

University of London - Centre for Transport Studies

by A.W. Evans, B.G. Heydecker and J.W. Polak

INTRODUCTION

This report summarises the activities of the Centre for Transport Studies at Imperial College London and the Centre for Transport Studies at University College London (UCL). These include the Railway Technology Strategy Centre (RTSC) and the Imperial College Engineering Geomatics Group (ICEGG) at Imperial College London, and the ESRC Transport Studies Unit (TSU) at University College London. Postal and web addresses are given below.

After this introduction, The Centres' programmes of research during 2004 are described in two sections: first, the work at Imperial, and then the work at UCL.

MEMBERSHIP

John Polak is Head of CTS at Imperial College and Benjamin Heydecker is Head of CTS at UCL. The two bodies combine to form the University of London CTS to run an Intercollegiate Transport MSc Course and other joint activities. Stephen Glaister is Director of the RTSC and Washington Ochieng is Director of the ICEGG.

Phil Goodwin retired as Professor of Transport Policy at UCL, was appointed Emeritus Professor, and took up a part-time post at the University of the West of England. Andrew Evans moved from UCL to become Lloyd's Register Professor of Transport Risk Management at Imperial College London. Bob Noland was promoted to Reader in Transport and Environmental Policy at Imperial College London. Helena Titheridge and Francesca Medda were appointed lecturers at UCL.

Derek Turner was appointed visiting Professor at UCL and Robert Cochrane at Imperial College London. Fabian Bastin, Benjamin Condry, Marie-Dominique Dupuy, Shaojun Feng, Charles Lindveld, Miles Logie, Rainer Mautz, Hwee See, Mark Trompet, Andrew Westlake, Victoria Williams, and Chang-Hyeon Joh joined the research staff at Imperial College. Shepley Orr, Craig Childs, Taku Fujiyama, Harry Rostron and Derrick Boampong joined the research staff at UCL. Will Adeney, Kimberly Schumacher and Chang-Hyeon C H Joh left the research staff at Imperial College. Lindsey Lucas, Mark Hanly and Joyce Dargay left the research staff at UCL. Tomas Ruiz from Valencia, Dick Ettema from Utrecht, and Fabian Bastin from Namur, Fumitaka Kurauchi from Kyoto, Walter KI Wong from Hong Kong and Yanyan Chen from China were academic visitors at Imperial College London and Kenzi Nagano at UCL. The Smeed lecture was given by Gerd Sammer of BOKU, visiting from Vienna.

At University College London, Su-Eun Chang,

Ioanna Spiropoulou, Woo-young Ahn, and Patricia Idaewor were awarded PhDs. Twenty one new research students joined Imperial College London.

Washington Ochieng, Mohammed Quddus and Robert Noland were awarded a prize for the best paper at the 2004 international meeting on Global Navigation Satellite Systems at Long Beach, California and Michael Bell, John Polak, Jan-Dirk Schmöcker and Fumitaka Kurauchi were awarded a prize for the best paper at the TRANSED 2004 conference in Hammamatsu, Japan. Washington Ochieng was elected a member of the Council and Trustee of the Royal Institute of Navigation. Nick Tyler and Stephen Glaister were elected Fellows of the Institution of Civil Engineers. Stephen Glaister was the keynote speaker at the Ordnance Survey Transport Solutions Seminar in November 2004. Benjamin Heydecker presented results on the monitoring of safety camera performance at the Royal Statistical Society. Mike Bell and Andrew Evans presented Inaugural Lectures at Imperial College.

RAILWAY TECHNOLOGY STRATEGY CENTRE (RTSC)

The Railway Technology Strategy Centre (RTSC) at Imperial College London was established in 1992 assisted by funding from British Rail as a centre of excellence serving the railway industry on strategic, technology and economic issues, in the UK and worldwide. The intervening years have seen the RTSC broaden its international client base and strengthen its position as strategic to the global rail industry. The RTSC has also continued to develop its portfolio of benchmarking studies, now including urban metros, national railways, railway infrastructure providers, and in 2003, buses. Since Professor Stephen Glaister took over as Director in 2001, the RTSC has increased its work in the fields of economics and regulation, which now account for a significant proportion of its output.

RTSC currently comprises three senior researchers, four research associates and a number of part time senior associates. In 2004, RTSC welcomed Ben Condry, who joined as a research associate from Mott MacDonald and Mark Trompet who joined as a research associate after his graduation from the Erasmus University Rotterdam in The Netherlands.

IMPERIAL COLLEGE ENGINEERING GEOMATICS GROUP (ICEGG)

The Imperial College Engineering Geomatics Group (ICEGG) is based at the Centre for Transport Studies, Imperial College London. ICEGG's teaching activities cover Surveying, Engineering Geomatics, Highway Engineering, Transport Telematics and Air Traffic Management.

ICEGG conducts fundamental and applied research in Geomatics and other areas in particular: air traffic control and management, environmental impacts of multi-modal transport systems, satellite geodesy, navigation system design and applications, transport telematics, geographical information systems (GIS) and earth observation. The group also includes the London Centre for GNSS Research (LCGR) which is a joint initiative between Imperial College London and University College London. ICEGG currently comprises two academic faculty staff, seven research associates and ten PhD students.

ESRC TRANSPORT STUDIES UNIT (TSU)

The ESRC Transport Studies Unit (TSU) completed its 10 year programme of research as an ESRC Designated Research Centre. The Centre hosted a major conference at UCL in September 2004 with the theme 'Changing Travel behaviour'.

EDUCATION AND TRAINING

As well as providing training leading to research degrees, Imperial College and University College London together run the Intercollegiate cluster of MSc courses in Transport, Transport with Business Management and Transport with Sustainable Development. The courses can be taken either full-time or part-time over two or three years.

The courses are one of a group of Transport Masters courses at currently seven universities which form the Universities' Transport Partnership (UTP). The partnership has been awarded funding of over £1.7 million to support Masters training in transport over four years. The UTP is based at Imperial College London and coordinated by Professor John Polak. The UTP builds on the successful collaboration over the previous four years between the universities in the provision of Masters training under the National Masters Training Package. The funding covers fees and maintenance for students studying full time for a Masters in transport at a Partnership institution. There is an associated Employers' Forum, which meets at Imperial College.

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The Imperial College London/UCL courses are accredited for the award of Rees Jeffreys Road Fund and Brian Large Bursary Fund studentships and bursaries, are accredited by the Engineering Council and the Institution of Civil Engineering, and meet the academic requirements for membership of the Institute of Logistics and Transport (ILT) and the Institution of Highways and Transportation (IHT). Employers can send their staff to take selected modules from the MSc Course for purposes of professional development.

PROFESSIONAL CONTRIBUTIONS

In addition to their research and teaching, members of the Centres make many professional contributions in the transport field, both in the UK and abroad.

Members of the Centres made professional contributions to the work of: AA Motoring Trust, Child Accident Prevention Trust, CSS, Association for European Transport, Commission for Integrated Transport, DFT, Ergonomics Society, EPSRC, ESRC, EU, European Transport Safety Council, House of Commons, ILT, IHT, International Association for Travel Behaviour Research, OECD, ONS, TfL, Parliamentary Advisory Council on Transport Safety, Railway Forum, Rees Jeffreys Road Fund, Roadsafe, Road Safety Advisory Panel, Royal Academy of Engineering, Royal Institute of Navigation, Transport for London, Transport Planning Society, US Transportation Research Board, and various local authorities. In addition, members of the Centres served on the editorial advisory committees of many of the transport-related journals.

