TRL Academy

Quarterly Research Report

July to September 2016

TRL THE FUTURE OF TRANSPORT

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01 Introduction

The focus of this Quarterly Research Report is TRL's original research, which is funded through the annual investment made by the Transport Research Foundation (TRF). Within this report, we provide an overview of last year's projects and those selected for the current year.

I have to say the process of reviewing and selecting these research projects is one of my favourite tasks as director of the Academy. I am continually impressed at the ingenuity of my colleagues in producing innovative project ideas that can help keep TRL at the forefront of future transport. Our ability to generate and apply this knowledge enables us to address and solve complex transport challenges for our clients.

Through our research programme this year, we are tackling some exciting new areas including critical topics such as data science, machine learning and cybersecurity. We're also addressing some increasingly important and emerging issues such as mental health and the assessment of head injuries. In other areas we are building on previous research projects in the areas of virtual reality, automated vehicles, truck platooning and driving simulation. Although diverse in nature, all of TRL's research topics address transport issues and align with our strategic objectives – to produce a transport system that is safe, clean, affordable, accessible and efficient. I am eagerly anticipating the outcomes of these exciting activities.

Professor Nick Reed
Director, TRL Academy.

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02 About the TRL Academy

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The Academy is TRL's innovation and development centre that delivers research programmes and projects, underpinning our position as a leading transport research institute. The work of the Academy supports knowledge creation and transfer, aiming to increase our intellectual capital, skills and capabilities across science, engineering and research disciplines. We collaborate with academia, industry and the public sector to foster learning and discovery that benefits our customers and employees.

People

Our people are critical to the process of discovery and innovation. Through the Academy we facilitate career progression for TRL employees by proactively encouraging inventive thinking and supporting their academic studies. Academy investment in our people means that our clients benefit from pioneering, industry-leading and evidence-based research..

Research

The Academy's work is supported by internal and external funding programmes. TRL's parent body, the Transport Research Foundation (TRF) is a non-profit Scientific Research Association, which uses the income from its investment in TRL to fund an annual programme of research in areas of strategic importance.

As an Affiliated Research Centre to the Open University, we recruit, supervise and conduct examinations for internal and external candidates pursuing research degrees. The Academy is currently funding and supervising PhD and EngD programmes with the University of Southampton, University of Warwick, Royal Holloway and University of London. The Academy has also recently formed an alliance with the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT (Massachusetts Institute of Technology) to build our capabilities in this exciting and critical area of development for the transport sector.

Outcomes

The Academy's work is vital for the development of evidence-based solutions and new insights into the ever changing and demanding transport landscape. Our ability to generate and apply this knowledge not only helps to shape and define the future of transport, but also enables us to address and solve complex transport challenges for our clients.

Through the Academy's research programmes, projects and relationships across industry, academia and the public sector, we build knowledge and awareness in the transport and mobility market. By understanding short, medium and long term developments across these sectors, the Academy ensures we have the skills and capabilities needed to maintain our market leading position.

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03 Our Research

3.1 Reinvestment projects FY 2015/2016

Smart asset management technology review

For many years TRL has been at the forefront of the development and implementation of measurement technology for asset management. Focused on network level condition monitoring and assessment, TRL traditionally developed high-end survey and research vehicles, enabling highways infrastructure owners to assess the condition of their assets in order to make informed maintenance decisions.

However, the emergence of new technologies enabling widespread availability of smaller, cheaper and more feature-rich devices is creating new ways to assess and monitor assets and/or achieve better results more efficiently. Anticipating client demand for novel solutions based on these new technologies, TRL embarked upon a project to understand their future application – not only for asset condition monitoring and assessment, but also as part of a wider 'smart infrastructure' eco-system.

The project explored areas of demand for data in and around the road environment. This included both the availability of new types of data, but also the opportunity to improve or enhance existing data through the application of new technology. Furthermore, the project considered the practicality of data collection, analysis and onward use, identifying opportunities to develop and deliver leading edge solutions for specific applications in the road-side environment.

The outcome of the project was a prioritised list of potential technologies that could be developed to achieve significant improvements in smart asset management. A selected number of these are being taken forward in the current year.

