Research &
Innovation
in Steer

steer

Contents

Foreword

For Steer Davies Gleave, robust and insightful research is a prerequisite, and continuous innovation essential.

It is these qualities that allow us to address the most pressing issues facing our cities, communities and infrastructure providers, and to do so blending experience and fresh perspectives.

Our Research and Innovation Club, which recently celebrated its 100th meeting, epitomises this spirit, regularly bringing together staff of all grades, disciplines and offices to work collaboratively, and completing over 80 projects since its formation in 2013.

The club has a remarkable ability to deliver fresh insights grounded in the robust use of data, to advance professional standards and techniques and challenge the status quo when appropriate. These attributes are deeply valued; they also set a high benchmark for the next 100 meetings of the Research and Innovation Club!

Hugh Jones
CEO

Introduction

A few years ago, I talked to an academic guru about how to encourage innovation in an organisation like Steer Davies Gleave. One of his suggestions was to set up a 'club', a regular open event at which people could present ideas, problems or topics, with as wide a brief as possible, and to provide a way of following through on the best ideas. "Don't ask for permission", he said, "just do it".

And so, early in 2013, the first meeting of the Research and Innovation Club was held. We only invited recent graduate recruits, believing they would still be fresh with ideas from their time at university, their imaginations not yet constrained by the knocks of day-to-day consultancy. The meeting was kept strictly to one hour. There was no agenda, but there were rules restricting how long anyone could talk, to ensure everyone who wanted to contribute could.

It was a big success. A list of 'open topics' was generated and carried over to the next meeting two weeks later. In the meantime, volunteers were given modest amounts of time to investigate their topics, on condition they reported back at the next meeting. If an investigation turned out to require a lot of work, they were encouraged to submit a proposal for a more formal, internally funded, R&I project. In fact, anyone in Steer Davies Gleave can do that, at any time, whether or not they attend the Club.

After a while, as word got around, the Club was opened to all staff. With the meetings being held in London, mainly UK staff and colleagues from our Italian office (joining via video links) took part. However, in time clubs in South America and, more recently, North America, were set up.

We made efforts to share our work within the company and outside, holding 'Showcase events' where we gave quick-fire presentations of some of our best pieces of work to a selected audience. The meetings continued regularly, every two weeks until, in March 2017, we held the 100th R&I Club meeting. This occasion was a good time to pause and look back at what we have achieved over the last four years, and this booklet is the result. I believe it gives a fascinating account of the range of topics our staff have taken on and developed since the beginning of the club. Some large, some small; many in the UK but others run in our overseas offices; some highly technical, others using soft skills; but all of them always challenging and thought provoking.

One of the reasons we invest in Research & Innovation is that it works. It delivers ideas, knowledge and products that we can use in our work to improve the service we offer clients.

I hope you will find this booklet interesting and even surprising. And if it stimulates ideas for new lines of R&I work, maybe working collaboratively with our staff, please get in touch.

John Swanson
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R&I Projects

Funded and larger projects

Legend
Rail Network
Bus Network
Road Network
Central
Inner Urban
Outer Urban
Rural

UDM – Lite

For many years, Steer Davies Gleave has had a simulation model of how transport interacts with the shape and form of cities and regions.

Known as the Urban Dynamic Model, or UDM, this model has been used in numerous locations in England and Scotland to test how transport investment or policies will impact on a city or regional economy. The headline indicator is usually employment, but the model provides many other measures: travel behaviour, population, workforce, unemployment, dwellings, commercial property, and emissions.

However, in times of budget constraints, the market for even moderately expensive models has shrunk. This R&I project set out to develop a simplified version of the UDM that would be significantly less costly to implement, while having very fast run times. Both objectives were achieved admirably. We use a variety of off-the-shelf data sources to initialise the model, drastically cutting the set-up time and cost, and have developed a sequence of calibration and validation checks for each new implementation. Simplification of the model's internal engine has cut

runtimes sharply to, typically, just a few minutes to simulate as much as twenty years. We also developed a prototype online version of the model, which we are now developing further and expect to release this year. We believe this will deliver a quantum leap in the technology of practical urban simulation.

Who should be interested?
Anyone wanting to develop balanced transport and land use policies for their city or region to support their local economy.

Key value of the project

- Significantly reduced set-up time and cost
- Faster run times
- Proved the feasibility of an online version
- UDM-Lite used on three commercial projects to date

Asset maintenance: tracks and engines

Asset maintenance is a widespread managerial concern. While there are differences in detail, many asset maintenance problems have common underlying properties.

Typically, there is a stock of assets – vehicles, track, infrastructure – that deteriorates with time and use, may be subject to random failures that get more frequent with age and that will need to be replaced at some stage. Service delivery will be interrupted by breakdowns, and there may be penalty costs associated with the disruption. Management might take any of several approaches to maintenance, ranging from reliance on preventative maintenance (delivering high levels of service but possibly entailing unnecessary costs), through to a purely reactive approach, where assets are fixed when they breakdown, and replaced when they are life-time expired.

In 2013/14, we built a simulation of the life cycle of Light Rail track, following it from new, through various stages of wear and tear (and associated changes in performance), to life-expired. The work was done using data supplied for that purpose by a local authority and showed, fortunately, that the programme of renewal being undertaken at the time was, in fact, the best policy. A revised version of the model was then developed in partnership

with a Rolling Stock company, to look at engine maintenance.

Although the life-cycle differs in detail, the underlying structure of the model was very similar to the original. However, an interesting difference this time was that we used an online simulation environment to build the model and make it available to the Rolling Stock company, without them needing to install any new software. This time, the model suggested that savings could be made by changing the timing of major overhauls, something that the company's management had already suspected.

Who should be interested?

Organizations with assets to maintain over long periods of time.

Key value of the project

- We now have a tested high-level asset maintenance model ready for new applications
- Realism tested with the cooperation of two organisations responsible for maintaining significant asset stocks
- Demonstrated the feasibility of providing on-line models of this type
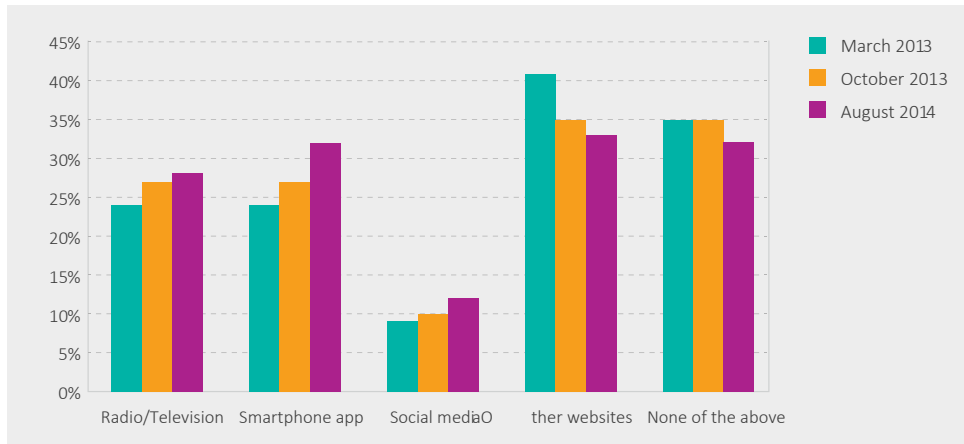
Information people use to plan their journeys

In 2013, one of our market research partners gave us the chance to insert two questions in one of their omnibus surveys. These are surveys sent out to large numbers of people at regular intervals to explore lifestyles, consumer choices, travel preferences, and so on.