RESEARCH AT IMPERIAL COLLEGE LONDON

This section reports the research activities of staff and students of the Centre for Transport Studies at Imperial College London. The Centre includes the Railway Technology Strategy Centre and the Imperial College Engineering Geomatics Group. Further information on current research is available from the Centre's website (www.imperial.ac.uk/cts).

TRANSPORT ECONOMICS, POLICY AND REGULATION

Wider economic benefits of transport improvements: link between city size and productivity *D. Graham*.

The aim this project is to provide a solid quantitative understanding of the relationship between city size and productivity and an assessment of the importance of transport investment to this relationship. The motivation for the research is the desire to provide some empirical assessment of the external benefits that may arise from the provision of transport

infrastructure that are not included in standard transport appraisals. One of the key parameters that the research will focus on is the elasticity of productivity with respect to city size. Econometric models will be developed that are able to isolate the effect of city size on productivity from other sources of non-constant returns to scale for individual industrial sectors. The research will also consider how transport investment affects productivity and the scale of urban economic output.

Transport pricing and investment in England: Further research *D.J. Graham, S. Glaister*.

In this research we build upon and extend the results of the Glaister and Graham pricing model for England in the following ways (a) establish a realistic future base year for policy implementation that describes traffic and other conditions, including capacity changes, across England, (b) allow transport users to switch the time of day of travel and model temporally differentiated pricing, (c) analyse the implications of spatial differentiated pricing regimes, (d) assess the impacts of pricing on different groups within society.

Road pricing in Mexico City. *A. Crotte, R.B. Noland, and D.J. Graham*.

Motorist related social marginal costs, such as road damage, pollution, and congestion amongst others, are not currently well represented by the wide range of taxes on road users (petrol, car ownership, etc.) in Mexico City. The purpose of this research project is to assess the effect of the elimination of various taxes on road users and substitute them with road pricing mechanisms, ideally for different types of vehicles, roads and times of the day. Mexico City will be used as a case study of a congested city with a lack of road pricing schemes. Price elasticities of new cars, fuel and public transport will be calculated in order to analyze different congestion charging policies in Mexico City.

The implications of income, taste and substitution effects for the assessment of user benefits using discrete choice models. *J.W. Polak and E. Cherchi*.

Recent developments in mixed multinomial logit (MMNL) and generalised extreme value (GEV) models of travel choice have raised a number of important issues regarding the calculation of welfare measures. In particular, in many cases, the simple log-sum measure of welfare will no longer be appropriate and alternative measures should be used. There is also evidence to suggest that welfare estimates can be extremely sensitive to the subtle details of model specification. The objectives of this project are (a) to develop recommendations regarding how welfare assessment should be carried out under different MMNL and GEV model forms and utility specifications and (b) to investigate the extent to which heterogeneity of tastes, complex substitution patterns and income effects would, if

present and detected by such models, affect the appraisal of transport policy measures (relative to current MNL/NL approaches).

The impact of transport investment on regional employment. *P. Jiwattanakulpaisarn (Supervisors: R.B. Noland, D.J. Graham and J.W. Polak)*.

The objective of this research is to empirically investigate whether highway investment has an impact on regional employment. This will be accomplished by developing and estimating econometric models that control for effects associated with employment growth and that can disentangle the causal nature of these effects. In theory, reduced travel times and costs of travel associated with improved transport facilities could yield long-term economic benefits by influencing firm and household decisions that affect the overall productivity of various sectors of the economy. This can effect employment in several ways. This research will examine the impact on different sectors of the economy, and how transport infrastructure may increase employment in some sectors while reducing it in others.

TRANSPORT AND THE ENVIRONMENT

Oil demand restraint in the transport sector.

R.B. Noland in association with ICF Consulting Ltd.

This study has evaluated the ability to reduce fuel consumption in the transport sector via the use of demand restraint policies, in the event of emergency supply constraints. The focus of this analysis has been to evaluate a range of policy options commonly used under normal circumstances by transport planners to manage transport demand, primarily to reduce traffic congestion and environmental impacts associated with transport. This analysis differs in that it views these same measure under the much different circumstances of a supply disruption or sudden severe price shock. This analysis is based, to the extent possible, upon existing estimates within the literature and experience from past fuel crises. In some cases, given the shortage of data covering emergency situations, expert judgement has been used to estimate behaviour and response to policies in such situations. The transport literature generally analyses the effects associated with various policies under normal fuel supply conditions, and thus, we have tried to estimate likely effects under conditions of supply constraints including the altruistic effects that would influence travel behaviour under crises conditions. The analysis considers effects of different measures on oil demand for each IEA region (Japan/Korea, Europe, North America, and Australia/New Zealand). Wherever possible we have used sources and data for specific countries within each region and aggregated to regional totals, with specific assumptions outlined for each measure. In cases where data was not available, we have used estimates from similar countries or regions.

Tradable carbon permits for the personal road transport sector: An evaluation of equity and effect on other Modes. *Z. Wadud (Supervisor: R.B. Noland)*

Tradable carbon permits are receiving increased attention as a means of reducing carbon emissions. This research aims to examine how tradable carbon quotas for personal road transport can both reduce greenhouse gas emissions and what the equity effects of such a policy might be. The fuel demand response of different income groups with respect to price changes due to policy interventions is an important aspect in determining social welfare. A significant part of the project will thus focus on determining price elasticities of fuel for different income groups. Applying a carbon permit policy will affect the travel pattern of individuals and modal share will change as well. The final part of the project will focus on forecasting the possible changes in modal share.

Evaluation of the OYBike System. *R.B. Noland, and M. M. Ishaque.*

The OYBike System is an innovative new bicycle rental system being piloted in the London Borough of Hammersmith and Fulham. This project will conduct an evaluation of the effectiveness of the OYBike System as an alternative mode of transport. Locking stations at which bicycles can be rented and deposited are currently being deployed throughout the Borough. This project will examine data generated by actual rentals and survey data collected both on-line and by contacting existing customers.

Transportation and air quality legislative reform in the Federal District of Mexico. *R.B. Noland in association with C. Zegras, M. Replogle, R. Yuhnke, W. Hook.*

This initiative intends to develop a model piece of legislation that will codify a rational transportation planning process in the Federal District (DF) of Mexico in order to ensure that all future transportation infrastructure investments in the DF are planned, programmed and developed based on clearly defensible evaluation procedures. These include transportation planning techniques (i.e., travel demand modelling, traffic modelling) and project evaluation processes (social evaluation – value of time, etc. – and environmental evaluation – mobile source modelling including, for example, consideration of induced traffic and induced demand). The ultimate goal is to develop legislation that can be actually passed at the state level, not only in the DF but also in other states in Mexico and, perhaps, at the national level, if relevant.

Instantaneous vehicle emission monitoring. *R.B. Noland, W. Y. Ochieng, J.W. Polak, R.J. North, I. McCrae in association with T. Barlow (TRL), M. Bell (ITS-Leeds), C. Frey (NCSU).*

This project, conducted on behalf of the UK Highways Agency, will collect and process real time vehicle performance and emissions data using both the VPEMS device and the Clean Air Technologies on-board emissions monitoring device. The focus of the work will be to collect data along the M42 motorway prior to the installation of variable speed limits and other measures to reduce congestion. Data will also be collected by vehicles supplied by the Transport Research Laboratory and ITS-Leeds. The collaboration also includes participation by North Carolina State University (NCSU) who are providing the Clean Air Technologies equipment for monitoring particulate and other gaseous emissions.