Applying data science to develop a route risk tool

An ever increasing volume of transport data is collected each day, examples include traffic, accident, asset inventory and road condition data. Having the ability to derive information from these multidimensional data sets has potential to deliver significant gains to the transport industry, as well as its related markets. Consistent with FEHRL's vision for a seamlessly connected, resilient, highly efficient and highly automated road transport system, TRL undertook a project to address some complex transport issues through a big data approach.

TRL has a strong data science legacy, as well as unique access to a broad range of transport data sets. Supported through a university partnership offering advanced computing capabilities, the project explored the opportunity to link and query combined data sets, applying new data mining techniques. The output was a proof-of-concept tool, with potential application in the Insurance and Telematics markets. Using a big data approach, driver risk can be more accurately calculated based on the combination of routes travelled and telematics data captured on the journeys made.

The environmental impact of fuel cell electric vehicles
In this project we investigated and quantified the environmental impacts of a Fuel Cell Electric Vehicles (FCEV) and sought to establish a comparison with other new vehicle technologies, such as Electric Vehicles (EVs) and current Internal Combustion Engine (ICE) vehicles.

FCEVs are currently perceived to be the ultimate solution to reduce transport emissions. As a result, there is a considerable amount of research and development funding, as well as government incentives and subsidies to accelerate their development and implementation.

However, although FCEVs produce zero tailpipe emissions, generation and distribution of hydrogen used by the Fuel Cell, requires energy. Depending on the methods used to generate and distribute hydrogen, FCEVs could be more environmentally friendly than EVs, similar to EVs or much worse than EVs or other alternatives. Understanding which options provide the best results and which can be realistically achieved in the near future, is fundamental to understanding both the sustainability and environmental friendliness of FCEVs.

The outcome of this project is a clear assessment of the relative environmental impact of operating a range of ultra-low emission vehicle types. This is clearly valuable for regulators and authorities in understanding which technologies should be supported and under what circumstances each technology provides the greatest benefit.

Developing a cellular automata model for bicycle traffic modelling
The use of bicycles as a mode of travel in large cities is growing. To accommodate and encourage such growth there is a need for modelling tools that can deal with both vehicles and bicycles at the same or equivalent level of detail and with the similar theoretical vigour. Over the past 40 years the focus on bicycle traffic studies in some Western European countries has been in the preparation of design standards. Vehicular traffic theory has developed and matured while bicycle traffic modelling and theory are much less advanced. A knowledge gap has steadily grown in the areas of behaviour of bicycle traffic flow, and in the impact of bicycles on overall traffic movements.

In this project, a Cellular Automata (CA) model for simulating bicycle traffic flow was developed with potential application in designing and planning cycling infrastructure schemes. This project is the first stage of the research in which we have developed a CA model for bicycle-only traffic. The natural next step is to extend the model to include vehicle traffic to take account for the interactions between bicycles and vehicles.

Fast Response NO2 sensor investigation
The purpose of this project was to review NO2 sensor technologies with the objective of developing a robust optical NO2 Measurement System with sufficiently rapid response times to enable the measurement of kerbside NO2 tailpipe emissions produced by vehicles in real time.

The UK has been breaching legal limits for nitrogen dioxide since 2010 in 16 different cities and regions. As a result of the EU & UK court decisions there has been increased interest in the contribution of tailpipe NO2 emissions correlated with the vehicle producing the emission.

Through this investigation we have found several fast response NO2 measurement systems and have started to identify a market for this type of device. The main hurdle to overcome is to achieve sufficient accuracy and speed of response at an affordable price. Following on from this part of the project we would like to move on to building a prototype low cost device that provides an acceptable level of performance to help authorities measure air quality issues and target corrective measures.

3D Capture and Visualisation
In this project, advanced techniques were explored to capture, model and measure collision scenes and crashed vehicles.

The project investigated using scanned images to create 3 dimensional models for use in virtual environments. Within these virtual environments, it was shown that it is possible to model vehicle mirrors, experience blind spots and track hand and head positions in real time. This not only has application from an investigation perspective, but also provides the ability explore design and simulation capabilities. The groundwork established by the project has been taken forward into the 2016/17 Direct vision and blind spot simulator project.

