board for the Institution of Civil Engineers Transport Journal
- Editor of the special issue of the ICE Transport Journal on "Transport systems: moving to a low-carbon future"
- Member of the Transportation Research Board's committee on Urban Freight Transportation, AT025

Ben Waterson:
- Member of the EPSRC Peer Review College
- Member of the NEARCTIS Network of Excellence in Cooperative Traffic Management

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

Outreach

Public engagement activities undertaken by various TRG staff and research students, under the direction of Dr Waterson included:

- showcase for Delivering Research Impact to the Research Councils U.K., including the Engineering and Physical Sciences Research Council (ESPRC).
- Alan Wong assisted the National Schools Partnership in developing three transport-themed educational videos for the Institution of Engineering and Technology (IET)'s Faraday' Programme. This Programme aims to introduce the sheer excitement of science, technology and engineering to a new generation, and the IET transport videos featured, among others, Neville Stanton's Human Factors Group, including Vicky Banks and Rich McIlroy, and the University's Jaguar XJ saloon Driving Simulator.
- TRG also participated in 'Marine Engineering Connections', a science busking project for the Southampton Marine and Maritime Institute (SMMI) that engaged the public with portable experiments and gadgets in discovering interesting maritime engineering concepts on board an Isle of Wight ferry. This innovative SMMI project, which was funded by an Ingenious grant from the Royal Academy of Engineering, involved many outside partners including Lloyd's Register and Wightlink.
- The Human Factors team visited *school* in *month* to showcase Human Factors research at the *science and engineering day*

3. RESEARCH

TRG research fits within our view of transport – that of 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 both the engineering and physical sciences and social sciences. 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 and a growing portfolio of studies on Human Factors in Transport. We also undertake research on a number of other interrelated themes, including bus priority, energy and environment, freight and logistics, future technologies, rail and transport policy.

The remainder of this report summarises TRG research activities ongoing in 2013 within different topic areas. Research titles listed in **blue** represent contract (funded) research, whilst those in **green** are studies by Postgraduate Research students (PhD or EngD)

3.1 Traffic Operations, Management and Control

NEARCTIS – A Network of Excellence for Advanced Road Co-operative Traffic management in the Information Society (European Commission Information Society, from 2008 to 2013). Dr B. Shrestha. *Contract Holder:* Prof N.B. Hounsell.

NEARCTIS draws together expertise within Europe and establishes a working network for the research and development needs of co-operative traffic management systems (i.e. those involving communications between vehicles and between vehicles and the infrastructure). As one of eight partners, TRG contributed to defining research and experimental requirements for traffic modelling, traffic optimisation and control, positioning and communications systems, multi-modal user networks and evaluation. TRG also led the work on Education and Training in ITS and co-operative traffic management, which included: the identification of user requirements; existing provision in Europe; and developing recommendations for the way forward. www.nearctis.org

Will Privacy Barriers Limit the Uptake of Cooperative Transport Systems? (NEARCTIS PhD studentship, from Feb 2010 to May 2013). Scott Cruickshanks. *Supervisor:* Dr B. Waterson, Prof N. Hounsell

While demonstrable benefits exist from increased levels of cooperation between transport infrastructure, vehicle systems and individual travellers, there is also the potential for such systems to be perceived as an invasion of personal privacy. While technology defines the potential leading edge of transport systems therefore, the actual state-of-the-art is more often defined by public acceptability and formal legislation. This research aims to (i) quantify the perceptions of collaborative systems in terms of whether people feel that the loss of privacy is outweighed by the gains received in return, (ii) quantify the extent to which these views vary across the cultural differences across the European Union, (iii) understand the degree to which such perceptions impact on the deployment of collaborative transport technologies, and (iv) to develop an understanding of whether existing legislation on information exchanges within the transport sector align with the desires of European citizens. . www.nearctis.org

TIDE – Transport Innovation Deployment in Europe (European Commission Information Society, from 2012 to 2015). Dr B. Shrestha, Emeritus Prof M. McDonald. *Contract Holder:* Prof N.B. Hounsell.

The mission of the TIDE project is to enhance the broad transfer and take-up of

15 innovative urban transport and mobility measures throughout Europe and to make a visible contribution to establish them as mainstream measures. TIDE focusses on 15 innovative measures in five thematic clusters: financing models and pricing measures, non-motorised transport, network and traffic management to support traveller information, electric vehicles and public transport organisation. Each cluster is led by a city which has particular experience on the specific thematic areas and ambitious aims for future developments. The cities are assisted by Thematic Support Partners, who are consultancies and universities with proven expertise in the respective cluster areas. TRG is a thematic support partner for 'network and traffic management to support traveller information' cluster. www.tide-innovation.eu/en/.

GOAL - Growing Older, stAying mobiLe (European Commission Information Society, from 2011 to 2013). Dr B. Shrestha, Emeritus Prof M. McDonald. *Contract Holder:* Prof N.B. Hounsell.

The aim of the GOAL project has been to develop an action plan for innovative solutions to fulfil the transport needs of an ageing society. The development of different profiles of older people representing their range of physical and mental characteristics has formed the basis for this project. These profiles have been used to explore in a structured way the needs while driving, using public transport, walking and cycling and the relevant information needed before and during travel. The action plan focuses on the development of innovative solutions for transport needs of older people in the near future and will guide future development and research requirements being proposed by the project. www.goal-project.eu.

Monitoring and Evaluation of Managed Motorway Schemes (EPSRC and Mott MacDonald Ltd. EngD Studentship, from October 2008 to September 2014). Mami Jennifer Ogawa. *Supervisors:* Prof N.B. Hounsell (University of Southampton), R. Meekums (Mott MacDonald Ltd.)

Managed Motorway schemes aim to address congestion and improve Journey Time Reliability (JTR) by utilising a set of advanced Intelligent Transport Systems applications to make as much use of the available capacity as possible. This research is looking into specific aspects of managed motorways, particularly capacity and lane utilisation, the use of Hard Shoulder Running up to 60 mph and the implementation of Through Junction Running (i.e. the use of the hard shoulder through the junction).

Investigating Drivers' Behaviour on Approaching a Junction at the End of Green Time (PhD studentship, from August 2009 to September 2013). Shiaw Yin Yong. Supervisors: Prof N. Stanton, Dr B.J. Waterson.

This research studied the behaviour of drivers when approaching signal controlled intersections at the end of green time. The main objective of this research was to assess the existing countermeasures for drivers' problem zone and to enhance their effects where applicable.
Factors affecting drivers' decision were identified using real time data and the TRG driving simulator was also used to replicate driving scenarios and generate qualitative sample data. Innovative treatments were tested using the driving simulator and the effects and drivers' performance in different treatments were compared and analysed.