Real world urban particulate emissions from a light duty vehicle. *R.J. North (Supervisors: W.Y. Ochieng, J.W. Polak and R.B Noland).*

This research seeks to investigate the influence of driver behaviour on the emission of particulate matter (PM) from a light duty vehicle operating in an urban environment, where exposure to these harmful pollutants is highest. Recent advances in on-board vehicle emissions monitoring technologies will be combined with detailed chassis dynamometer experiments to investigate how ultrafine particle emissions correlate with various driving modes. This will involve the development, testing and validation of a vehicle activity based emissions model compatible with existing environmental modelling techniques.

Estimating the increase in emissions associated with induced travel from road capacity expansions and traffic flow improvement projects. *R.B. Noland and M. Quddus.*

The objective of this project is to determine whether road schemes that increase the availability of road space or which smooth the flow of traffic results in increased vehicle pollution. The net impacts on vehicle pollution of such schemes have largely been a matter of conjecture with some arguing that policies to reduce congestion (by adding more road space) will reduce pollution. This occurs due to reductions in stop and go traffic and the smoothing of total vehicle flow. This project uses a combination of simulation and statistical methodologies with the objective of evaluating the overall strategic policy question of how changes in available road capacity effects vehicle emissions. The research combines the most recently collected modal emissions databases with microscopic vehicle simulation packages (VISSIM) to analyze this question. The research will evaluate the elasticity factors associated with break-even points for each of the primary pollutants, similar to previous work conducted by Stathopoulos & Noland (2003). This method essentially evaluates the changes in vehicle emissions associated with changes in vehicle flow and balances this against the inducing effects of the flow improvement.

Aviation and climate change. *V. Williams and R.B. Noland.*

Research is ongoing into the links between aviation and climate change, focussing on carbon dioxide emissions and contrail formation. Air traffic simulations have been used to explore the impact on fuel burn, journey times and air space congestion of policies adjusting aircraft cruise altitudes to reduce contrail formation. An additional project is now underway, looking at the implications of a changing climate for UK air transport operations and at the feedback mechanisms which may influence the future climate impacts of air transport.

The impact of climate change on UK air transport. *R.B. Noland, V. Williams, R. Toumi, and T. Pejovic.*

This project will identify the possible impacts of climate change for UK aviation and the feedback mechanisms involved. This research is concerned with the possible impacts of climate change on UK aviation and the feedback mechanisms associated with it. Through this new approach, it will identify how changes in the climate will affect UK air transport and how those effects will sequentially influence the ways in which aviation contributes to further climate change. Additionally, it will identify the sensitivities of the mechanisms through which aviation contributes to climate change and identify the most significant ones for the UK region. The research will explore the climate impacts associated with the continuing growth in UK air transport, considering factors such as increased airspace congestion and increased use of regional airports. In addition, the research will analyze and propose policy options to mitigate the impact of air transport on climate change. This work will complement ongoing work by the research team which combines atmospheric data analysis and air traffic simulations to evaluate policies to mitigate the climate impacts of aviation.

Simulating aircraft emissions and condensation trails and their impact on global climate. *V. Williams, R. B. Noland, and R. Toumi.*

This project, which is funded through the EPSRC Advanced Fellowship scheme, focuses on developing the capability to evaluate fully the potential trade-offs of policy alternatives seeking to reduce the climate impact of aviation. The work combines analysis of atmospheric data with detailed air traffic simulations using the RAMS model. Particular emphasis is placed on identifying the consequences for contrail formation of procedural changes such as possible altitude restrictions, changes in aircraft fleets and changes in routing.

TRANSPORT SAFETY

Estimating train accident risks. *A.W. Evans.*

In recent years the railway industry has developed a fairly detailed 'Safety Risk Model' (SRM) for

estimating all risks on the main line railway. The estimates from the SRM can be compared with those from Evans' time series data. Evans' estimates of mean fatalities per year in train collisions and derailments are lower than those of the SRM. The SRM was reviewed in 2004 by Professor Tim Bedford of the University of Strathclyde and colleagues, leading to a discussion of the two approaches.

Fatal train accidents on Britain's main line railways. *A.W. Evans.*

Andrew Evans continues to produce an annual analysis of fatal train accidents on the British main line railway network with papers at the end of 2003 and 2004 based on data from 1967. The work now covers collisions between trains and road vehicles as well as train collisions, derailments and overruns.

Rail safety and rail privatisation in Britain. *A.W. Evans.*

This work investigates what has happened to railway safety after privatisation by analysing data on almost all fatal railway accidents, together with the most important non-fatal train accidents, from 1967 to 2003, with additional brief analyses back to 1946. BR had achieved downward trends in the mean numbers of accidents per train-kilometre for all the main classes of accident in the 27 years up to 1993, and the work takes the extrapolation of these favourable trends as the yardstick by which to judge the safety performance of the privatised railway. The paper finds that the privatised railway had fewer accidents than this yardstick for all classes of accident. Only one indicator is adverse: the number of fatalities in train collisions and derailments is higher than expected, because of the severity of the accident at Ladbroke Grove in 1999. The principal conclusion is that there is no evidence that privatisation caused railway safety to deteriorate.

Railway risks, values and costs *A.W. Evans.*

This work discusses the valuation and costs of preventing accidental rail fatalities and contrasts these with the valuation and costs of preventing road fatalities. In general the benefits of preventing road fatalities are less than their costs, but there are examples of implemented rail safety measures with costs greater than their official values. It is clear that society could prevent more fatalities at the same cost by devoting relatively more resources to road safety and less to rail safety, but it is apparently content not to do so.

Interactions between rail and road safety. *A.W. Evans and J.D. Addison (UCL).*

This project aims to investigate the safety implications of policies that may result in changes in modal choice. The transfer of passengers in either direction between rail and road may be induced by safety and non-safety policy and expenditure decisions. The project will give a better understanding of the safety consequences

for both the travellers concerned and for third parties. Work this year has focused on developing suitable models based on the National Travel Survey data. This has involved a thorough examination of the data available and the extraction of journey information with associated data on individual and household data in a form to facilitate model building. Work is now progressing on the final specification of various models.

TRAVEL BEHAVIOUR AND DEMAND MODELLING

The integration of multi-modal reliability in the assessment of transport schemes (Aramis) *J.W. Polak, R.B. Noland, X. Liu, J.J. Bates in*

association with P.M. Jones (University of Westminster) and AEA Technology Rail (with Network Rail, the Association of Train Operating Companies, iTIS Holdings, the Highways Agency and the Department for Transport).

The aims of this project are to develop improved methods for the assessment and evaluation of multi-modal transport schemes and improved models and software for the operational and strategic monitoring and reporting of reliability in multi-modal systems. This work extends earlier research undertaken by the project team, which has focused on the reliability of individual modes. The work involves the development of new theoretical models and algorithms and the collection and consolidation of network monitoring data from relevant road and rail operators and managers.

Improving the efficiency of travel by improved household activity scheduling (Apostle). *J.W. Polak, W.Y. Ochieng, M.G.H. Bell, C-H Joh, S. Feng and Y. Hu and in association with PTV AG and Saturn Technologies Ltd.*

A wide range of conventional traveller information systems are available to support travellers' trip planning and re-planning behaviour. However, existing systems focus on the planning of individual trips rather than the broader (and more relevant) problem of scheduling activity patterns. Moreover, few systems exploit the growing opportunity to exploit positioning and navigation technologies to offer planning support that takes account of a travellers current spatio-temporal location. The overall aims of this project are to develop a Personal Scheduling Assistant (PSA) function to support individuals and households in their activity scheduling behaviour and to develop, field test and evaluate a prototype device delivering the PSA function in a portable handheld device with position capability.