Normally there is a charge for inserting questions, but this was a free offer, and we took it. We used our two questions to ask about experience of travel delays, and about sources of information people had used to help plan trips. The questions were repeated in three waves over 2013 and 2014, with over 2,000 respondents replying in each wave.

We found a clear increase in the number of people reporting delays over the three waves. At the same time, there was a change in the types of information people were using: travel apps became steadily more important; the use of social media, while far behind apps, also grew; and the use of websites declined (see image on the right). London was far ahead, compared to the rest of the country, in terms of app usage. This probably reflects the fact that this is the city where the earliest apps were targeted. Interestingly, the use of radio and TV as means to help plan trips held up strongly, even increasing over time.

We gained an insight into how the use of information was changing, learning that the rate of change was rapid, and that there were clear differences between London and elsewhere in the country. We also learned about how useful insights can be gained quickly and at low cost when using a few well-designed questions (even if we'd had to pay, the cost wouldn't have been great).

Who should be interested?
Organizations with assets to maintain over long periods of time.

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Heatmap showing areas by combined cost of commuting and housing © Steer Davies Gleave
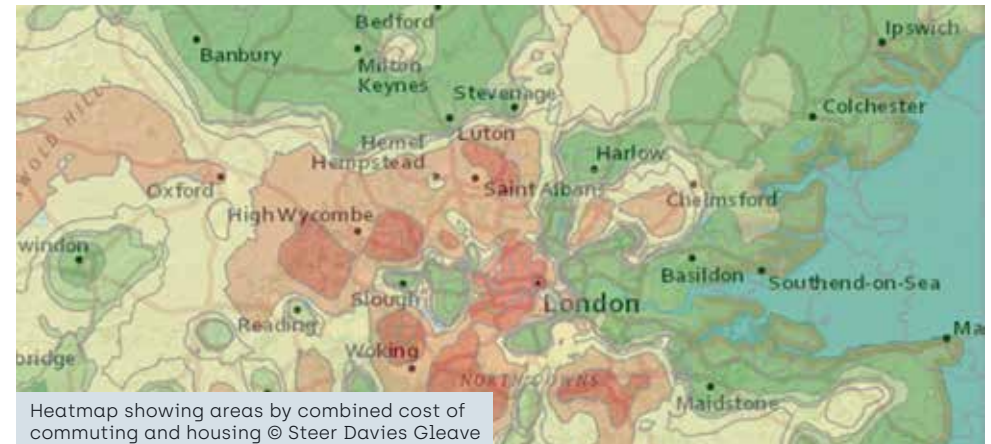
Using the Open Access Rail Fares database

In January 2013, the Association of Train Operating Companies (ATOC) started to publish data extracted from the Rail Journey Information System – in essence creating an open source database for rail fares in Great Britain. The data was not supplied in a ready-to-use format, so we downloaded and processed it to create a database system with some 18 million records.

We began exploring the potential for this data by looking at the prices of commuter season tickets into London. This showed some surprising variations, depending not only on distance but also between corridors and radial sectors; for example the costs for one particular pair of stations eight miles apart differed by £1,500pa.

We then combined the season ticket prices with the cost of housing, and plotted heat maps showing how the combined cost of commuting and housing varied geographically. Some findings were no surprise at all: central and inner-London are very expensive. Other findings confirmed what everyone suspects: West London is expensive, but there are areas east of the capital that are much less costly, while 'new towns' tend to be

bargains, at least by comparison. This work attracted the interest of the press and BBC radio.

Later releases of the data allowed us to produce analyses of how costs had changed year on year, while, as our database interrogation system improved, we were able to produce similar analyses for each of ten regions in England.

Who should be interested?
People involved in rail policy; anyone deciding where to live in the South East of England.

Key value of the project

- Experience of using the Open Access Rail Fares database

- A significant resource (i.e. the processed fares database) for future consultancy work

- New insights into season ticket pricing
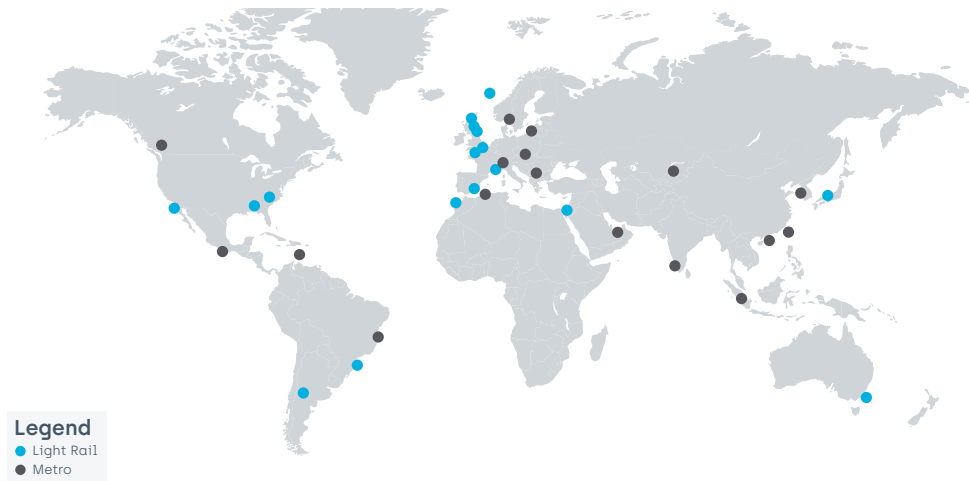
Benchmarking Metro and Light Rail construction costs

This project set out to compare the construction costs of Metro and Light Rail systems.

We assembled cost data for forty systems worldwide, twenty of each type. The comparison was based on estimates of the construction cost per kilometre of line. It showed, not surprisingly, that costs for Metro were higher than for Light Rail, but also that the picture is more complicated than that.

There are wide cost variations within each type of system, and these seem to be due to factors such as:

- City densities, which can affect the costs of delivery of materials and construction activity.

- The features of the line, especially how much of it is below ground, at surface level, or elevated.

- Local economic and social factors such as the availability and cost of skilled labour.

The ratio of Metro to Light Rail unit costs also varied by region and, at the time of the project completion, it was around

6 for Europe, Africa and Asia; but 1.6 for North and South America. A regression model was built relating unit costs to the factors found to generate differences in costs. This explained about 50% of the variation in costs. The results were used to build a spreadsheet capable of providing initial estimates of Metro and Light Rail unit construction costs, given a base specification.

Who should be interested?
Anyone considering the costs of building LRT or Metro systems.