Improving Traffic Movements in an Urban Environment (EngD studentship from October 2010 to September 2014). Andrew Hamilton. *Supervisors:* Dr B.J. Waterson, Dr T.J. Cherrett, Dr S. Box (University of Southampton), Mr I Snell (Siemens).

This research project is investigating the potential improvements in traffic signal control systems that can be enabled through richer data sources. Focussing specifically on the benefits of knowing, in advance, a vehicle's intended route through an isolated junction. The research involves both simulation work to quantify the benefits of including turning intention into traffic control

algorithms (including sensitivity tests with imperfect knowledge) and investigation into the level with which turning intention actually can be predicted from outside the vehicle.

Wirelessly gathered road vehicle data for traffic control and other applications (Technology Strategy Board from June 2011 to 2013) Dr S. Box. *Contract Holders:* Dr B.J. Waterson and Siemens.

It is understood that wireless communication links between road vehicles and infrastructure will be commonplace in the near future. Such links will lead to the availability of a rich new data source potentially containing real time position and speed data (among others) for some or all vehicles on the UK road network. This is known as localization probe data. The availability of this new data source creates business opportunities to develop tools that manage, store, and process these data for applications. Similarly there are data sources, such as smart phone data, that are present but not fully utilised. The aim in exploiting these multiple data sources is to create a single coherent image of the state of the network.

Modelling Roundabout Capacities (PhD studentship sponsored by the Government of Brunei Darussalam, from January 2012 to January 2015). Yok Hoe Yap. *Supervisors:* Dr. B.J. Waterson (University of Southampton), Dr. H.M. Gibson (University of Southampton)

The capacities of roundabouts are often determined using empirical relationships which predict entry capacity based primarily on geometry and circulating flows. This research aims to investigate the impact of additional factors which may have significant impact on roundabout capacities, especially related to multilane entries. Existing roundabout capacity modelling methods have been critically reviewed, and field data collected and analysed for empirical and simulation studies to assess the limitations of existing relationships. Further analysis will enable the importance of additional factors to be quantified and identify how they can be best included within existing models to improve roundabout capacity analysis and design.

Optimising Urban Parking Operations (PhD studentship, from October 2011 to September 2014). Chris Charles. Supervisors: Dr B.J. Waterson and Dr S. Box

The imperfect interactions between parking supply (spaces and costs), parking demand (durations) and parking behaviour (searching) create inefficiencies in the system that lead to traffic congestion, economic costs, increased pollutant emissions and increased frustration amongst drivers. Other transport sectors (most noticeably air travel) however have established strategies for optimally aligning supply and demand through web based 'pre-booking' systems.

This research is therefore considering the practical, environmental and economic consequences of operating an equivalent pre-booking style system for private car-parking in urban areas, addressing issues such as deterministic/stochastic durations of stay, search strategies of non-booked drivers, revenue optimisation, capacity utilisation and modal shift.

A pre-booking parking system arguably contradicts current sustainable transport policy as it potentially enhances the attractiveness of the private car to access the town centre. However, with a pre-booking system in place, it becomes evident to travellers when they will be unable to park their car close to their intended destination, encouraging mode shifts to public transport or trip-retiming effects. Prior knowledge of parking availability can therefore have a significant benefit on patterns of movement within urban areas and hence reduce the consequential economic and environmental costs.

3.2 Driver Information

Modelling Driver Experience and its Role in Adopting Diversion Behaviour (EPSRC DTC PhD Studentship, from October 2009 to September 2013). James Snowdon.

Supervisors: Dr B. Waterson, Dr H. Fangohr.

While traditional, aggregate techniques for transportation demand forecasting are capable of providing a single impression of road network usage, the consideration of individual traveller's decisions allows for varying levels of experience and the presence of more plausible decision rules to be explored along with their impact on traffic flows. This research focuses on determining and modelling driver routing reactions to incidents and unexpected congestion using a combination of information gathered within day, such as from variable message signs or the observed presence of congestion, and past experiences of the road network in previous trips. If the presence of a congestion causing incident is likely but uncertain, a driver must decide whether to hope for favourable conditions on a potentially faster route (but risk disruption to their journey) or divert to take a more reliable (but higher travel time) alternative. In particular this research addresses of the question of how sources of uncertainty impact start of trip routing decisions and contribute to expected traffic flows on an "average" day.

3.3 Bus Operations and Priority

A Comparative Assessment of Innovative Public Transport Technologies (PhD studentship, from October 2011 to September 2014). Xucheng Li. *Supervisors*: Prof J.M. Preston, Dr B. Shresthra.

The increasing urbanization around the world raises the passenger requirement for public transport. Due to the increasing demand of public transport, many innovative modes have been developed to suit various passenger requirements in different cities. This research aims to study the key characteristics of different public transport technologies including conventional buses and innovative forms such as Personal Rapid Transit and Straddle Bus and hence develop a comparative model to assess those public transport forms in terms of user benefits and non-user benefits. Two different but closely related models will be developed to form the assessment. The first is a stand-alone spreadsheet model on Microsoft Excel to investigate the theoretical social cost of public transport technologies operating on a single route. The second model is a microsimulation model based on a realistic city network to assess the performance and actual social cost when the public transport modes interact with other vehicles in the traffic flow. Results from these two model can then be used to show the most feasible public transport technologies for the selected network.

Exploring New Bus Priority Strategies at Isolated Vehicle Actuated Junctions (EPSRC, PhD Studentship, from October 2010 to September 2014). Bashir Ahmed. *Supervisors:* Dr N.B. Hounsell, Dr B. Shrestha

Priority to buses at traffic signals is very effective to improve speed and reliability, thus improving passenger service quality and operational efficiency. Traditional form of priority at traffic signals (e.g. Selective Vehicle Detection (SVD)), currently implemented in London, gives priority to all detected buses. At signalised junctions, priority can be given by altering signal timings in favour of approaching buses. Such method reduces junction delays. But bus priority benefits and impacts on general traffics depend mainly on priority parameters used and priority strategies implemented. Priority parameters used in London are based on field experiences and not enough research evidence found to justify those parameters. Also only traditional forms of priority strategies implemented. In this study existing priority parameters for VA signal controller will be evaluated and new parameters will be explored using VISSIM microscopic simulation model. This research will also investigate ways of enhancing priority strategies to improve bus travel time savings.