New developments in the area of simulation-based estimation of discrete choice models for transport demand. *S. Hess and J.W. Polak.*

Discrete choice models have been used extensively for over twenty years in the field of economics, and especially so in the area of transportation research. Initially, virtually all

applications were based on the Multinomial Logit (MNL) model and basic Nested Logit (NL) models; more recently, the use of more flexible model forms, such as advanced Generalised Extreme Value (GEV) models and the Mixed Multinomial Logit (MMNL) model has increased dramatically. While the MMNL model has a crucial advantage over other models in that it allows for the representation of taste heterogeneity in a population of travellers, the absence of a closed-form expression for the integrals representing the MMNL choice probabilities means that simulation is required in the estimation as well as application of this model. Depending on the complexity of the modelling application, the cost of this simulation process can be prohibitively high. While advances in computer technology have helped to reduce this cost, researchers have also looked into improving the efficiency of the actual simulation processes. One such improvement has come in the form of Quasi-Monte-Carlo integration, as opposed to standard (Pseudo-)Monte-Carlo integration. As part of this research project, we have developed several new types of quasi-random approaches, and have compared their performance to that of existing methods.

Developments in advanced discrete choice structures *S. Hess, D. Bolduc (University of Laval), J.W. Polak.*

This work looks at the advantages of model structures allowing for the joint analysis of random taste heterogeneity and inter-alternative correlation. It compares the two most commonly used structures for such analyses, the error-components logit model, and Mixed GEV models, and discusses their advantages and disadvantages. The project also highlights the issues of confounding between these two separate phenomena. Finally, a separate study expands on existing discrete choice models by allowing for random variations in the inter-alternative correlation structure across individuals, which can be useful in the presence of shared unobserved attributes to which different respondents react in different ways.

Modelling air-travel choice behaviour. *S. Hess and J.W. Polak.*

The aim of this project is to develop models for the analysis of the joint choices of airport, airline and access-mode for passengers departing from multi-airport regions. The project makes use of data collected in the London area as well as in the San Francisco Bay area. The analysis advances the current state of the art in this area of research by explicitly defining the three-dimensional nature of the choice set, and by making use of advanced structures for the analysis of taste heterogeneity and inter-alternative correlation.

Modelling mode and time of day choice. *S. Hess, J.W. Polak and A.J. Daly (RAND Europe).*

The relative sensitivity of mode and time of day

choice to changes in travel costs is a critical issue in developing sound structure for large scale transport planning models. The empirical literature on this question is to date mixed. The objective of this project, which is carried out in collaboration with RAND Europe, is to develop an improved understanding of these sensitivities. The work will involve the detailed re-analysis of existing stated preference datasets from London, the Netherlands and the West Midlands, using advanced discrete choice models.

Distributional assumptions in mixtures of discrete choice models *S. Hess, M. Bierlaire (EFPL), K. Axhausen (EHT), J.W. Polak.*

Researchers and practitioners are increasingly using mixtures of discrete choice models, especially the Mixed Multinomial Logit model, for representing random variations in tastes across respondents. The various studies grouped into this project look at a number of important issues that need to be faced in the specification and interpretation of such models. This includes the choice of distribution for coefficients with a strong a priori sign assumption, the interpretation of counter-intuitive results, and the use of discrete distributions, as well as more advanced (and thus far unused) continuous distributions.

Advanced adaptive methods for the estimation of discrete choice models. *F. Bastin and J.W. Polak.*

Recent interest has focused on the use of quasi-Monte Carlo sampling techniques and adaptive optimization methods as means of accelerating the performance of simulation based estimation methods for discrete choice models. However, there is currently no clear consensus on the methods to use in practice. The aim of this research is first to systematically investigate the performance of alternative approaches using a comprehensive experimental design and second, building on this, to develop improved methods of combining quasi-Monte Carlo approximation with adaptive optimisation. Extensions to new class of problems are also examined.

Discrete choice modelling with an inter-temporal resource constraint. *J.W. Polak, F Bastin and J-D Schmöcker.*

Recent projects on the mode choice behaviour of older and disabled people led to this follow-on work. In the London Borough of Newham elderly were given a trip budget for special transport services. The users were given 40 "Saver trips" per month which could be used for local services booked in advance and 6 "Standard trips" per month which could be used for immediate travel needs. A simple choice model has been developed in the precursor project. The research question in this work is broadened and the objective is to develop a dynamic discrete choice model that explains user choice when inter-temporal budget constraints exist. Such problems arise also in other contexts such as with certain forms of pre-paid public transport ticket products. The salient

characteristic of such problems is that, over some relevant time horizon, there exists a constraint (direct or indirect) on the frequency with which certain choices can be made. Such constraints induce complex inter-dependencies amongst decisions in different time periods.

The scheduling of commuter tours in congested networks with pricing. *J.W. Polak and B. G. Heydecker (UCL).*

An extensive literature exists on the equilibrium scheduling of peak period trips in idealised networks and the welfare impacts of alternative forms of pricing. Such models are useful in that they provide insights into the underlying structure of more complex systems. However, they are limited because they consider the scheduling only of single trips, rather than complete tours. The aim of this project is to extend these existing models to accommodate tours and to explore the welfare impact of alternative pricing regimes.

Day-to-day dynamics and traveller learning. *A. Jotisankasa (Supervisor: J.W. Polak).*

Understanding the dynamics of individual travel choice behaviour is widely regarded as one of the most challenging topics in travel behaviour research. Of particular interest are the day-to-day dynamics of commuters' route and departure time choice decisions as these decisions determine the major flow patterns in transport networks during peak periods. The objectives of this research are to develop a new theoretical framework for modelling the day-to-day dynamics of drivers' route and departure time choice decisions in a commuting context, and to empirically estimate the models based on the proposed framework.

Modelling activity scheduling conflict resolution *T. Ruiz, J.W. Polak and C-H Joh.*

An issue of growing importance in activity based modelling is understanding activity rescheduling behaviour. A key set of questions concerns how people deal with the scheduling conflicts that occur when new activities are introduced into an existing planned schedule. The objective of this project is to characterise the response to such scheduling conflicts in the specific case in which one single new activity episode is inserted in between two consecutive planned activities and in which one or both of the planned activities involved in the conflict are modified without changing the original sequence of activities in the schedule. Data collected from an Internet-based activity-travel survey are used to develop models structural models to characterise alternative conflict resolution strategies.

Optimising the use of partial information in urban and regional systems (OPUS)

J.W. Polak, C. Lindveld, M. Logie, A. Westlake and S. Richardson, N. Best, M. de Iorio, D. Briggs (Imperial College School of Medicine) and in association with a number of European collaborators.

The aim of this project is to develop a generic statistical framework for the optimal combination of complex spatial and temporal data from survey, census, real-time and telematics sources. The framework will be sufficiently general to be applicable to a wide range of potential socio-economic domains, but will be specifically applied in the context of transport applications in London and Zurich. The project will also undertake feasibility studies of the applicability of the methods to a number of related transport and health domains. Transport planning is a prominent example of a topic that uses multiple sources of data, and will be the main test case for OPUS, but the cross-sectoral nature of the research will be demonstrated through the inclusion of an application in the field of health information as another example. The methods developed make extensive use of Bayesian belief networks coupled with advanced metadata techniques.

Modelling accessibility to and by public transport *O. Ashiru in association with Surrey County Council (Supervisors: J.W. Polak and R.B. Noland).*

The aim of this research is to develop improved methods of modelling public transport accessibility and to integrate these methods into the planning and management of public transport service provision at a local level. Three key areas have been identified for study: (i) conceptual and theoretical issues related to different notions of accessibility (particularly, accessibility to public transport and accessibility by means of public transport to desired destinations), (ii) the treatment of public transport service reliability and information effects and (iii) treatment of multi-modal trips. An initial application of a model including temporal aspects of accessibility has been undertaken.