Key value of the project

- A substantial database of Metro & LRT construction costs from projects across the world

- Insights into what causes these costs to vary

- A model for providing initial estimates of construction costs to a given specification
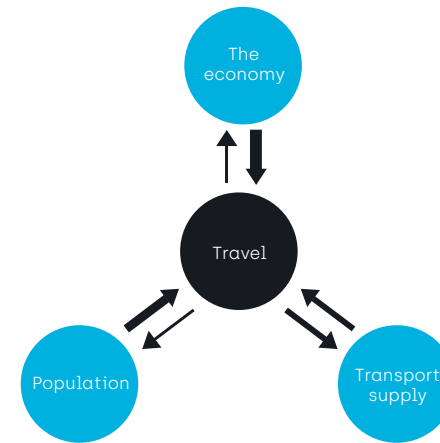
How well do transport models work?

This project was prompted by one of the flurries of criticism of transport models and forecasts that appear every few years in the trade press. The accusation usually is that the forecasts invariably turn out to be wrong, sometimes with hints that the reasons are something to do with the incompetence or mendacity of the modellers.

At the time, we were aware of a very thorough review Transport for London (TfL) had carried out of the performance of their models, including a careful analysis of factors that affected their accuracy. [1]

Some examples of this from TfL were the expectations that: car use would grow as London grew; car ownership and use rise with income; people switch modes as their incomes rise, from bus to rail, to car; and, consequently, use of public transport falls. In London, none of these things have happened over the last decade: car use has stabilised (or even fallen), while public transport use has increased. The reasons identified by TfL were various: some were deliberate policy-led changes (i.e. fares, public transport capacity, use of road space), but others were due to large social and economic changes that almost certainly could not have been

foreseen. For example, there has been a densification in central London, while car ownership among the young is lower than for earlier generations, and there are many more workers from overseas who are more likely to be dependent on public transport.

We debated TfL's evidence at workshops and compared it to our own experience. Our observations were:

- Many of these social and economic changes have a significant bearing on outcomes, but transport models may be blind to them or make hidden assumptions about them (as in 'no change').

- Often, these changes are slow to take effect, building up over the years. Population growth or changes in land-use are examples of this as neither of them happens instantly.

- Uncertainty about these factors inevitably increases the further into the future we try to look.

- Consequently, the value of highly-detailed but narrowly-focused models falls as forecasting horizons increase; this is because the balance of influence shifts from local transport factors to larger social and economic changes

- It is possible for a transport model to be perfectly 'correct' in its own terms, but still to give incorrect forecasts.

1 The evidence we refer to in what follows comes from the TfL work, which is largely in the public domain, and for which we thank TfL; the commentary and conclusions are ours.

Who should be interested?
Anyone involved in long-term strategic transport modelling

Key value of the project

- Engagement with TfL's work

- Valuable internal debate

- Lessons for future strategic transport modelling work
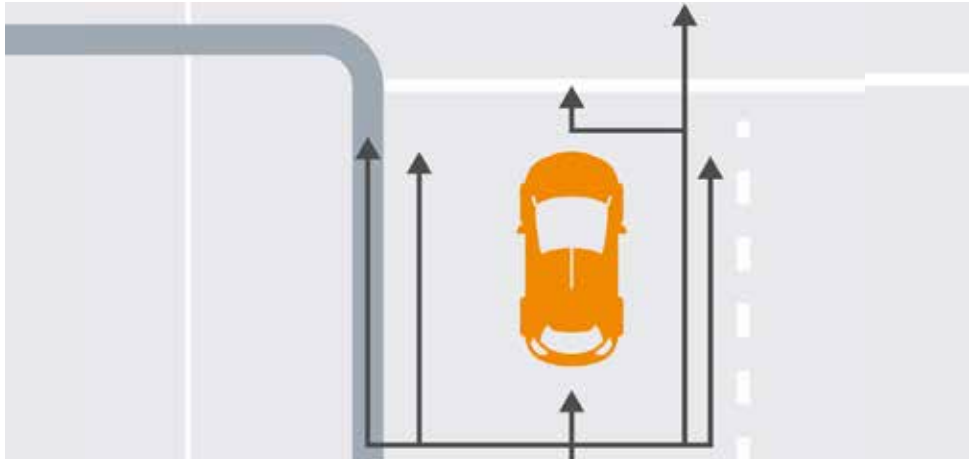
Female cyclist deaths in London

Following a string of fatal cycling accidents in London in 2015, a number of news outlets highlighted what appeared to be a gender gap in cycling fatalities, with females appearing to be more likely to be involved in fatal collisions.

We analysed data published by Transport for London and carried out a review of scholarly and journalistic articles published on this topic. The main finding was that, given the ratio of female to male cyclists, females were indeed disproportionately represented in collisions with Heavy Goods Vehicles (HGVs).

Potential reasons behind this were addressed in a paper by Frings, Rose & Ridley (2012), which concluded that in cases where HGVs were stopped at traffic lights, females were more likely to overestimate the risk of overtaking on the outside, leading them to undertake on the inside instead. This is a dangerous manoeuvre, given the turning circles and visibility constraints of HGVs. Males, on the other hand, generally considered overtaking on the outside to

be less risky. An additional finding of the study was that advanced cycle training (such as Bikeability Level 3) was found to alter perceptions of the risk of overtaking on the inside.

Who should be interested?
Anyone involved in cycle safety (incl. Bikeability), behaviour change, or urban design.

Key value of the project
- Provides valuable insights about cycle safety to be used in our cycle training and bikeability projects

Understanding major events, live sites, and road events

Summer 2014 saw a number of world class sporting events take place. To build on our Sports and Major Events Team's knowledge of event operations, members of staff attended several of these events - including the Brazil World Cup, the Glasgow Commonwealth Games and the Yorkshire Tour de France Grand Depart - to undertake transport and crowd movement observations.

A particular focus of this work was to gather information about the popularity of live sites and road events so we would be able to give better advice to clients about expected crowd sizes. By including observations made at the Brazil World Cup, our Sports and Major Events team has strengthened their knowledge of major event operations beyond the UK.

Our observations have allowed us to develop event arrival and departure profiles, identify the gender ratio at

football world cup matches to inform toilet provision for a major sports stadium, and provide advice on the security requirements for a range of event types.

This project has helped to provide Steer Davies Gleave with the knowledge required to pitch for, and win, work at major events.

Who should be interested?
Stadia, event organisers, transport operators and planning authorities.

Key value of the project
- Empirical evidence about attendance and crowd behaviour at major events
- Improvements in the accuracy of forecasts we make for clients about attendance and crowding
- Proven impact on our ability to win work
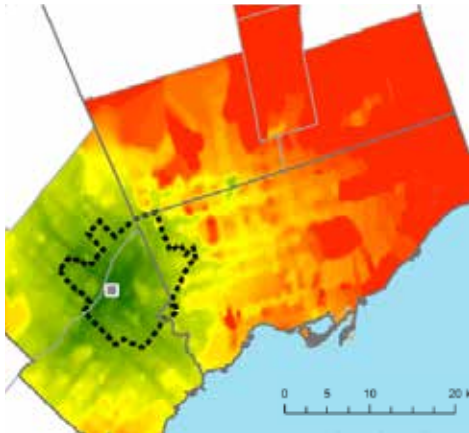
Examples of different ways of presenting T5 analysis © Steer Davies Gleave

T5: Using GTFS data feeds to support transport planning

Many public transit agencies around the world use the General Transit Feed Specification (GTFS) data format to make their schedule data available to third parties for use in apps, websites, and in-depth analysis.