A secondary objective of this project was to determine whether current collision investigation techniques could be extended by the use of alternative technologies. TRL already uses a range of methods to gather physical evidence. At one end of the measurement spectrum is direct measurement techniques. These include the use of a measuring wheel at the collision location, as well as the use of tapes and rulers for vehicle inspections. There are however some limitations to direct measurement techniques. They are not always wholly reliable and in some instances are not appropriate. This can either be as a consequence of a lack of access, or due to the requirement to adopt safe working practices.

At the other end of the measurement spectrum is fixed base laser measurement technology. This is a subject area in which TRL has a well-established competence and the ability to produce in house evidence of extremely high quality. However, other measurement technologies are available which might span the gap between these existing methods.

The project delivered a technology evaluation of three measurement tools, assessing their practical application in a collision investigation scenario. The tools evaluated included; laser scanning; photogrammetry (including PhotoModeler software); and a portable handheld laser scanner.

3.2 Reinvestment projects FY 2016/2017

This year's research programme is underway and promises to deliver some interesting insights into the ever changing transport landscape. We're looking forward to sharing our research findings in due course. In the meantime, below is a brief summary of the research topics.

Cybersecurity and the Internet of Things
The Internet of Things (IoT) is the broad concept of linking objects (including those in the transport domain) and although in its infancy, it is expected to have a profound effect on transport and mobility. Cybersecurity is already critical as transport becomes more connected, so cybersecurity in the IoT world encapsulates an important intersection of issues that will be explored as part of this project.

Machine Learning
This computer science project will explore the application of Machine Learning (ML) to transport data. Enabling a dynamic and self-learning approach, artificial intelligence of this nature has the potential to facilitate significant efficiency and performance improvements, to optimise the transport network.

Mental Health
Mental health is an increasingly important area of interest across many sectors, yet little consideration has been given to the relationship between transport and mental health. This research project will understand the ways in which transport systems can impact and improve mental health, providing the basis for future interventions and countermeasures that will improve the mental health of road and rail users.

Truck Platooning
Vehicle automation is becoming more prevalent and more sophisticated. While a lot of this new technology is focusing on the automation of cars, the automation of heavy goods vehicles (HGVs) is gathering pace. Through this project we will explore the implications of this type of automation on transport network infrastructure.

Wireless Mesh Sensor Networks
The asset management technology review project (FY15/16) identified Wireless Sensor Mesh Networks (WSMN) as a promising 'smart infrastructure' technology. This project will understand the opportunity for and feasibility of, wireless mesh sensor networks for asset management applications.

Automated Vehicles
Automation of the driving task is progressing rapidly. Increasingly, we are seeing concepts that are transforming the experience for vehicle occupants into a comfortable, connected and user friendly environment. This project will explore how occupant protection characteristics of vehicles may need to evolve in order to provide passengers with an acceptable level of impact protection in this new era of vehicle design.

Head Injuries
Assessing the likelihood of traumatic head injuries from collisions is a core part of the work performed by TRL's Investigations and RAIDS teams. This project will consider a state-of-the-art approach to head injury assessments and its potential applications for collision investigations.

Virtual Reality
This project builds on last year's 3D capture and visualisation research. Taking TRL's virtual reality experience further, the project will explore the application of this technology to support a range of complex transport related scenarios.

Driving Simulation
Typically, driving simulators are considered standalone pieces of equipment, installed at host institutions. In this project we will work in partnership with other simulator facilities to establish the protocols for shared simulated driving studies, which may be vital for extending research on connected and automated vehicle operation.

Data Science
With additional funding this year, we will continue with our work on data science in transport scenarios. Using a combination of approaches, this project will explore the application of data science techniques to identify and solve complex transport issues. The project also forms the basis of TRL's connection to the Strategic Alliance Programme at CSAIL – MIT's Computer Science and Artificial Intelligence Laboratory.

3.3 Postgraduate research

Through our Open University programme, or via relationships with other academic institutions, the Academy is able to recruit and supervise both PhD and EngD students. A number of postgraduate activities are being funded by the Academy this year.