Utility theoretic models of activity timing and duration *O. Ashiru, J.W. Polak and D. Ettema (Utrecht University).*

The objective of this project is to develop a utility theoretic model to describe how travellers select the timing and duration of activities. The model assumes that marginal utility derived from activities encompasses two distinct components; one derived from duration of activity involvement and the other derived from activity participation at a particular time-of-day. An operational model is developed, which is calibrated on a stated preference data set collected in London as part of a study, to test travellers' responses to road pricing schemes. The estimation results suggest that utility derived from work is partly duration dependent and partly time-of-day dependent. The inclusion of both components has implications for the prediction of potential responses to travel demand management policies, such as road user charging.

Non-response and weighting in the National Travel Survey. *J.W. Polak.*

In recent years the National Travel Survey has been subject to a growing level of unit non-response. The Department for Transport has recently commissioned the National Centre for Survey Research to undertake a project to develop a new weighting scheme to deal with this problem and Professor Polak has been invited to as an advisor on this work.

Modelling heterogeneity in travel decision making under uncertainty. *X. Liu (Supervisor: J. W. Polak).*

In recent years a number of alternative theories have been proposed to describe how travellers take into account uncertainty regarding the consequences of their decisions (due for example to variable network performance). However, just as there is now abundant evidence of pervasive heterogeneity in tastes with respect to a number of key attributes, so it seems possible that their may be heterogeneity in the approaches to decision making under uncertainty, both between individuals and (possibly within individuals across different circumstances). The objective of this project is to explore this question using a number of existing and newly collected datasets and drawing on recent advances in discrete choice modelling.

Modelling and simulating the impact of location based services on travel behaviour *Y. Hu (Supervisor: J. W. Polak).*

There is currently considerable interest in the development of various forms of location-based services, which will potentially provide travellers with access to a wide variety of spatially specific information related to travel and activity opportunities. The impacts of these services on travel behaviour are potentially profound but are as yet very poorly understood. The objective of this project is to develop and validate an agent-based simulation platform which can be used to test and evaluate the likely impacts on both transport and telecommunication network efficiency of the provision of alternative forms of activity scheduling support and access to alternative forms of transport network and point of interest information. This will entail modelling the operation of both the transport and the telecommunications networks and the behaviour of individual travellers, including their response to the new services

Trials of GPS-GIS links for activity-based travel analysis *M. Lee-Gosselin (Laval University, Canada), J.W. Polak, W.Y. Ochieng.*

The aim of this project is to undertake field trials of the use GPS/GIS technologies for the design of new types of panel survey methods to track household travel and activity. The project involves detailed testing of analysis approaches to route choice (Imperial) and activity destination frequency and sequencing (Laval). The trials are starting with one or two test vehicles in each site. Low cost approaches to signal processing are

being tested to allow the use of commercially-available GIS interfaces with little ambiguity at the level of precision of the available map bases. Considerable effort is being invested in maximising the use of multiple layers of data in GIS format. Based on analysis needs, a vehicle based survey package, including respondent input through a terminal or palmtop, will be designed. For the design of respondent inputs in the vehicle, there is a link to other projects on CAPI and CASI interfaces.

An informatics grid for e-science at Imperial College London *J.W. Polak with J. Darlington (Department of Computing), S. Richardson, J. Scott, C. Higgins and B. Robertson (Medical School).*

The aim of this project, which is supported under the Research Council's Joint Research Infrastructure Initiative, is to provide facilities for the storage and analysis of very large scale datasets, of the sort that arise in many scientific, engineering and medical disciplines. The Centre for Transport Studies will use the facility to undertake the analysis of a range of very large spatio-temporal datasets arising in a number of areas of its activity, including data from instrumented vehicle fleets, the simulation traces of highly detailed microsimulation models of traffic systems and large Monte Carlo simulation work.

Scoping a model travel behaviour dataset programme to address research and policy needs in transport. *J.W. Polak, J.-D. Schmöcker and M.R. Wigan, J. Cooper (Napier University).*

The aim of this project, which is supported by the EPSRC, is to undertake a scoping study to identify key areas where data limitations have held back needed behavioural research and to define how best, in the light of current trends in data collection methods, these limitations can be addressed. The project involves extensive collaboration with the academic community, Government and the private sector.

Estimation of the use of smartcards by concessionary travellers. *J.W. Polak and L. Oh in association with John Bates Services.*

Bus operators issue smartcards to specified groups of concessionary passengers. For the transport authority to compensate the bus operators, the frequency of concessionary trips must be estimated. However, the smartcard records only the entry point of a journey and not the exit. A proposal has been made to estimate the Average Equivalent Single Fare (AESF) for concessionary passengers by matching the boarding point of a journey with a feasible alighting point of the previously recorded journey using 10-year metropolitan bus trip records from the UK National Travel Survey. The concessionary groups are characterised by their tour formation, trip chains and bus trip profiles in support of the estimation.

Changing behaviour towards a more sustainable transport system. *J.W. Polak in association with a number of European collaborators.*

This project, which is funded under the Commission's programme for European Co-operation in the Field of Scientific and Technical Research provides the opportunity for researchers from a number of European countries to meet periodically to share ideas and information regarding ongoing work. The main focus of the work is to analyse the conditions under which the process of growing unsustainable transport demand could be reversed, by changing travellers, shippers, and carriers' behaviours. The project is divided into a number of streams dealing with freight transport and energy consumption, car use and national transport surveys.

Access to activities and services in urban Canada: Behavioural processes that condition equity and sustainability *J.W. Polak, M. Lee-Gosselin (University of Laval) and S. Doherty (Imperial College and Wilfred Laurier University).*

Imperial College is an external collaborator in this major 5-year research programme supported by the Social Science and Humanities Research Council of Canada. The objectives of this programme (which involves collaboration between 5 Canadian Universities - Laval, Québec, Toronto Calgary and Wilfred Laurier) is to make fundamental advances in the understanding and modelling of urban travel behaviour. Imperial College is contributing to a number of the research themes including the dynamics of household car ownership, longitudinal studies of activities, travel and urban form and alternative frameworks for modelling individual behavioural response.

Relationship between travel and shopping activity for older people *F. Su (Supervisor: M.G.H. Bell).*

The research is focused the way shopping fits in with other household activities, the relationship to travel, and the impact of household type and structure. There is a particular interest in the problems faced by older and disabled people, and the role of Special Transport Services in household logistics. An analysis of LATS data augmented by post code-based transport supply and accessibility indices has thrown light on the travel characteristics of older people. In the next stage of the research, it is planned to look at the role for electric scooters, using data from the London Borough of Camden.

The impact of the congestion charge on retail in London. *M.G.H. Bell and M. Quddus.*

Following on from a study carried out for the John Lewis Partnership into the impact of the congestion charge on its Oxford Street store (reported last year), further econometric work is being conducted. Sales data for six John Lewis stores in the London area is being explained by a measure of Gross Value Added for London (minus

retail, to avoid circularity), entrance and exit counts for the Oxford Circus and Bond Street tube stations, tourist expenditure in London, and a dummy variable for the congestion charge. Both independent models and a panel data model have been fitted to weekly sales data for all six stores in the London area, yielding estimates of the impact of the congestion charge on the Oxford Street store over the period analysed of about 10%. An alternative difference model based on monthly data yields a comparable estimate. This work will be written up and published shortly.