Our work on improving public transit services in and around Toronto Pearson Airport created a need to analyse transit travel times in a multi-agency environment to a variety of points within the study area. To do this, we created a bespoke tool to use the GTFS data from the various agencies to analyse travel times.

Recognising its potential wide applicability, the R&I project funded upgrades to the tool to improve its run time and usability, as well as the creation of documentation to aid its use by staff members beyond the original development team. The resulting total transit travel time tool (or "T5" for short), has since been used on a wide variety of projects. The tool is also sufficiently quick for us to be able to include client-specific examples of its capabilities in bids for work. Some examples of how we can

present our analysis are shown above. The red-green "heatmap" shows travel times to a point in a study area (shown by the dashed black line); green areas have the lowest travel time, and red the highest.

The dot-based image shows travel times to an industrial park on the edge of a small city in Alberta, with blue being the lowest travel time, and red being the highest travel time.

> **Who should be interested?**
> Anyone needing rapid analysis and presentation of public transport/transit service information.
>
> **Key value of the project**
> • Significant improvement in the usability of an existing tool developed for a particular project
> • A fully generalised version of the tool, useable wherever GTFS data is available
> • Full user documentation to help new users in the company
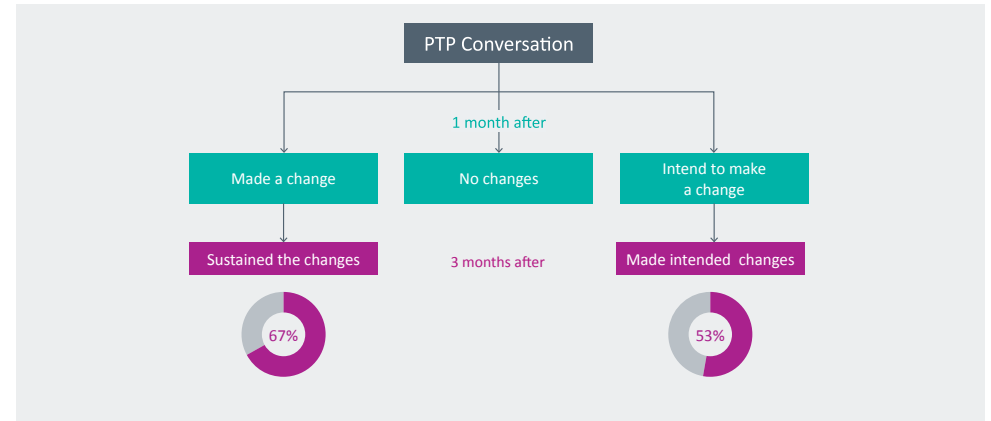
The longer term impacts of behaviour change projects

Guidance from the DfT2 highlighted the lack of evidence on the longevity of smarter choices interventions such as personalised workplace or school travel planning, public transport information, and travel awareness campaigns. This lack of evidence meant that in evaluating these types of intervention very conservative assumptions had to be made, such as a decay rate of 33% per year.

Our experience on the ground led us to believe that once someone had successfully adopted a new behaviour it became a habit, to be continued until a new interruptive event (such as moving house) initiated a re-think. This R&I project was set up to test this hypothesis. We went back to participants in two of our Personalised Travel Planning (PTP) projects in Thurrock and Cheltenham, to see whether the changes they had made had been sustained, or they had lapsed into old behaviours. The follow-up interviews confirmed that the great majority of participants who had changed their behaviour by travelling more sustainably (using car less, travelling by bus, walking or cycling more) either gave up in the first few weeks or sustained the new behaviour. There was hardly any noticeable on-going relapse. The overall result was that, on average, 67% of participants had sustained the change after three years, with nearly all

the drop-off happening within the first three months. This provided useful quantitative evidence for what we believed happens.

An additional unexpected finding was that just over half of those saying that they intended to make a change to a more sustainable travel behaviour, did so within three years. Prior to this evidence, we had tended to write-off this intended change, assuming that people wouldn't get round to it unless given another external nudge. The overall benefit of this project was to provide evidence which implies a much higher BCR for behaviour change projects than previously assumed.

> **Who should be interested?**
> Anyone considering investing in travel behaviour change projects.
>
> **Key value of the project**
> • Empirical evidence for the persistence of behaviour change
> • New understanding of when drop-off occurs and whether "good intentions" become real

Managed lanes and traveller choice

Managed lanes, found mainly in the USA, offer drivers a choice between driving on a regular freeway lane or paying a toll to drive in a lane that offers less congestion and quicker drive times.

This project was prompted by evidence that a significant number of drivers were paying to use managed lanes but receiving very small time savings, and that the lanes were not only used by travellers with higher incomes. We set out to explain these somewhat counter-intuitive observations and to understand better how drivers decide whether or not to use a managed lane.

We first examined stated preference data from a Texas A&M University study which showed that the value of time of travellers in urgent situations is higher than that of travellers in ordinary situations. Importantly, the value of time was often higher for low-income groups in urgent situations than for high-income groups in non-urgent situations. This suggests that travellers on managed lanes are not necessarily those with high-incomes, but those on an urgent trip, whatever their level of income. However, while these findings suggest a substantially higher value of time for urgent trips, they do not explain why managed lanes are used even when the expected time savings are very small. A recent Texas Department

of Transportation survey into travellers' motives for using managed lanes found that travellers attach high value not only to travel time savings, but also to increased travel time reliability, while the third most valued factor was having a less stressful journey. Toll transaction data shows that managed lanes can, in fact, provide increased travel time reliability, but does not explain directly either how travellers perceive reliability or how they change their behaviour in response to a change in it.

The project provided valuable insights (the importance of reliability rather than time savings, and the effect of urgency), but there remain many other questions about the relationship between perceived and actual travel time, and drivers' responses to them.

Who should be interested?
Anyone designing managed lanes or similar tolled highways.

Key value of the project
- Provided an explanation for an apparent paradox: that people pay yet get very little time saving
- Showed the importance of reliability
- Suggest that propensity to use a managed lane increases with trip urgency

Fuel prices and travel demand

In the second half of 2014, oil prices fell rapidly by roughly 40% and, in turn, this led to a drop in car fuel prices. An R&I team set out to examine whether this drop in prices had affected car travel.

Unfortunately, statistics about car use and travel volumes are only available with a long delay. Fuel sales data is, however, available much sooner, so we set out to measure the relationship between price and sales. The analysis showed long-term trends of a decline in petrol sales, and a compensating rise in diesel sales (a trend which is unlikely to continue).