The Improvement of Bus Networks Based on GIS Technology (PhD Studentship, from October 2013 to September 2016.Yuji Shi. *Supervisors:* Dr N.B. Hounsell, Dr S.P. Blainey)

A fundamental way to solve today's urban traffic problems is to prioritize the development of public transport. However, today's bus networks are still not perfect-in the UK outside London privatization and bus deregulation have contributed to some problems concerning bus network structure, fares, demand, and service quality. The aim of this research project is therefore to use Southampton as a case study to diagnose its current bus system, to find out its weak areas and problem lines, and to explore the corresponding improvement methods which could be applied. Due to the wide application of Geographic Information Systems (GIS) in transit for the last two decades, specialised transportation GIS software (e.g. TRACC) will be used in this research to help with mapping, planning and visualizing the research results.

Evaluation of Bus Performance Using Advanced AVL Data: (PhD Studentship from Sept 2012. Mahesh K Dhakal. Supervisors: Prof Nick Hounsell and Dr Birendra Shrestha)

AVL data is used in bus transit for a number of reasons including performance evaluation. In London, this is available on 8000 buses using their iBus system. A range of studies have been conducted in the past to evaluate bus performance, such as 'Headway Regularity' and 'On-Time Performance'. This research is focussing on Bus Journey Time *Variability* (JTV), an important performance measure in the Mayor of London's aspiration to provide consistent journey times for all road users. Research is also analysing passenger 'Excess Waiting Times (EWT)' – a key performance criterion currently used by Transport for London (TfL). Further analysis will then be undertaken to explore any correlations between JTV and EWT, using iBus data for a variety of bus routes across London.

3.4 Energy & Environment

LSTF Case Study on Carbon Impacts and Congestion Relief (DfT, from August 2013 to July 2015). Dr Y. Song, A.J. Hickford, K. Ghali *Contract Holder*: Prof J.M. Preston

This case study is to provide evidence of the effect of Local Sustainable Transport Fund (LSTF) schemes on carbon impacts and congestion relief. This will be achieved by analysing the extent to which LSTF programmes reduce carbon emissions and congestion through reducing and/or modifying patterns of car use, and generating mode shift towards more sustainable travel modes such as public transport or active travel. The study will be based on a case study approach, building on current work being undertaken by the University of Southampton on monitoring and evaluating the LSTF programmes in South Hampshire, Greater Manchester and Leicestershire. During the first year of the study baseline data collection was carried out in five case study areas (Rochdale, Hyde, Coalville, Eastleigh, Gosport) and three control areas (Wigan, Hinckley, Locks Heath).

Centre for Sustainable Travel Choices (TfSH and SCC, from September 2012 to August 2015). Dr Y. Song, A.J. Hickford, K. Ghali *Contract Holder*: Prof J.M. Preston

The Centre is a partnership between Southampton City Council, the University of Southampton (UoS) and Sustrans. It oversees the work related to two Local Sustainable Transport Fund (LSTF) bids and a Better Bus Area Fund (BBAF) bid and will explore related opportunities. TRG leads the monitoring and evaluation of various travel behaviour change schemes that aim to promote sustainable travel whilst suppressing private car use. This research began in September 2012 and currently three schedules of monitoring and evaluation work are being carried out. During the first year an online and a card survey instrument tools were developed and tested and these were used to collect baseline data in 2013, along with focus groups held throughout South Hampshire.

iConnect – The Impact of Constructing Non-motorised Networks and Evaluating Changes in Travel (EPSRC Energy Programme, from 2008 to 2013). Dr Y.

Song, K. Ghali. *Contract Holder*: Prof J.M. Preston

The iConnect consortium is an interdisciplinary consortium of eight academic institutions Southampton, Bristol, MRC Cambridge, Loughborough, Oxford, Edinburgh, UEA, and UWE, with expertise in energy, environmental, physical activity, public health and transport research. The iConnect study aims to measure and evaluate the changes in travel, physical activity and carbon emissions related to Sustrans' Connect2 programme, which is an ambitious UK-wide project that will transform local travel in 84 communities by creating new crossings and bridges to overcome barriers such as busy roads, rivers and railways, giving people easier and healthier access to their schools, shops, parks and countryside. TRG are providing project management and leading the measurement and evaluation of travel impacts. The five-year iConnect study started in May 2008 and involves a broad evaluation of the whole programme coupled with detailed investigations at a small number of specific sites (Cardiff, Cheshunt, Glasgow, Kenilworth and Southampton) in which four have been constructed and opened. See: www.iconnect.ac.uk

POINTER: Support Action for Evaluation and Monitoring of CIVITAS Plus (European Commission, from 2008 to 2013). Dr J. Piao, *Contract Holder:* Prof M. McDonald

POINTER is the Support Action of the CIVITAS Plus programme which comprises 5 Demonstration Projects (ARCHIMEDES, ELAN, MIMOSA, MODERN and RENAISSANCE) involving 25 cities across Europe to implement over 300 measures. The main objective of POINTER has been to support the Projects, Cities and the EC with the monitoring and evaluation of the whole CIVITAS Plus action, as well as developing policy recommendations and recommendations for best practice on monitoring and evaluation. TRG has been the leader of the evaluation work package being responsible for development of the evaluation framework, co-ordinating the evaluation activities with the Projects and conducting the final cross-site evaluation. Other partners of the project include TNO (Netherlands), GOPA-Cartermill (Belgium), CDV (Czech Republic), Pöyry (Germany), TRT (Italy) and Uniresearch (Netherlands). Pointer project is coordinated by TNO.

Intelligent Agents for Home Energy Management (full-time PhD studentship from October 2010) Kirsten Revell. *Supervisors:* Prof N. Stanton, Prof A. Bahaj

This is a collaborative interdisciplinary project that is seeking to develop intelligent agents within the smart grid in order to reduce energy use within domestic settings. Bringing together an interdisciplinary team comprising School of Electronics and Computer Science, Sustainable Energy Research Group and Transportation Research Group this 3 year EPSRC project (starting in October 2010) seeks to apply novel artificial intelligence approaches to develop intelligent agents that will enable domestic consumers to visualise, understand and manage their energy use. The human factors work package of this project, will address the fact that it is humans, and not buildings, that consume energy. Understanding how to influence householder's energy consuming behaviour, could inform far reaching strategies to combat climate change. This work package explores how a Mental Model (MM) approach to design, could encourage optimal behaviour. Methods to capture, analyse and apply mental models of home heating systems have been developed. A lab-based experiment comparing a naturalistic home heating interface with a mental model promoting interface will be used to gain insights into the capacity of this approach to encourage optimal energy consumption in the home.

Towards a Verifiably Robust Cycle Microsimulation Model (EPSRC DTC PhD Studentship, from October 2012 to September 2016). Chris Osowski. *Supervisor*: Dr B. Waterson

Quantitative tools are widely used to evaluate the effectiveness and value for money of schemes both before and after implementation. Tools for motorised traffic and pedestrians are widely available but this is not the case for cyclists. Additionally, the core behaviours of cyclists which would inform such a model are also poorly studied. This project aims to develop and validate a model for bicycles with the aim of enabling the modelling of interactions between bicycles and ultimately with other modes. Such a model would have application to shared-space and common highway scenarios and would form the basis of economic scheme evaluation tools.