Trip generation and mode choice of older people.

M.G.H. Bell, J.-D. Schmöcker, R.B. Noland, M. Qudus, S. Fengming, B. Condry, and F. Kurauchi.

The "A d2d travel budget scheme for London" project, completed and reported last year, studied the behaviour of current users of door-to-door services in the Newham pilot scheme. This follow-on project aimed to understand the behaviour of all those eligible for door-to-door services, a substantially larger group of people than dealt with in the precursor project as there are a significant number of those eligible who do not participate. The simulation model is further developed in order to estimate trip generation and mode choice London-wide for this population group. Special attention is given to the potential and actual demand for Special Transport Services (Taxicard, Dial-a-Ride) in inner and outer London.

TRANSPORT OPERATIONS AND CONTROL

Capacity constrained transit assignment

M.G.H. Bell and J.-D. Schmöcker.

Work on a new approach to solving the frequency-based transit network loading problem using an absorbing Markov chain has continued. Congested transit networks, where some passengers will not be able to board a given train/tram because of insufficient space on board, are handled. The impact on the equilibrium transit assignment of risk-averse route choice behaviour with regard to the ability to board is demonstrated. In cooperation with Kyoto University, choice between common lines has been added and prototype software developed. Current research has added time dependency to the model in order to handle varying OD demand over the simulation period. Further work is looking at the representation of "bus bunching" effects and delay management strategies in the model.

Application of fuzzy logic to traffic assignment in developing countries.

D. Rudjito (Supervisor: M.G.H. Bell).

The heterogeneous traffic of developing countries leads to complex problems in traffic assignment as the relationship is shown not to be isotropic, in the sense that heterogeneous flows cannot be reduced to passenger car units. The objective of this research is to apply fuzzy logic to multi-class traffic assignment in a way that allows for

uncertainty regarding link costs. Smooth link cost functions, which are difficult to establish empirically, are replaced by look-up tables based on data collected in Bandung City, Indonesia. The results of this research show that the proposed model seems to be suitable for the characteristics of developing countries. The draft thesis has been completed.

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Path flow estimation

M.G.H. Bell and H. See.

This project is motivated by the importance of OD matrices for efficient and effective transportation planning and control. OD matrices contain information on the travel between different origins and destinations required by planners and engineers for the design and control of road and public transport networks. As OD data is expensive and impractical to obtain directly, so there is a need to estimate OD flows from other types of data. There are many approaches, and most of them employ a two-stage approach. This project looks at a single-stage approach known as the Path Flow Estimator (PFE). The original version of the PFE was developed for the DRIVE2 project MARGOT, was tested for urban traffic management and control systems in Lyon, Toulouse and Turin in the CLEOPATRA project, and was integrated in a traffic signal control system in Piraeus, Greece in the MOTION project. The current work introduces additional constraints to further enhance the capability and efficiency of the PFE in handling selected screen-line survey and historical travel distribution information.

Tanaka Technology Venture Fellowship.

H. See and M.G.H. Bell.

The Fellowships are awarded by the Entrepreneurship Centre of the Tanaka Business School and are intended for researchers who aim to commercialise their work by starting a new company. The Fellowships enable them to join MBA classes in new venture creation and venture capital finance in the Spring term of 2005. The Path Flow Estimator is being taken as a case study.

Risk-averse dynamic route guidance.

I. Kaparias (Supervisor: M.G.H. Bell).

Starting with luxury makes and models, in-vehicle information systems are spreading through the vehicle fleet. An important function is dynamic route guidance. The ideal outcome of dynamic route guidance is to provide the driver with route

recommendations that prove ex-post to be good. A sensible approach may therefore be to pick the most reliable route which does not differ much from the expected fastest route. Route features such as right turns in the United Kingdom (left turns on the continent), links undergoing road works and links that are often congested are very likely to increase travel time. Correlations between links should be taken into account. The project includes the development of a risk-averse dynamic route guidance algorithm, the execution of a microscopic simulation model on a test network, as well as field trials, where the algorithm developed will be implemented on a test vehicle.

The development and testing of an in-vehicle dynamic route guidance algorithm.

Y Chen and M.G.H. Bell

The objective of the research was to devise an efficient, accurate and robust dynamic route guidance algorithm for use in vehicles. A good route in this context is one that, although possibly not the best (fastest), is reliable and acceptable to the driver. The research fits within the system architecture being developed by BMW, which includes in-vehicle units with limited processing power and a subscription-based Traffic Information Service. Risk-averse constrained A* algorithms have been formulated for both autonomous and supported navigation systems in the first stage. The algorithms will be tested in simulation in the second stage this year, and in the third stage the algorithms will be field tested.

An inter-modal equilibrium model of privatised transit in combination with road-based congestion charging.

M. Wichiansin (Supervisor: M.G.H. Bell)

A new inter-modal equilibrium model links an urban road network subject to a congestion charge to a parallel urban transit market, with a view to finding the optimum congestion charge consistent with the commercial decisions of the transit operator(s). The sum of consumer and producer surplus is maximised with respect to the congestion charge. Different forms of transit market are considered. The prices and supply of transit services are treated as endogenous variables. The problem has been formulated as a bi-level programme and solved by a gradient-based algorithm. A small example has been solved giving insights into the problem and the solution method. It is intended to apply the method to a larger VISUM network.

Multi-objective signal control for urban environments (MOSCUE).

S. Ahuja (Supervisors: M.G.H. Bell and T van Vuren)

This four-year project, supported through the FIT programme, addresses signal control in urban centres where vehicular traffic may not have the highest priority. Traffic signal control is increasingly seen as a way to implement social policy and not just a way to improve traffic safety and efficiency. Local authorities expect it to

deliver priority for public transport, easier and safer walking and cycling, secure access for the mobility impaired, cleaner air and, more generally, revitalised town centres. To help fulfil the expectations of local authorities, a software tool for multi-objective traffic signal optimisation is being developed, using fuzzy logic for the control. Effective signal control in pursuance of multiple objectives requires user reaction to be correctly anticipated. Pedestrian and vehicle networks will be defined and the impact of control on pedestrian and vehicle routing will be considered as part of the signal control policy.

Scheduling dial-a-ride transport for people with disability *K. Hor, M.G.H. Bell and K.I. Wong.*

Recent research for Transport for London on mode choice for people with disabilities has demonstrated the need for improved routing and scheduling of demand responsive transport, specifically dial-a-ride. While there is a literature on routing and scheduling for demand responsive transport, people with disabilities have additional requirements that need to be taken into account in scheduling. For demand responsive transport, insertion and exchange heuristics have received most attention in the literature to date. At present, dial-a-ride scheduling is done manually, so some guidance on how to automate the task would be welcomed. This project will propose a suitable method for dial-a-ride scheduling.

An evaluation of reliability of taxi service quality. *K.I. Wong and M.G.H. Bell.*

Potential taxi customers will consider the taxi service quality as well as the fare in making their mode-choice decisions. The passengers face uncertainty about the availability of taxis, which varies by time of the day. An impatient customer cannot effectively communicate with the supplier to express his willingness to pay more for a reduced wait, but has to accept the stochastic wait given by the equilibrium of the taxi market. The objective of this study is to assess the reliability of taxi services while considering passenger demand elasticity with respect to traffic congestion and service quality.