Overall, fuel sales showed a distinctive seasonal pattern, but had been relatively stable for many years up to 2008, after which they dropped a little. On the other hand, car-kilometres increased up to 2008, but the gap is presumably due to the rising efficiency of vehicles. The relationship with price, however was weak. Over the long term (we had data for January 1998 to January 2015) the elasticity of sale volumes with respect to price was estimated to be about -0.1.

Restricting the analysis to the more recent price reductions yielded almost no relationship: prices fell, but sales also fell. The work suggests that the relationship between price and sales is weak, and other factors to do with the economy and car technology are probably more important. Perhaps surprisingly, it also shows that, at least in the short-term, this is true even for substantial price changes, such as the one we saw late in 2014.

The answer to the original question seems to be that the fall in price had very little effect at all on demand for fuel and, therefore, little effect on travel.

Who should be interested?
Anyone analysing, modelling or forecasting car travel.

Key value of the project
- New estimates of fuel sales price elasticities in the UK.
- Practical experience of time series data analysis
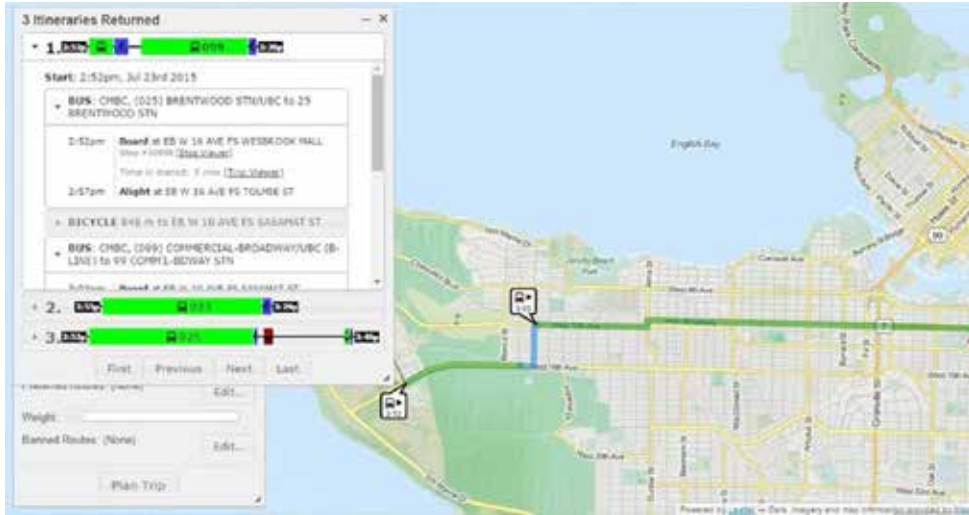
Journey planner research

Steer Davies Gleave has delivered 18 journey planners around the world for a wide variety of clients in different sectors.

Traditionally, we have relied on third-parties to provide routeing engines for specific modes, and we simply brought them together in a single interface for the end user. This method is very cost effective for the client but means we don't have any control over the results that are returned, and we are unable to provide routeing for more sophisticated options like park and ride services and car club vehicles.

The purpose of this R&I funded project was to develop an instance of Open Trip Planner (OTP) – an open source multi-modal routeing engine – to understand the effort required to set up a comprehensive, locally-specific OTP, and, just as important, to keep it updated after that. We used the fund to set up an OTP for Vancouver which was able to plan trips across the city by any mode, including truly multi-modal journeys such as cycle/bus and park and ride. The set-up was relatively straightforward. However, it became clear that keeping the Planner up

to date afterwards by capturing updates to datasets, particularly service schedules and the road/cycle/walk networks, would be labour intensive and an important cost consideration for clients adopting this approach.

Lessons learnt from this project have been successfully applied to a number of our more recent projects involving General Transit Feed Specification (GTFS) data, which has become an international standard, especially in North America.

Who should be interested?
Anyone wishing to develop a journey planner or who needs help understanding Open Street Map or GTFS data.

Key value of the project
- Experience gained of Open Trip Planner
- Successful implementation in Vancouver
- Experience transferable to new commercial projects
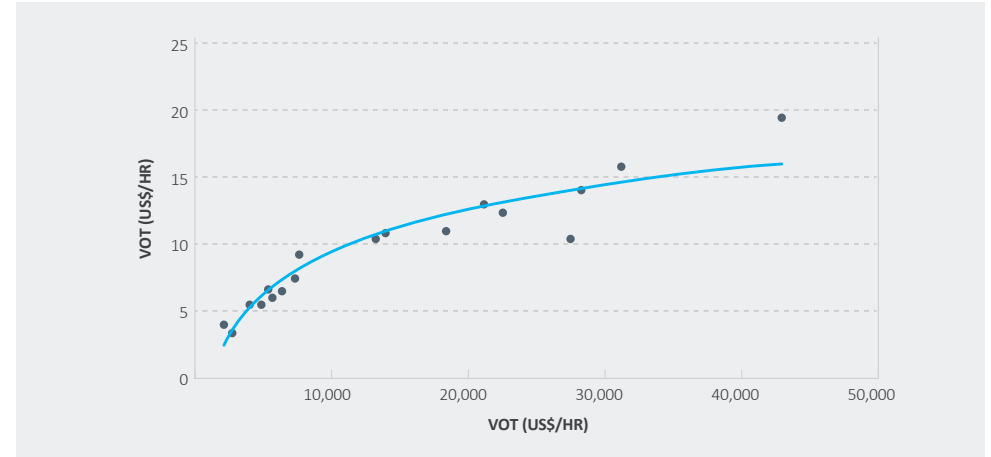
Review of Value of Time evidence

The value of time (VoT), or more accurately, the value of travel time savings, is a parameter that underpins the business cases of many transport investment projects.

Over the years, we have carried out many studies around the world where local values of time have been measured. This project was commissioned to review the body of evidence we have collected, and to carry out a comparative analysis. We chose 18 projects carried out between 2008 and 2013. They covered 17 countries, with highways, rail, and bus investment projects, for toll roads, access to airports and others.

A comparative analysis showed that:

- Values for HGVs were larger than for private cars by factors ranging from 1.5 to 3.1;

- The ratios for airport users were even higher, between 3.5 and 4.5;

- Values for bus users were about half those of car users.

The relationship with GDP is often a

crucial assumption when forecasts are being made; the value of time rises with wealth but by how much? The evidence from our study was that it does rise, but – admittedly using relatively few examples – not linearly.

Who should be interested?
Anyone using VoT to support an investment project, especially if local estimates are not available.

Key value of the project
- Empirical evidence of how values of time vary across countries and between modes

Commuting on the Thames

The River Thames has been crucial to London for 2,000 years, providing a thoroughfare within the city and a link to the rest of the country and the world.

The growth of the port of London was key to the development of the city as a centre for world trade, and up to the end of the 19th century there was massive investment in docks and riverside industries. However, the second half of the 20th century was a period of decline, as containerisation, air freight, and the loss of industry took their toll.