Developing tools to determine the environmental impact of transport interventions (EPSRC and Southampton City Council, EngD studentship, from October 2012 to September 2016). Matthew Grote. *Supervisors*: Professor I.D. Williams (Centre for Environmental Science), Professor J.M. Preston and S. Kemp (Centre for Environmental Science).

Road traffic is an important source of greenhouse gas (GHG) emissions and other air pollutants detrimental to air quality. These emissions are exacerbated in urban areas by the stop-and-go nature of congested traffic conditions. Therefore, when relevant authorities make decisions regarding changes to a transport system (transport interventions), quantifying the impact on emissions from road traffic is essential. The only practical method to quantify emissions at road network level (e.g. a city's road network) relies on Road Traffic Models (RTMs) to simulate vehicle movements, and Emissions Models (EMs) to calculate resulting emissions. Currently the EM options available to relevant authorities are simple models based on vehicle average speed that do not fully account for the impacts of congestion; or more complex models that do account for congestion, but are excessively resource intensive. This research aims to develop a new EM that can predict emissions from road traffic at network level, including the important influence of congestion, whilst avoiding the complexity that would render it impractical as a decision support tool for relevant authorities. Southampton City Council (SCC) is the industrial sponsor for this project, and the background to their involvement is SCC's ambition for Southampton to be a world-leading low-carbon city, and a desire to know how transport can contribute to realising this ambition

3.5 Freight & Logistics

Investigating alternative supply chain strategies for Great Ormond Street Hospital (ESPRC and Transport for London). EngD Studentship, from October 2010 to September 2014). Gavin Stephen Bailey. *Supervisors:* Dr T.J. Cherrett, Dr B.J. Waterson (University of Southampton), Mr J. Chani (Transport for London).

This research involves the assessment of current NHS logistics practices for Great Ormond Street Hospital for Children (GOSH). The work involves evaluating a number of different strategies to improve the internal and external operation of hospital supply chain activities at GOSH, with the end goal of implementing successful models and mechanisms throughout all major NHS London trusts. The aim of the research is to provide more cost effective, resource efficient and environmentally friendly medical supply to hospitals whilst maintaining the necessary levels of service typically required within healthcare. Audits at GOSH have been conducted in the form of Delivery and Servicing Planning and Travel Planning to assess the current operations of the hospital. One of the main focusses of the research is reducing the number of vehicles making deliveries during day-time hours. Currently, two solutions are being tested i) unattended Locker box delivery solutions, intended to enable more out-of-hours deliveries to be made during less congested periods of the day; and, ii) consolidating hospital deliveries at a mobile London out-base. In addition the main themes, a study into the courier traffic for the pathology department, which represents a significant financial outlay at the Trust, is being conducted to investigate the scope for

lower cost, environmentally-friendly non-motorised transport.

Reducing the Carbon Footprint in the Food Supply Chain (EngD studentship, from October 2010 to July 2014).Anthony Velazquez. *Supervisors:* Dr T.J. Cherrett, Dr B.J. Waterson, Mr P. Holdsworth (Martin Brower)

This research is investigating the ways in which adopting various alternative vehicle, powertrain and refrigeration technologies could positively contribute to decarbonizing the food logistics supply chain. The work is undertaking economic, operational and technological appraisals to determine the optimal combination of low carbon alternatives for more efficient fleet operation using the logistics fleet of a major UK fast food chain as a case study. More sustainable freight with vastly reduced carbon emissions could improve the efficiency of operations through deployment of alternative refuelling infrastructure and vehicles, while at the same time improving energy security and waste management and reducing transportation costs and other negative externalities of road haulage such as the impact of transport on global warming.

Sustainable 'take-back' Logistics for the Charity Sector (PhD studentship, from October 2010 to September 2013). Benjamin Norton. *Supervisors:* Dr T.J. Cherrett, Dr B.J. Waterson (University of Southampton), Mr Matthew George (Oxfam).

Oxfam operates a complex 'take-back' logistics operation, servicing its UK stores and bring-banks. This enables the charity to i) transport goods (primarily second hand clothing) between its stores for re-sale ii) feed recyclate generated in stores back into recognised commercial recycling streams iii) take-back low-grade clothing to its sortation facility in Huddersfield for separation and onward processing. The annual transport cost of these operations runs into several £ million and considerable savings (financial and environmental) could be gained through optimising the use of the current regional and local transport fleets and improving donation bank performance (regarding stock quality and quantity) through informed bank placement techniques. Of real interest is the impact the underlying population characteristics have on the yield volume and stock quality at collection sites, and whether a better understanding of this relationship can be gained using historic fill levels over time, and quality audits of donated stock. If a relationship exists and different postcodes can be shown to yield significantly different weights and quality of stock, then banks can be targeted to certain areas, and the logistics optimised accordingly. This project will quantify and qualify the potential benefits from these proposed approaches.

STRAIGHTSOL (EU 7th Framework, Cooperation Work Programme, from 2011 to 2014). F.N. McLeod. *Contract Holder:* Dr T.J. Cherrett.

The STRAIGHTSOL project brings together seven innovative field demonstrations of various freight initiatives from around Europe, using a common evaluation framework to provide transferable results and conclusions. In the UK, TRG are working with Oxfam, using remote monitoring sensors in textile donation banks to allow more dynamic scheduling of collections. Results suggest that the technology can be used to significantly reduce weekly collection mileage, particularly when servicing remote bank locations. The extent of the savings depends on whether a more flexible shop servicing strategy can also be adopted. Oxfam's ultimate goal is to maximise profit from donated goods, which involves a trade-off between minimising collection costs and maximising quantity, and quality, of goods collected. www.straightsol.eu

Sixth Sense Transport (Reducing/re-distributing transport options through a flexible interpretation of time) (EPSRC, from 2011 to 2014). F.N. McLeod, K. Ghali. *Contract Holder:* Dr T.J. Cherrett

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The 6th Sense Transport project is exploring the transport and business opportunities that could be gained by improving the temporal

and spatial visibility of transport using Smartphones. TRG is working with Oxfam in this research, giving their collection/delivery vehicles and clothing/book banks (the latter equipped with Smartbin fill rate sensors) the properties of a channel within a social network (as in Facebook or twitter). This enables them to transmit data about their status, receive data about possible opportunities and carry information for others in the network, so enabling better travel and transport decisions to be made. A Smartphone app has been developed to help Oxfam staff to improve the efficiency of their logistics processes. A main interest for TRG is in how such new 'visualisations' of vehicle, bank and shop status given to Oxfam staff (drivers, area managers, shop managers) might enable more effective localised decision making to save time/fuel and lead to more reactive stock management.
www.sixthsensetransport.com.