The optimal dispatching of taxis: A rolling horizon approach. *M.G.H. Bell and K.I. Wong.*

This study is concerned with algorithms for the real-time dispatching of taxis in response to incoming requests. For a given fleet size, the objective of the dispatcher is to minimise over time the total wait experienced by requesters. It can be shown that the taxi that can reach the current request first might be better assigned to a subsequent request. However, finding the taxi that minimises the expected total wait over a rolling horizon is computationally very demanding, and for large fleets not possible in real time. Consequently a heuristic has been devised which for each taxi compares the wait that would be experienced by the current requester if it were assigned now with the expected wait of the next

requester if instead it were assigned to the next request. The taxi with the largest balance of advantage in an assignment now is the taxi assigned. The heuristic is able to considerably reduce total waiting time, particularly during periods when the demand for taxis is high. Research with this heuristic and other heuristics is continuing with a view to producing exploitable taxi dispatching software.

Post-Lighthill traffic flow theory *M.G.H. Bell and K.I. Wong.*

In their seminal 1955 paper, Lighthill and Whitham introduced the traffic engineering world to kinematic wave theory, thereby for the first time explaining some of the dynamic properties of traffic. In the intervening half century the theory has continued to evolve. Through contributions from a number of experts in the field, this project seeks to trace the various strands of development that emanated from the original paper. The interaction between theoretical development, empirical observation, studies of driver behaviour and traffic simulation will be described. The work will culminate in an assessment of the future for traffic flow theory in the light of the gradual development and implementation of intelligent transport systems.

Secondary road network traffic management strategies (SENSOR). *M.G.H. Bell with R. Bird, P. Blythe, S. Grosso and J. Nelson. (Newcastle University) and various European collaborators.*

The aim of this new project is to develop appropriate tools and strategies for the collection of real time traffic data on secondary roads. The project will consider what data are needed and how they can be most effectively collected. Imperial College will have an advisory role in number aspects of the project.

Modelling the bilateral micro-searching behaviour for urban taxi services using an absorbing Markov chain approach. *K.I. Wong, S.C. Wong (University of Hong Kong), M.G.H. Bell and H. Yang (University of Hong Kong Science and Technology).*

The aim of this project is to study both the customer-searching behaviour of vacant taxis and the taxi-searching behaviour of customers in the network. The meeting mechanism between taxis and customers at a taxi rank is formulated as a queuing model with double-end queues. Numerical tests are given to compare the current formulation with the previously proposed approaches.

Cost benefit analysis of non-motorised transport policies using microsimulation. *M. Ishaque (Supervisor; R.B. Noland).*

This research studies operational level transport policies and urban traffic control systems and how they affect the travel times of all road users. Investigation of how non-motorised modes interact with motorised traffic and the effect on

relative travel times is also covered in this study. Policy areas where intervention in the transport system might result in overall cost benefits are to be identified. These are then investigated in detail through modelling of hypothetical transport networks that are tested for multi-attribute performance measures using microsimulation. Results obtained through analysis of data generated in microsimulation will help explain how policy changes result in overall cost reduction (or increases) when non motorised modes are considered in traffic control plans.

Pedestrians and micro-simulation modelling *R.B. Noland, M. Ishaque in collaboration with Babtie Group.*

Current signal timing and other policies can result in deterring walking, due to increased travel times and increased perceptions of the risk of walking, while simultaneously making car travel relatively less costly. To be consistent with government policy, Local Authorities need to consider alternative approaches to accommodating pedestrian travel while considering the interactions that occur with vehicular travel. Micro-simulation modelling allows the evaluation of potential interactions between pedestrians and vehicles. Various commercially available micro-simulation packages will allow pedestrian street crossing behaviour to be simulated (e.g. VISSIM, PARAMICS, and AIMSUN). A key issue for Transport for London and Local Authorities, is the overall network travel time impacts of interventions to improve pedestrian access. For example, while street closures and conversions to pedestrian-only zones provide various benefits, including reduced travel delay for pedestrians, they also effect traffic circulation. Anecdotal evidence suggests that network delays can propagate throughout the system, sometimes resulting in substantial increases in vehicular travel time within several miles of the intervention. From the pedestrian perspective, many current traffic signalisation policies may result in substantial travel time increases. For example, staggered pedestrian cross-walks may necessitate the pedestrian waiting for up to two signal cycles before safely crossing a street. Uncoordinated pedestrian timings may also lead to multiple delays at complex intersections that large amounts of pedestrian traffic need to negotiate (many of these occur in the vicinity of Underground stations). Retiming many of these signals, often to the disadvantage of the vehicular traffic can significantly improve pedestrian flow rates, however, network effects on traffic need to also be considered. This study analyses these issues in detail and examines the costs and benefits of various pedestrian prioritization policies.

An agent-based model to simulate motorcycle behaviour in mixed traffic. *T-C Lee (Supervisors: J.W. Polak, M.G.H. Bell).*

In many countries, motorcycles comprise a significant proportion of the total traffic stream

and therefore their behavior has important implications for safety, capacity and overall road network management. Yet despite their importance, motorcycles are poorly represented in existing traffic simulation software, in part because their behavior is potentially much more complex than that of larger vehicles, requiring more complex simulation rules. Agent based simulation techniques are in principle well suited to representing complex behaviours displayed by motorcycles. The aim of this project is to develop such an agent based model to describe the behavior of motorcycles in traffic flow. Probabilistic behavioural rules are developed for four classes of motorcycle manoeuvre: vehicle-following, progressing through bottlenecks, lateral movements and route choice. These behavioural rules will be calibrated using field data collected in Taiwan by using camcorders.

Short term traffic forecasting in a wide area network *R.K. Krishnamoorthy (Supervisors: J.W. Polak and W.Y. Ochieng).*

An increasingly wide range of traffic management and traveller information applications depend upon system managers being able to make robust short term predictions of future traffic conditions. The objective of this project is to propose a new method for this problem. The method combines aspects of a cell-transmission model approach with existing forecasting methods and draws on both historical and real-time data. The approach is currently being tested in a simulation environment and will later be applied to the London network using real data.

The development and application of an urban link travel time model using data derived from inductive loop detectors. *S. Robinson (Supervisor: J.W. Polak).*

Increasingly it is becoming important to accurately measure urban link travel time (ULTT). ULTT can be used to measure the performance of road networks and be used as input into in-vehicle guidance systems. Research has been undertaken to model ULTT using data from inductive loop detectors (ILDs). The first part of this model involved developing and quantifying the performance of new techniques to remove erroneous ILD and travel time data from the training data set. The second part of this research proposed the use of the k nearest neighbours (k-NN) method to model the relationship between ILD based data and travel time. The k-NN method has been shown to output more accurate estimates than existing ULTT models. This method is also seen to have several other beneficial characteristics. Finally, the research showed that estimates of ULTT obtained from the k-NN model can be used to accurately model various components of travel time variability.

London SCOOT Archive Database. *S. Robinson and J.W. Polak.*

The London Scoot Archive Database (LSAD) is a

joint project between Transport for London and Imperial College London. LSAD is a data warehouse storing raw inductive loop detector (ILD) data from approximately 6000 ILDs in London. LSAD will provide researchers with a record of the traffic state in London with unrivalled spatial and temporal resolution. LSAD went operationally live in November 2004, and data is now being archived from all 3 SCOOT regions of London. LSAD data has already been used for research into modelling urban link travel time. Future projects may include research into identifying faulty ILDs, determining the effect of the frequency of communication on the performance of urban traffic control systems, and the study of the variability of traffic characteristics.

Years: 2001-2004

Travel time reliability and variability by different modes. *J.W. Polak in association with AEA Technology Rail and Cranfield University.*

The objective of this project is to provide a consistent and comparable characterisation of the variability in travel time on alternative modes of travel including rail, car, express coach and air. The project makes use of a wide range of existing data sources. Key issues addressed in the project include the comparison of scheduled and non-scheduled services and dealing with the different temporal granularity of the different data sets.