Now we see change and regeneration in the form of older industrial buildings and warehouses being converted into residential units. The London Plan envisages substantial increases in housing units and employment on the riverside, not all of it well-served by the existing surface transport networks. The question for us was: can the river provide transport that is sufficiently attractive to serve these new developments? While still a minority mode of travel for commuting, River Bus patronage has been rising steadily (the work was done in 2014), and services have expanded. For the future, we identified a mix of opportunities and constraints. River Bus services tend to be slower and more expensive than competing public transport modes, while there has been some inflexibility over ticketing (this has been partially addressed since 2014) and poor connections with other public transport services. On the other hand, the vessels offer more comfort and free wifi, which may be attractive to many commuters. The big issue though is capacity. There are gaps in the provision of piers in central London with limited opportunities to provide more; there are many different pier owners; and there are limited facilities for maintaining the boats.

Expansion of river traffic is part of the mayor's transport plan for London, and if these constraints can be addressed there is good reason to think the river could once again be an important transport thoroughfare for Londoners.

Who should be interested?
London planners, historians, residents, workers and visionaries.

Key value of the project
- Enhanced awareness and understanding of the Thames as a transport mode to support London's new riverside regeneration
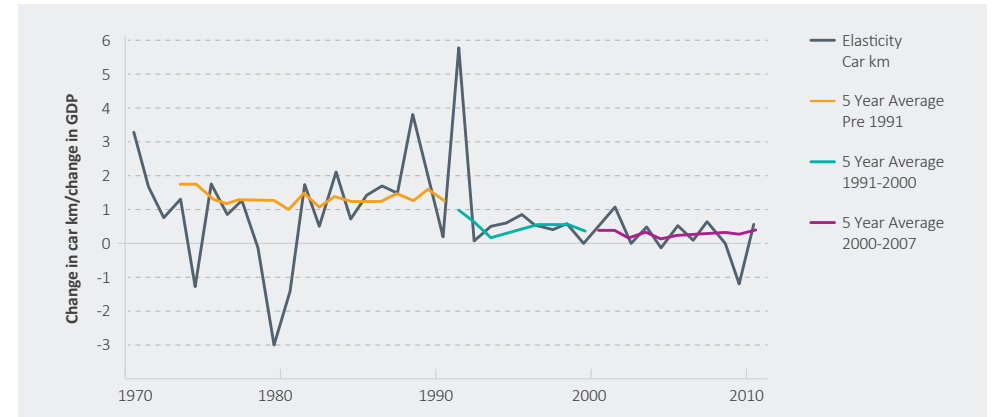
UK road traffic and the economy

The business case for road projects depends on forecasts of traffic volumes, and they almost invariably depend on forecasts of the future state of the economy.

The underlying assumption is that there is a relationship between the economy, typically measured as GDP, and travel volumes. This project set out to examine the strength of that relationship in the UK, particularly in relation to significant changes in the economy such as the recession of 2008/09. The work was done using publicly available data. The analysis tools were a mix of graphical exploratory analysis and formal multiple regression.

Travel volumes by car in the UK increased steadily for many years until the start of the recession, when they levelled off and even started to fall. The relationship with GDP seems to have varied over the period 1970-2011. There was a clear positive correlation up to 1991, after which the relationship weakened, and towards the end of the analysis period the correlation declined almost to zero.

For Heavy Goods Vehibcles (HGVs), the picture is different. HGV activity is more directly linked to the economy, and the correlation – and consequently the elasticity of travel with respect to GDP –

has been stronger over the entire period. There is evidence that for cars, the results vary by type of road. Growth on motorways persisted for longer than on strategic roads, which in turn persisted longer than on urban roads. This is possibly connected to the more recent provision of new capacity on motorways and the strategic network after the urban roads had, effectively, become 'full'.

In summary, for cars the link with GDP has weakened steadily over time, and other factors, possibly including capacity, are influencing behaviour. HGV traffic, being more directly related to the economy, has shown a more persistent relationship over time.

Who should be interested?
Anyone making forecasts of travel based on projections of economic performance.

Key value of the project
- Insights into how the relationship between the UK economy and traffic has changed over recent decades
- Staff experience of time series analysis and modelling

Personalised Travel Planning in San Diego

Personalised Travel Planning (PTP) is a commonly employed form of community-based social marketing in the United Kingdom.

It involves door-to-door outreach using motivational interviewing techniques to understand a participant's current travel experience and any barriers or frustrations they encounter with their current mode or alternatives. The aim is to provide advice about travel that helps participants meet their needs while reducing their reliance on car travel.

While we have much experience of PTP in the UK, there was concern about how practical it would be in the United States. There were several reasons for this: some were cultural, such as public attitudes to car and public transportation; others related to the physical environment, for US cities have much lower population densities than cities in the UK. To test how transferable the technique would be, Steer Davies Gleave, in partnership with the San Diego Association of Governments, implemented a pilot project, Travel Encinitas, in San Diego in March 2014.

A total of 372 households were visited over three days. Successful interviews were carried out with two-thirds of them, and around half then participated in the PTP programme. Five weeks after the

initial contact, we carried out telephone interviews with participants to review their travel behaviour. We found evidence of significant change, including a ten percentage point reduction in lone car driver mode share, a five percentage point increase in bike mode share; and a six percentage point increase in walking mode share.

Our conclusion was that the pilot study showed not only that PTP or Individualized Marketing (IM), as it is more commonly known in the United States, was practical (allaying many of the earlier worries), but that it is also effective. Since then, we have gone on to deliver four similar projects in the US including one for a transit agency with a specific goal of increasing ridership on a recently improved bus route.

Who should be interested?
City or regional administrations in North America considering the use of PTP to reduce car travel.

Key value of the project
- Proof that PTP can be carried out successfully in the US
- Lessons about how to achieve that success
- Several new commissions as a direct consequence of this success

Cycling Potential Index for North America

Cycling is often encouraged as a way of improving health and reducing reliance on car travel. However, the underlying potential for cycling differs greatly across our cities and towns.

The Cycling Potential Index (CPI) was developed to help identify places most likely to deliver good returns on investment in infrastructure and other efforts to encourage cycling.

The index is based on three criteria: hilliness, socio-demographics and trip length. It can be mapped to show areas where potential is high, and compared to data about actual cycling behaviour, or current cycling infrastructure such as segregated cycle lanes. A simple differencing can then be used to show where potential is high but cycle use is low: these are areas where new cycling initiatives are likely to be most successful.