Time-Dependent Vehicle Routing Problems for Flexible Logistics (PhD studentship sponsored by the Government of Colombia, from October 2013 to September 2016). Nicolas Rincon Garcia. *Supervisors:* Dr B.J. Waterson, Dr T.J. Cherrett.

The vehicle routing problem (where, in the basic formulation, a set of N_v vehicles must be assigned to visit N_L locations with the minimum total route length) is one of the most widely studied theoretical problems in logistics. The basic formulation however is almost never applicable in reality and therefore over the years many variations have been proposed, including for example capacity constrained problems for heterogeneous vehicle fleets, time constrained 'delivery window' problems which restrict the freedom of the schedules, and congested network problems which attempt to reflect time variant travel times between locations.

Unfortunately, despite this attempt to make theory better reflect reality, theoretical models are often poorly suited to especially smaller or atypical logistics operations as they do not reflect the real constraints imposed by unpredictable real life scenarios. This research therefore seeks to develop improved implementations and better use of existing algorithms.

3.6 Future Technologies

CITYMOBIL2 (European Commission, from 2012 to 2016). Dr J. Piao, Contract Holder: Prof M. McDonald

CityMobil2 is a European project under the Seventh Frame- work Programme for Research and Technological Development. It started in September 2012 and will run for four years. The main objective of CityMobil2 is to implement large-scale pilot platforms for technical and socioeconomic test and validation of automated transport systems (ATS) in urban environments by demonstration and evaluation in cities with different socio-economic conditions. By using the pilot demonstration test bed established, CityMobil2 will undertake research focusing on technical, financial, cultural, behavioural aspects, and assess ATS's potential effects on land use policies and how new systems could fit into existing infrastructure in different cities. The project has 47 partners including local cites for demonstration, manufacturers of automated road transport systems, and academic/research institutions. TRG is mainly responsible for the evaluation of demonstration results.
http://www.citymobil2.eu/

Electric vehicle drivers and their use of digital media.
(PhD, from December 2013 to December 2016).
Farah Alkhalisi. Supervisors: Dr B. Waterson, Dr T. 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'. Though electric vehicles currently just 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.

3.7 Rail

Rail Demand and External Impacts

(Passenger Demand Forecasting Council, Association of Train Operating Companies, from July 2013 to April 2014). Dr S Blainey. *Contract Holder*: Prof J Preston, joint with Mott Macdonald

This research project aims to provide a greater understanding of how factors external to the passenger rail market have been affecting rail demand since the early 1990s, focusing particularly on the likely reasons for the general durability of rail demand since the economic downturn in 2008. The first stage of the work involves carrying out a literature review alongside backcasting of rail demand over the study period to test the predictive power of the existing Passenger Demand Forecasting Handbook (PDFH) modelling recommendations. This work makes use of a comprehensive dataset on rail passenger numbers and on the factors which determine rail demand, supplied by the Department for Transport. The results from the first stage of the project will then be used to inform recommendations for further research to be undertaken in the second stage of the research. This is likely to include using more sophisticated modelling techniques (particularly suited for panel data of this type) such as partial adjustment models and error correction models, and disaggregation of explanatory variables (such as GVA and employment) to capture the effects of structural changes in the economy.

Improving Quality of Rail Service in Kuala Lumpur, Malaysia

(PhD Studentship, from October 2008 to February 2014). Siti Nurbaya Ab Karim. *Supervisors:* Prof J.M. Preston, Dr S. Blainey

Primary data collection work has been undertaken at fourteen railway stations along the Pelabuhan Kelang-Sentul line in Kuala Lumpur (KL). The field work was divided between Origin-Destination (OD) surveys, Attitudinal surveys, Passenger Boarding and Alighting Counts and Train Volume Counts at main stations. Questionnaires and direct interviews were used, supplemented by direct observation and photography. For the OD survey, 377 questionnaires have been collected whilst the attitudinal surveys recorded a total of 388. Detailed descriptive statistics have been produced, whilst both the Generalised Journey Time (GJT) and the Generalised Travel Cost (GTC) have been computed. The aim of this research is to give recommendations for improving the overall KL rail service quality. Factor Analysis and Structural Equation Modelling (SEM) techniques had been used to identify the variables that best define a high rail service quality using data from the Attitudinal surveys. The OD surveys and Passenger Boarding and Alighting counts have been used to compute demand (volume and distance) and fares. With secondary data supplied by the operator KTMB, they have been used to calculate indicators of operational efficiency such as the operating cost per passenger kilometre and the farebox ratio. The Train Counts have been used to calculate the average number of transit unit (TU) per day per line, the total train kilometres, the total train capacity provided and the utilization ratios. These data sets will be used to appraise different measures to improve the quality of rail services in KL, with particular focus on service, fares and overcrowding levels.

Determining the Environmental Performance of Rail Transport Relative to Other Modes (EPSRC and Arup, from October 2009 to September 2013). James Pritchard. *Supervisors:* Prof J.M. Preston (University of Southampton), Dr J. Armstrong (Arup, University of Southampton).

The objective of this project has been to investigate rail's environmental performance and make comparisons with other modes. "Environmental performance" is a broad topic and the decision has been taken to focus on energy usage and greenhouse gas (GHG) emissions, the reduction of which could be classed as key sustainability objectives. After reviewing the contribution of the transport sector to overall GHG emissions levels, the decision has also been taken to focus mainly on passenger transport within the UK. The standard metrics for comparison between modes are energy and carbon emissions per passenger-km. There are three separate areas of interest – operational energy usage and emissions, embedded energy usage and emissions and passenger loadings. Many comparison tools rely heavily on average data, and a review has been conducted of the available data for rail's operational energy consumption and emissions. It was found that there is a relative lack of specific data, and the bulk of the research has concentrated on investigating this further, through the development of a simulation tool and the analysis of energy metering data provided by train operators. A basic model has been developed for Arup, which can output the energy usage of a train over a given route. A sizeable data set of energy consumption recorded by the train operators has been analysed with a view to validating some of the simulation results and further understanding how energy consumption (and the related GHG emissions).

Some work has also been undertaken to consider embedded energy and carbon in rail infrastructure. The EngD project forms the basis for a further Knowledge Transfer Partnership with Arup, in which it is planned find ways of considering possible trade-offs which may exist between reducing embedded energy and operational energy.