PhDs

The Academy is supporting two part-time PhDs via our status as an Affiliated Research Centre to the Open University. Both students are TRL employees and are focusing on international aspects of transport infrastructure. Via the Academy, TRL is also supporting and supervising two PhD students from Royal Holloway University of London and University of Warwick in the important areas of automated vehicles and data science respectively.

EngD

The Academy is also supporting the supervision of two EngD students from the University of Southampton. These students are exploring elements related to the modelling of electric and automated vehicle uptake and use.

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04 Our People

Below is a summary of other activities that our people were involved in within this quarter.

4.1 TRL Science in the media

- Helen Viner wrote the first of a new, quarterly TRL column in Highways Magazine on the infrastructure needed to support connected and automated vehicles
- Richard Cuerden was interviewed by WhatCar? about the safety of autonomous and semi-autonomous vehicles.
- Phil Clarke did an interview on 2nd August with The National newspaper (United Arab Emirates) regarding the proposal for UAE Federal certification of 'Accident Experts' (Forensic Accident Investigators).

  http://www.thenational.ae/uae/transport/plans-to-regulate-uae-traffic-accident-investigators-welcomed-by-experts
- In another front page article on 9th August in The National – Phil Clarke gave an interview regarding the 45% increase in fatalities on Dubai's roads in the first half of 2016 compared with same period in 2015.

  http://www.thenational.ae/uae/transport/safety-experts-want-to-see-more-police-on-uae-roads
- Phil gave another interview to the same paper regarding the benefits of the emergency vehicle priority system currently being implemented at some of the signalised intersections in Dubai. This included comment on drivers currently not giving way to emergency vehicles and the need for awareness campaigns to try to improve this.
- Phil Clarke did a live radio interview on The Agenda show (Dubai Eye 1038) regarding the imminent 'Hyperloop' development competition – interview focused on the potential merits of such a travel system for commuters, tourists etc.

  http://gulfbusiness.com/hyperloop-train-travel-dubai-fujairah-less-10-minutes/#.V6q_CVJPodV

4.2 Lectures, presentations, conferences

TRL staff are regularly invited to participate in conferences and symposia, recent events in this quarter include;

Event	Topic(s)	Participant(s)
Roads UK Conference, London	Automation and Infrastructure	Nick Reed
Automotive Council Air Quality subgroup, London	Potential solutions to mitigate transport impacts on health	Richard Cuerden
Government Office of Science Emerging Technology committee, London	Automated Vehicles	Nick Reed
International Conference on Traffic and Transport Psychology, Brisbane	Driver inattention, Driver frustration, Electric, vehicles, Autonomous vehicles (GATEway), Driver testing and licensing	Neale Kinnear

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05 Publications

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This quarter's publications by TRL staff (links provided where available).

Some Aspects of the Interaction between Landslides and Forestry Operations
MG Winter PPR794

http://trl.co.uk/reports-publications/trl-reports/report/?reportid=7051

Scottish inspection panel report 2015
MJ McHale PPR790

http://trl.co.uk/reports-publications/trl-reports/report/?reportid=7046

Review of hydraulically bound materials for use in Scotland
D Bateman and J C Nicholls PPR792 L

http://trl.co.uk/reports-publications/trl-reports/report/?reportid=7048

Trial of surface dressing with SAMI: Final report
MJ McHale PPR793

http://trl.co.uk/reports-publications/trl-reports/report/?reportid=7049

Understanding variation in car use exploration of statistical metrics at differing spatial scales using data from every private car registered in Great Britain
SD Ball, S Cairns, P Emmerson, RE Wilson, J Anable, T Chatterton MIS017

http://trl.co.uk/reports-publications/trl-reports/report/?reportid=7045

Monitoring of surfaces on the A46 Sixhills to Widmerpool: September 2013 to June 2016
PD Sanders PPR785

http://trl.co.uk/reports-publications/trl-reports/report/?reportid=7043

Rapid Charge Network: Station canopy feasibility study
J Hopkin and C Torkington PPR786

http://trl.co.uk/reports-publications/trl-reports/report/?reportid=7044

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