The R&I project tested the technique in a range of case studies in Boston, Vancouver and Portland. Since then it

has been further adapted to be used in consultancy projects in Mexico and Puerto Rico.
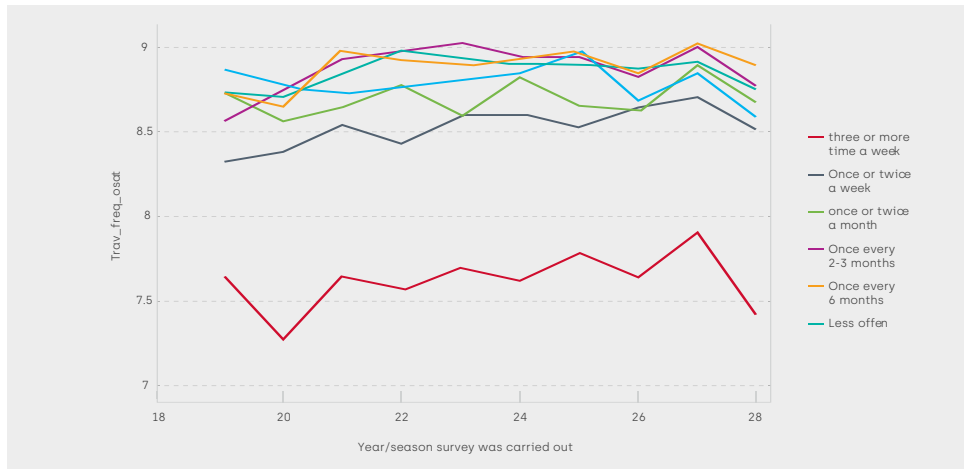

Who should be interested?
City or regional administrations in North America considering the use of PTP to reduce car travel.

Key value of the project?
A proven, transferable tool that can be applied quickly to map out where investment in cycling projects is most likely to be successful

Better use of the National Passenger Survey

The National Passenger Survey (NPS) is a large survey of rail passengers in the UK, carried out by Passenger Focus.

Over 50,000 passengers are interviewed each year, and asked about their satisfaction with thirty aspects of their travel experience. The survey therefore provides a very large database about trends in rail passenger satisfaction over time. Train operating companies (TOCs) use NPS scores to help make investment decisions, and franchise bids will often include discussion about the impact on satisfaction of new investment. However, it can be difficult to quantify that relationship, with little evidence available to advise TOCs about which kinds of investment will have the greatest impact on satisfaction. This project set out to analyse more closely this relationship, and to provide tools to help TOCs identify which investments would have the greatest impact on satisfaction.

The project was divided into three phases: data assembly and a review of trends; detailed statistical modelling of the relationship between overall satisfaction and satisfaction with lower level attributes;

and a review of best practice in other countries and markets. The statistical work, based on logistic regression, developed models that quantified how much influence, or leverage, passengers' answers to lower-level satisfaction scores had on overall satisfaction scores. The models were tested by developing them using data for 2013, and then checking how well they predicted respondents' overall scores for 2012. They all performed well.

The work gives us a quantified, validated, basis for advising TOCs where to invest to have the greatest impact on future passenger satisfaction scores.

Who should be interested?
Train operators seeking to improve customer satisfaction.

Key value of the project

- A quantified tool for advising TOCs where to invest to have the greatest impact on future rail passenger satisfaction scores

Analysis of Rugby World Cup Journey Planner data

Steer Davies Gleave designed and built the journey planner application used by over 500,000 people to help plan their journeys to rugby matches during the 2015 Rugby World Cup.

The planner was linked to a Google Analytics account which collected anonymised data about the information people requested from the app. The objective of this project was to analyse that data, to help us better understand how people had used the planner, and to learn from that how to improve it for use in future major sports and other events. Google Analytics provided a rich picture of people's enquiries: their origins and destination stadia, preferred modes, timings and their use of 'secondary' information provided by the planner. We were able to plot GIS maps of origins and modes, and to see how the use of the app peaked over time in anticipation of matches.

We found some of the functionality was used very little, such as printing journey details, or non-match specific journey planning. On the other hand, we observed

a greater interest than expected in some areas like taxi travel. In addition, as the planner was used by people in countries all round the world, we concluded that planner designs must recognise the truly international and multi-lingual audience they will be serving.

The results of this work have been used in successful bids for new work at major sports stadia events in Europe and elsewhere, most recently a mobility app for the 2017 UEFA Champions League Final in Cardiff.

Who should be interested?
Organisers of large stadia events.

Key value of the project

- Detailed analysis of and insights into how the 2015 Rugby World Cup journey planner was used by over half a million people
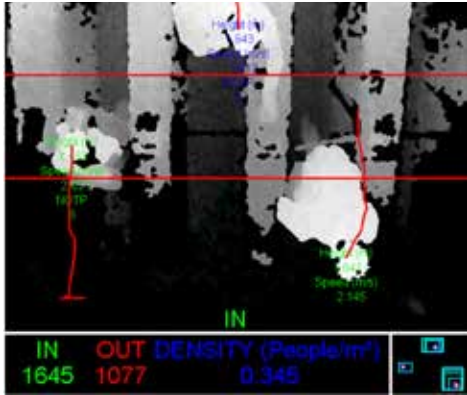
Still image from the 3D cameras video capture. The vertical bars are the gate-lines, and the whiter shapes are people, viewed from above.

3D Infrared People Counter

The capture of accurate crowd flow data is an essential part of many projects and it can be essential for the safe management of crowds in stadia, stations, or other public spaces. It is also a required input to many micro- simulation models of crowd behaviour.

This data capture is also difficult to do. Typically, it entails manual analysis of video footage, which is slow and expensive. Automated techniques, like laser counters, can work well at controlled points, such as gate lines, but not in places where multiple bodies pass simultaneously. This project was done in collaboration with two MSc students from Imperial College, London, who had developed a prototype InfraRed tool to capture, track, and analyse crowd movements in complex indoor environments. The key innovation in their approach was to use a 3D Infrared camera to observe crowds.

These cameras provided a measure of depth, so that, viewing from above, it was possible to identify correctly the heads and shoulders of pedestrians, and any bags they were carrying, as they moved past the observation point. Steer Davies Gleave provided funding to allow the students to develop the software, and then ran a controlled test of the application in

a congested interchange station in Sao Paulo, Brazil.

The camera was suspended from the ceiling, above a line of ticket gates with simultaneous flows of people in both directions. The software provided real-time counts of the movements of people, and dumped data to file for later analysis. By comparison with the turnstile's automatic count, the 3D imager was 96-98% accurate, and was robust against events that could have caused confusion, such as people changing their minds at the point of entry/ exit, or people with unusually large bags.

Who should be interested?
Organisations responsible for the safe management of crowd flows and/or ticket revenue estimation.

Key value of the project
- Development of sophisticated 3D-imaging software capable of counting people moving in crowds
- Empirical testing of the product in a large, busy station

Twitter rail incident database

Anyone who has tried analysing events over time, such as rail passenger numbers over months or years, will be familiar with the problem of the unexplained blip: there is a change in the regular pattern, possibly transitory, but no one knows why it happened. If only there was a database of disruptive events we could refer back to.

That was the aim of this project, to build a database of disruptive events on the rail network that could be used to help explain those mysterious blips long after the event. And the method was Twitter. We wrote a programme to capture tweets from National Rail Enquiries, the Train Operating Companies (franchised and non- franchised), Transport for London (including London Underground), Network Rail and Eurotunnel; in other words it captures tweets sent out about service disruptions – and many other things – by all the major train operators in the UK.

This program captures the tweet text, the account it came from, the date, time, and information about how much

it was re-tweeted. The database has been backdated to 2009, and is being automatically updated constantly. Enquiry tools have been built to give staff access to the data.

The value of the database rises over time as the volume of data increases. It has been used in commercial project work, and we are now exploring ways of extending it to include other modes and sources of tweets.