Transport PPP decisions in Korea considering completion delay and risk quantification (PhD studentship, from October 2010 to September 2013). Jihong Park. *Supervisors:* Professor J.M. Preston, Dr S. Blainey

This research developed a new quantitative Public Private Partnership (PPP) decision-making framework for the public sector by considering the impact of completion delays associated with conventional delivery. A modified Value for Money (VFM) measure, that considers the benefit difference between the completion delays associated with conventional delivery and the PPP alternatives, has been developed for PPP decision-making in Korea. In estimating the Modified VFM, quantified risks such as the winning bid ratio, construction cost overruns and traffic volume risks are reflected. Several road and railway projects in Korea have been studied to assess the usefulness of the Modified VFM model.

TRACK21: Railway Track for the 21st Century – Work Package 6 (EPSRC Program Grant from June 2010 to May 2015). Dr S. Blainey. *Contract Holder:* Prof. J. Preston

While the majority of the world's railways are currently on ballasted track, a transformation in track performance is essential if the Government's aspirations of reduced cost and increased capacity are to be realised. This Programme Grant aims to bring about a step-change improvement in the engineering, economic and environmental performance of railway track making it fit for a 21st century railway, by developing new techniques for its design, construction and maintenance. Research in the project will be enhanced by support from external stakeholders, including links with the Vehicle-Track Systems Interface Committee (VTSIC) and its Vehicle-Track Interface Strategic Model (VTISM), access to commercial software such as VAMPIRE and Adams Rail, access to cost modules of Network Modelling Framework, and the

provision of life cycle analysis data. TRG are currently focusing on modelling the whole life cost and carbon impacts of a range of alternative sleeper and ballast systems tested in other areas of the Track21 project. www.track21.org.uk.

3.8 Transport Policy

Child Pedestrian Road Safety; Practical Training and Interactive Learning Environments to Improve Road Safety (EngD studentship, from October 2009 to September 2013). James Hammond. *Supervisors:* Dr T.J. Cherrett, Dr B.J. Waterson (University of Southampton), L. Ellarby (Hampshire County Council)

This research project aims to assess the effectiveness of computer based interactive learning environments in aiding road safety amongst the young. It is focusing on teaching year one and two school children (ages 5-7) key pedestrian skills such as; crossing the road, finding safe places to cross and crossing between parked cars.

The intention is to assess the extent to which interactive videos have an impact on roadside behaviour. An interactive video demonstrating safe crossing techniques between parked cars has been developed and tested on schools in Hampshire. Results suggest that improvements in certain crossing behaviours are demonstrated as a result of training with the interactive video, however the resource is not intended to be a replacement for practical training which must still be prioritised.

Evaluating the Long Term Impacts of Transport Policy: The Case of Bus Deregulation (PhD studentship sponsored by the Kuwait Government, from February 2009 to March 2013. Talal Almutairi. *Supervisors:* Prof J.M. Preston, Dr B. Shrestha

There have been a number of bold experiments in transport policy in the United Kingdom that have attracted international interest. One of these is the package of reforms that has come to be known as bus deregulation. Local bus services in Great Britain outside London were deregulated in 1986, with tendering introduced for socially necessary services. The aim of this research is to evaluate the long term impacts of bus deregulation in Great Britain outside London. This will be achieved by pursuing the following objectives: (i) Examining the long term trends in key variables such as patronage, fares, service output, operating costs and subsidy in Great Britain outside of London and comparing these with the two 'control' areas of London and Northern Ireland, (ii) Disaggregating the analysis for Great Britain outside London by the seven Passenger Transport Authorities and the 10 Government Office Regions, (iii) Determining the counterfactual (what would have happened in the absence of the policy intervention) through the application of demand and cost models, (iv) Undertaking a cost-benefit analysis of bus deregulation in Great Britain outside London and of comprehensive tendering in London by examining the impact on operators, bus users, government, non users (e.g. through changes in congestion, accidents and the environment), (v) Attributing costs and benefits to specific elements of the bus deregulation package and (vi) Determining the implications for future policy both in the UK and elsewhere.

UK Infrastructure Transitions Research Consortium (EPSRC, from January 2011 to December 2015). A.J. Hickford, Dr S Blainey, F.N. McLeod. *Contract Holder*: Prof J Preston

This multi-institutional and multi-disciplinary project is informing the analysis, planning and design of national infrastructure, through the development and demonstration of new decision support tools, and working with partners in government and industry. The research deals at a national scale with energy, transport, water, waste, and information and communication technologies (ICT) systems. For these systems, the programme is: developing new methods for analysing performance, risks and interdependencies; providing a virtual environment in which to test strategies for long term investment; and increasing

understanding of how alternative strategies perform with respect to policy constraints such as: reliability and security of supply, cost, carbon emissions, and adaptability to demographic and climate change.

Following on from the Fast-Track Assessment (FTA) undertaken during the first year of the project, TRG have produced a model capable of forecasting transport demand and capacity within and between 142 UK zones for the period up to 2100, which includes 'soft' interactions with models of other infrastructure sectors to allow interdependencies between systems to be explicitly considered. The model includes road, rail, air and sea passenger and freight transport, and can capture the impact of a number of potential policy and technological options such as infrastructure construction, alternative pricing regimes and improved vehicle fuel efficiencies. The ITRC transport model has been used together with the other sectoral models to forecast the impact of a number of range of different transport strategies under different future scenarios for population, energy prices and the economy. Future work on the project will increase the level of interactions between the different sectoral models and expand the range of future strategic options which can be modelled. www.itrc.org.uk

3.9 Infrastructure

Low cost infrastructure free form of indoor localization (PhD Studentship, from January 2012 to 2015) Shashank Gupta Supervisors: Dr. Simon Box & Prof. R. E. Wilson (Bristol University)

Despite innovative research in indoor positioning, it is still not in the mainstream. In trying to trace the reasons, we identify two main reasons: (1) An indoor positioning application may require aisle-level precision (2) While such precision is attainable with pervasive radio based systems – Wi-Fi, however they come at a prohibitively high cost, mostly in the form of meticulous (signal) calibration. Therefore, this research aims to develop a self-contained low cost infrastructure free form of indoor positioning solution.

Recently smartphones have redefined the notion of mobile computing platforms. Ever improving features of affordability, ubiquity, and portability, increased sensory and computational power along with low power consumption fuelled by readily available batteries, have opened up a number of interesting applications. One such application is location based application. Therefore, this motivated us to use smartphone for our research. Primarily this research will investigate the techniques/algorithms that can assist in locating the position of the pedestrian based on the contextual information collected by several sensors in the smartphone. Moreover, this research will also be aimed to understand the movement pattern of the pedestrian. The smartphone's sensory signals would be collected and analysed. Various machine learning algorithms would then be employed to identify whether the pedestrian is walking, running, jogging, standing, going straight, turning, etc. based on the collected sensory signals - accelerometer and heading measurements.