Who should be interested?
Organisers of large stadia events.

Key value of the project
- A growing database of rail service disruption information for use in commercial work
- Experience of using the Twitter API for data downloads

Hackday

Take four teams of motivated people, give them challenging tasks, get them out of the office for a day of intensive collaborative work, and see what they can deliver.

This, in a nutshell, is how we ran our first SDG Hackday, back in April 2016. Well, it is, if you ignore all the planning that went on before the day: generating lists of potential topics, putting together teams, selecting topics with the maximum potential and the best match with the skills of the teams; finding a good venue with the necessary facilities; getting the t-shirts made.

The four chosen 'hacks' were:

- A process to provide a consistent and accessible companywide record of project experience to support proposal writing;
- A GIS tool to generate and display a local area 'attractiveness index' using publically available data;

- A model of 'surge charging' on the Underground to reduce super-peaks in demand; and
- A method for 'storytelling' through data visualisation.

Our teams worked intensively through a long day, interrupted from time to time to take part in entertaining (if not always immediately relevant) activities.

Who should be interested?
SDG staff awaiting the next Hackday.

Key value of the project

- Sharing of knowledge and experience
- The design for a new internal data capture system, subsequently implemented
- Practical use of data visualisation techniques
- Team building

At the time of writing, planning for Hackday2 is well underway.

Smaller exercises

Intermodal freight: "Modalohr" system

This research piece examined current innovations in intermodal freight, including the 'Modalohr' system, where containers are quickly transferred between lorries and rail waggons for onward travel.

Potential applications of the system to the UK were considered, but were not seen to be likely in the near future due to the restrictive gauging (size constraints) on the UK rail network.

Rolling stock financing

This was a brief research piece considering some of the factors that feed into a decision of whether to buy new railway rolling stock, or whether to refurbish existing stock.

It considered many factors, including the impact of disability compliance regulations, and electrification of railway lines.

The impact of communications technology on travel

This project, primarily a literature review, focused on how emerging communications technology is affecting travel demand through trip substitution, stimulation, or redistribution. In fact, we found no consensus about what is happening, while opinions were often in conflict.

The majority of studies we found (the work was done in 2013) pointed to a lack of empirical evidence, while what research there was tended to be somewhat tangential, looking at things like the impact on the value of time, with limited conclusions about the relationship with trip generation.

In short, this was an important topic, ripe for further study, and one we expect to return to.

The regional effects of High Speed Rail

We looked at High Speed Rail (HSR) in France, where there is evidence of both economic consolidation at the centre (i.e. Paris), and benefits to regional cities.

For regional centres to gain, there seem to be three requirements: local consensus about the need for action; good local connectivity between the HSR station, the city and its hinterland; and powers to shape land use in the vicinity of the station.

An interface between VISSIM and the UDM

VISSIM is one of the most popular software tools for micro-simulation of transport systems. The Urban Dynamic Model (UDM) is our simulation of towns, cities and regions.

This project's task was to develop an interface between the two, allowing transport networks built in VISSIM to be written out in a format ready for use in the UDM. A model of Parma, in Italy, was used as a test case.

Wider Economic Impacts calculator

Wider Economic Impacts (WEIs) can arise in some transport projects over and above the user benefits that typically underpin project appraisals. They arise from the densification that some projects can deliver, which has been shown to have a measurable effect on productivity and output.

The Department for Transport has published guidance for calculating WEIs in WebTAG. Under this project, we built a general tool in Excel to carry out the calculations.

Alternative uses for the old Royal Mail tunnels under London

Everyone knows about London's underground railways, but not everyone knows about the Royal Mail tunnels and stations, now out of use, but which were used for many years to move mail between Paddington and Whitechapel.

We were approached by an engineering consultancy with the idea of converting the tunnels into a new cycle superhighway under London. The feasibility of this radical idea was discussed at the R&I Club but, sadly, it was quickly clear that it would not work. Getting bikes down to the tunnels might be soluble, but a little geometry soon showed that the tunnels were far too narrow for this idea to be practical.
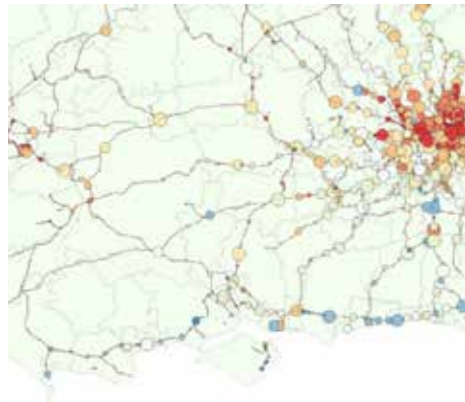
Analytics and data visualisation

These techniques are increasingly part of our mainstream consultancy work, but the R&I Club has done much work to develop them and to identify suitable tools.

Data visualisation and the construction of interactive dashboards for interrogating large scale databases, things that once required rare and expensive skills, are now readily available.

Escalators on the Underground

Anyone who has travelled on London's Underground will know there is an iron rule for users of the escalators: stand on the right, to allow walkers to pass on the left. In 2016, TfL carried out an experiment at one of its deepest and busiest stations, Holborn, asking everyone to stand – not walk– on the upward escalator. The result? The escalator's carrying capacity increased by 30%. The 'walkers' were now travelling more slowly, so how could this be?

The explanation is that Holborn is deep, so relatively few people choose to walk up, and they are separated by long gaps. When everyone stands those gaps are closed increasing capacity. On short escalators, more people walk and the gaps are smaller, so the gain would, presumably, be less.

And more...

The R&I Club works hard to maintain a wide brief, and has considered many other topics that we can only mention briefly.

At a time when many shops were closing we asked whether the high street is dying (probably not, but it is changing); we looked hard at new disruptive services and technology in transport and at the practicalities of large-scale use of hydrogen as a car fuel; we asked about the implications for transport of an ageing population and thought about uses for luminescent paint on highways; we learned about using APIs and reviewed battery powered Electric Multiple Units (EMUs); we wondered if a certain low-cost airline could board its passengers more rapidly and built statistical models of air passenger traffic; we counted waste vehicle trips and explored Mind Mapping; we tabulated the southward flow of graduates from the great Northern Universities and considered how those cities might retain more of them; we reflected on Building Information Management, or BIM, (which came with lots of fun with virtual reality kits) and researched London's air-quality monitoring stations; we looked at a world full of autonomous vehicles (AVs) and, toughest of all, we tried to figure out the impacts of Brexit for transport.

Let's hope the next 100 meetings are as much fun.

Acknowledgements: Our staff

Complex questions.
Powerful answers.

Infrastructure, cities and transport are constantly evolving to meet new demands, new ideas and new technologies. Mixing rigour and technical expertise with an open-minded, imaginative approach, we help our clients maximise opportunity and realise value within this rapidly changing landscape.

Impartial, objective and results-driven, we are never content simply to meet expectations. We combine our commercial, economic and planning expertise to find powerful answers to complex questions. Answers that help people, places and economies thrive.

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