Modelling the Coevolution of Land Use and Transport
(EPSRC DTC PhD Studentship, from October 2013 to September 2017).
Oliver Laslett. Supervisor: Dr B. Waterson.

The impact of land use on transport systems is a part of traditional transport demand models, with changes in land use being reflected as changes in levels of trip generation. More recently, the growing awareness of the impact of poor transport systems on accessibility and the need to more robustly quantify the wider benefits of transport system improvement schemes (e.g. faster rail connections between cities) has led to increased understanding of the impacts that good and poor transport systems can have on the attractiveness of surrounding land. This research therefore seeks to close the circle, to create a unified model linking both the impact of land use on transport and of transport on land use, to represent their coevolution and predict the

impact that transport policies can have on the coevolution of the full system.

3.10 Human Factors

ALICIA ((EU, from November 2009 to August 2014). Dr A. Roberts, K. Plant *Contract Holder:* Prof N. Stanton

The ALICIA project (All Condition Operations and Innovative Cockpit Infrastructure) is led by Augusta Westland Helicopter Company (UK) and involves forty-two partners from fourteen countries of the European Union. The research outcomes will be used to improve flight safety and extend the range of operations. The University of Southampton has undertaken an analysis of the cockpit architecture using Cognitive Work Analysis to model the demands and constraints of normal and non-normal operations. This work informed the development of new design proposals for glass cockpits, including a Head up Display (HUD) concept to assist helicopter pilots landing in degraded visual environments. In the past year a desktop simulator environment was developed to assist the evaluation of the HUD concept. Three evaluation trials were run, with approximately forty helicopter pilots. After each phase of testing the concept was refined and further developed. As the project enters the final year the technologies and concepts developed in the project will be subjected to evaluation trials. The University of Southampton is considered a key partner for this evaluation phase and will assist the technical partners to conduct Human Factors evaluation trials, whilst analysing and writing up the data collected in the HUD trials.

Human Component Considerations in Systems of Systems Safety (Defence Human Capability Science and Technology Centre – DHCSTC, August 2012 to October 2013) Principal Investigator: Dr C. Harvey; Co-Investigator – Prof N. Stanton.

MoD has long since recognised the importance of considering Human Factors issues in relation to safety. Therefore, as military capability increases in complexity and the focus of acquisition shifts from 'systems' to 'systems of systems' (SoS) so there is a need to consider not only the technical aspects of SoS safety but also the human component (i.e. behaviour, organisational/cultural issues, training). Because of the interaction of social and technical factors, the safety of a SoS is critically dependent on the behaviour and decision making of these people. While methods and techniques exist to support HFI at the systems level, the requirements for HFI at a SoS level are still emerging. The aim of this task is to develop an understanding of, and approaches to managing, the human issues associated with complex SoS and to understand the impact of organisational boundaries on the effectiveness of safety management. www.defencehumancapability.com/

Investigating the Human Factors of Fratricide (part-time PhD student from October 2008). Laura Rafferty. *Supervisors:* Prof N. Stanton, Prof J.M. Preston.

This research explores the way in which military teams make decisions in naturalistic environments. The project focuses specifically on fratricide and the decisions involved in such incidents. Fratricide is viewed as a systemic problem and therefore actions and individuals across the military system as a whole are explored. An initial review of the literature surrounding both teamwork and decision making allowed for the development of a model of team decision making; the Famous Five of Fratricide (F3) model. Through the application of the Event Analysis of Systemic Teamwork (EAST) methodology to case studies of decision making the processes involved in fratricide were explored. A series of three case studies were undertaken at military training institutions, comparing the performance of teams involved in incidents of fratricide and those who had completed the training scenario effectively.

This comparison allowed us to draw out factors that differed between the two teams

and therefore may have acted as causal factors in the incidents of fratricide.

Modeling Situation Awareness in Command and Control teams as a Function of Task Type and Network Structure (part-time PhD studentship from October 2009) Linda J. Sorensen. *Supervisors:* Prof N. Stanton, Prof J.M. Preston.

The phenomenon of situation awareness (SA) has received considerable attention in recent years and significant theoretical advances have been made which establish that SA is an important component of teamwork. This is especially true in complex environments, such as in command and control, where the team is required to deal with decision making problems under significant pressure. An extensive literature review was undertaken which identified three schools of thought on the phenomenon of SA and the measurement tools which are paired with these. For the first study two models of SA, from the two most prominent schools of thought, were selected to compare the extent to which they explain the nature of SA as observed in a team undertaking an intelligence analyst task in one of two command and control network structures. The second part of the research is undertaking further experimental work to measure, analyse and model the DSA in command and control teams as a function of task type and network structure. In the final part of this project the accumulated findings will be compared and the relationship between SA, task type and network structure in Command and Control will be modeled. The project aims to impact on the practical organisation of military command and control by ultimately showcasing which network structure given a particular task type is optimal considering the degree to which the two former allows for the development of DSA. This research was initiated at the University of Surrey but has now been transferred to the University of Southampton.

A pilot study: Applications of the Perceptual Cycle Model and Schema Theory in the cockpit (part-time PhD student from April 2010). K. Plant. *Supervisors:* Prof N. Stanton and Dr C. Harvey.

This research explores how the Perceptual Cycle Model (PCM) and Schema Theory can be applied to understand and explain the pilot decision making processes in the cockpit. The perceptual-cycle models the interaction between a person and their work environment and it is being used to show why actions and assessments made sense at the time in order to offer a causal explanation of phenomena such as human errors. As the work progresses the role of the PCM and Schema Theory at explaining team decision making throughout the cockpit will be considered. A literature review of Schema Theory has been conducted in which the future of Schema Theory was discussed. A case study followed, in which it was demonstrated how the PCM and Schema Theory could be used to explain the actions of the pilots involved in the Kegworth aviation accident. Critical decision method interviews have been conducted with pilots and the data thematically analysed according to the principles of the Perceptual Cycle Model. This data will feed into understanding influences on decision making when dealing with critical incidents. Data from a 4-man helicopter crew has also been collected in order to begin researching team decision making processes, i.e. team perceptual cycles. Over the past year, data was collected via cockpit recordings of 4-man helicopter crews and the analysis will be used to create a team-PCM. Theoretical and methodological developments are anticipated together with new insights into systems performance.

Encouraging eco-driving with multisensory feed-forward and feedback information (EngD studentship sponsored by EPSRC and Jaguar Land Rover, from October 2011 to September 2015). Rich C. McIlroy. *Supervisors:* Prof N.A. Stanton, Prof John Preston.

The way in which a car is driven has a significant effect on the amount of fuel that is used. Given the issues of the over use of

resources and the emission of large volumes of carbon dioxide (and equally damaging pollutants), the aim of this project is to encourage energy-conserving driving behaviours through the design of an in-vehicle information presentation system. While there have been a number of studies investigating the use of visual tools to help drivers save fuel, with varying success rates, each of these tools carry with them the issue of visual distraction. Considering that usage of the accelerator and decelerator pedals is a haptic task (i.e. of or relating to the sense of touch), can we provide information haptically to guide the driver's behaviour? To address these questions, a driving-simulator based study is planned that will make use of variety of different information presentation methods, including visual, auditory and haptic information, and all combinations thereof. Theoretical justification and design rationale find basis in the principles of Ecological Interface Design, an approach to design rooted in Gibsonian ecological psychology.

Human Factors in the Design of Traffic Management Systems (EngD studentship from October 2011 to September 2015). Joshua Price. *Supervisors:* Prof N.A. Stanton, Dr B.J. Waterson (University of Southampton), Spencer Jones (Siemens).

This research project aims to investigate the potential benefits a human factors design approach can have when applied to the development of the next generation of traffic management systems. Existing systems have been analysed using Event Analysis of Systematic Teamwork (EAST), including an investigation into resilience to disruption. Further analysis is now being undertaken using Cognitive Work Analysis (CWA) with a focus on operator's decision making processes. These analyses will guide the development of interface prototypes through Ecological Interface Design (EID) which will be tested empirically in the final stages of the project. The resulting findings are projected to have an impact on the design of future traffic management systems.

Automatic Cars are Safer and more Efficient (EPSRC and Jaguar Land Rover Ltd. EngD studentship, from October 2011 to September 2015). Victoria Banks. *Supervisors:* Professor N. Stanton, Mr D. Robertson (Jaguar Land Rover Ltd.)

With systems design plagued by criticism for failing to adequately define the role of the human operator within the system as a whole, there is lasting concern amongst the Ergonomics and Human Factors community that automated sub-systems in driving may contribute to safety concerns rather than overcome them. Failing to acknowledge the role of the driver in an automated vehicle system may lead to undesirable behavioural adaptation as a result of inadequately controlling for the changing role of the driver within the control-feedback loops. Adopting a Systems-theoretic approach, this project aims to address the issues surrounding task sharing between the driver and automated subsystems by analysing the interaction that takes place within the driving system at different levels of automation in a simulated driving environment.

i-VISION (EU, from October 2013 to October 2016). K. Plant *Contract Holder:* Prof N. Stanton

The i-VISION project (Immersive Semantics-based Virtual Environments for the Design and Validation of Human-Centred Aircraft Cockpits) is made up of a consortium of seven partners, both academic and industrial, from five countries of the European Union. The aim of the project is to design a tool for use in rapid prototyping for the design and evaluation of aircraft cockpits in order to reduce product development times and costs. i-VISION will combine methods and technologies from three distinct areas of research, namely Human Factors, Semantics and Virtual Reality, into advanced design and validation tools. The i-VISION tool will enable designers and engineers to visualise, manipulate and interact with a digital mock-up to allow key design decisions to be taken early in the process. The University of Southampton will provide advanced Human Factors methods to analyse the activities of the pilot and co-pilot during various phases of flight and

operating conditions in a virtual reality-based aircraft cockpit.

A pilot study: Applications of the Perceptual Cycle Model and Schema Theory in the cockpit (part-time PhD student from April 2010). K. Plant. *Supervisors:* Prof N. Stanton and Prof J. Preston.

This research explores how the Perceptual Cycle Model (PCM) and Schema Theory can be applied to understand and explain the pilot decision making processes in the cockpit. The perceptual-cycle models the interaction between a person and their work environment and it is being used to show why actions and assessments made sense at the time in order to offer a causal explanation of phenomena such as human errors. As the work progresses the role of the PCM and Schema Theory at explaining team decision making throughout the cockpit will be considered. A literature review of Schema Theory has been conducted in which the future of Schema Theory was discussed. A case study followed, in which it was demonstrated how the PCM and Schema Theory could be used to explain the actions of the pilots involved in the Kegworth aviation accident. Critical decision method interviews have been conducted with pilots and the data thematically analysed according to the principles of the Perceptual Cycle Model. This data will feed into understanding influences on decision making when dealing with critical incidents. Data from a 4-man helicopter crew has also been collected in order to begin researching team decision making processes, i.e. team perceptual cycles. Over the past year, data was collected via cockpit recordings of 4-man helicopter crews and the analysis will be used to create a team-PCM. Theoretical and methodological developments are anticipated together with new insights into systems performance.

Driver Distraction (EngD studentship sponsored by EPSRC and Jaguar Land Rover from October 2013 to September 2017). Katie Parnell. *Supervisors:* Prof N.A. Stanton, Prof. J Preston and Dion Thomas (Jaguar Land Rover Ltd.)

More technologies are entering road vehicles that offer secondary functions alongside the primary driving task. These place high visual demands on the driver and overloading cognitive capacity in this way may cause adverse effects on driving performance. The addition of systems to improve environmental efficiency of the driver and vehicle will only add to such concerns of driver distractions.
This project aims to investigate this issue by assessing cognitive load through such techniques as eye tracking in order to ultimately find a way of integrating secondary systems into the car more efficiently for the driver. An approach that does not require the driver to search for information but presents it at the precise time it is needed, without increasing cognitive demand on the driver to distractible levels. The project will therefore explore alternative design approaches for a range of Human-Machine Interaction tasks and empirically investigate the distractive effects in a driving simulator.

Latent Error Detection & Recovery in UK Naval Aircraft Maintenance (PhD funded by Royal Navy from October 2013 to September 2016). Commander Justin Saward. *Supervisors:* Prof N.A. Stanton, Prof. J Preston

In contrast to highly observable behaviours in some other safety critical organisations, less empirical research is available on cognitive behaviours associated the latent detection and recovery from human error within aircraft maintenance, and even less within the military context. Here a gap in knowledge exists, for which part-time PhD research is being sponsored by the Royal Navy to explore this gap in knowledge within the naval aircraft maintenance context."

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12. Banks, V. A., Stanton, N. A. & Harvey, C. (2013). "What the crash dummies don't tell you: The interaction between driver and automation in emergency situations". *Proceedings of the 16th International IEEE Annual Conference on Intelligent Transportation Systems* (ITSC 2013), The Hague, The Netherlands, October 6-9, 2013, pp. 2280-2285.
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15. Walker, J (2013) "Relief Effort: A Demand Management tool unrivalled by any other intervention". Tolltrans, pp50-55
16. Walker, J "Burning Question: Most valuable Deployment of the Decade – the London Congestion Charge". Traffic Technology International, August/September 2013, p.084
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