PUBLIC TRANSPORT OPERATIONS AND MANAGEMENT

Metro Railway Benchmarking CoMET and Nova. *R.J. Anderson, G. Kwan, B.J. Condry, M. Trompet, D.J. Graham, N.G. Harris, R.C.d'A. Hirsch, W.E. Adeney T.M. Ridley and S. Glaister.*

The objectives of these two ongoing studies are to collate and disseminate best practice in a number of key aspects of urban rail operations and planning. The CoMET study is undertaken on behalf of a consortium of eleven of the world's largest urban rail operators (Berlin, Hong Kong MTRC, London, Madrid, Mexico, Moscow, Paris, New York, Sao Paulo, and Tokyo). The study, now in its eleventh year, assists metro railways to identify and implement best practice through benchmarking comparisons and analytical case studies. Nova has similar overall objectives to those of CoMET, but consists of a consortium of eleven medium sized urban rail systems (Buenos Aires, Dublin DART, Glasgow, Hong Kong KCRC, Lisbon, Montreal, Naples, Newcastle-upon-Tyne, Singapore, Taipei and Toronto). The results of all CoMET and Nova studies have been made available to consortium members via the CoMET and Nova websites.

Metro performance: London-Berlin Comparison. *W.E. Adeney, R.J. Anderson, B.J. Condry.*

In 2001 a case study was undertaken within the CoMET group on "Identifying the importance of city context on the performance of metros". It was

concluded that there is a strong relationship between the city environment in which a metro operates and its performance. The aim of this work was built upon that case study, taking forward some of the concepts developed. Two metros within the CoMET group - Berlin and London - where taken as examples for this work. The aim of the report is to isolate entirely the components of overall metro performance that are due to managerial and organisational efficiency for each metro. This is achieved by identifying the factors that are in metros control, determining how these factors differ between individual metros, using Berlin and London as examples. Determine the impacts of these factors on metro performance by comparing the performance of Berlin and London in relation to the factors identified and comparing the performance of Berlin and London with other CoMET metros using Data Envelopment Analysis (DEA), relating differences in performance to the influencing factors identified.

International Bus Benchmarking. *R.J. Anderson, M. Trompet, E. Randall, B.J. Condry.*

Following the successful initiation in collaboration with STM (Montréal) and London Bus Services Limited, this new International Bus Benchmarking Group started in July 2004. Group members include bus organisations from Barcelona, Berlin, Dublin, Hong Kong, London, Madrid, Montréal, New York, Paris, and Rome. Work focussed on developing an appropriate set of Key Performance Indicators, harmonisation of data item definitions, development of a bus benchmarking member profile report and case studies on Driver Productivity and Service control and Route management.

CoMET Metro reliability, punctuality and regularity *J.-D. Schmöcker, W.E. Adeney and R.C. d'A Hirsch.*

This study compared the operational performance of large metro systems with regard to reliability, punctuality and regularity. It examined the responses to service disruption, and sought to identify strategies for returning the service to schedule with the minimum impact on passengers. This study considered the characteristics of different systems, resulting in an evaluation of factors and strategies that lead to a reliable service. The study also identified effective service management strategies, through the analysis of both quantitative and qualitative data on the perceived efficacy of current recovery strategies.

Measuring metro performance productivity and efficiency. *D.J. Graham and W. Adeney.*

This project is concerned with the productive efficiency of urban railways. It applies a two stage Data Envelopment Analysis (DEA) technique to data on 99 urban rail systems across the World. To understand the factors underpinning variation in efficiency, a second stage Tobit regression is

constructed in relation to Total Factor Productivity (TFP) within a cost and production function framework. In this way we develop a decomposition of productive efficiency in urban rail that identifies some fundamental influences arising from scale economies, economies of density and some firm specific characteristics.

Communications of Metros. *W.E. Adeney and G. Kwan.*

Urban railways face multiple public relations and communication challenges. This study examined examples of good practice and management of particularly important relationships, looked at the appropriate structures and reporting lines for delivering effective public affairs performance and compared the relative weight given to particular public affairs activities by different metros. The key output from the study, along with numerous good practices relating to each of the stakeholder groups, was an understanding of the need for "Agenda Setting".

Procurement Strategy Management. *R.C.d'A. Hirsch and B.Condry.*

Procurement and acquisitions are major activities for operations and maintenance of metros. The aim of this study is to examine the various procurement models and tools adopted by metros, and to identify best practices for lowest total cost of acquisition subject to quality that ensures best value for money. Initial analysis focuses on the organisation of procurement activities in each of the metros, strategies used for purchasing goods and services, and regulations. Further analyses have been carried out and they cover measurement of the efficiency and effectiveness of the procurement process. It was found that most metros measure some indicators to assess the efficiency and effectiveness of their procurement processes, but the number of indicators measured – and the type, varies considerably.

CoMET Accident Precursor Monitoring II. *R.C.d'A. Hirsch, & B.J. Condry.*

This study continues the work from the Accident Precursor Phase I case study that was carried out in CoMET 2003. While the previous study led to the sharing of monitoring practices, this study aims to develop common definitions for the highest priority precursors, allowing comparison of incidences across metros. Comparison of precursors and top event data led to the conclusion that there are two types of incident; those for which there is an identifiable precursor, and those where there is little distinction between precursors and top events. The study concludes by recommending to CoMET and Nova metros that metros should continue to monitor precursors and link them to the overall risk reduction programme, including testing whether the QRA fault and event trees in that model are correctly calibrated.

Initiation of a Bus Benchmarking group *R.J. Anderson and B.J. Condry in collaboration with STM (Montréal) and London Bus Services Limited.*

Following the nine years of success of the CoMET and Nova metro Benchmarking groups, public transport operators recognised that similar benefits could be achieved by developing an international benchmarking group for the urban bus industry. The objectives of this co-sponsored study were to identify appropriate partners and to establish a benchmarking group containing a balanced mix of urban bus operations from around the world. Appropriate benchmarking methodologies were developed, broadly based on the CoMET and NOVA approach, but adapted for urban bus operations. Work towards developing harmonised Key Performance Indicators was initiated, for refinement in the first annual benchmarking cycle which commences in the summer of 2005.

Options for Delivering the Merseyside Bus Strategy. *R.J. Anderson and S.Glaister in collaboration with the Institute for Public Policy Research and the Transport Studies Unit, University of Oxford*

This project was commissioned by Merseytravel. Its overall aim is to assess the current operation of the Merseyside bus network and to propose what regulatory options are best suited to deliver the Merseyside Bus Strategy. The work drew on econometric modelling work, employing the Model for Evaluating Transport Subsidies (METS). METS was originally developed by Prof. Stephen Glaister in the 1980s for the purpose of evaluating the economic costs and benefits of urban transport subsidies. Model parameters were updated to reflect the current characteristics of transport demand, price and supply in Merseyside. METS was then used to determine the economic costs and benefits of several policy options relating to changes in fares and public transport supply at an area level.

Hong Kong Mass Transit Railway Corporation – Fare Regulation *R.J. Anderson, and S. Glaister.*

The Hong Kong MTRC and KCRC railways are undergoing a period of review by the Hong Kong Government of how their fares should be structured and adjusted in the future. The existing mechanisms for adjusting fares throughout the world were reviewed, including pricing and regulatory mechanisms that are employed in the utilities industries. Suitable fare adjustment mechanisms were proposed to the MTRC and KCRC, and presentations and advice given to senior managers of both railways.

GEOOMATIC ENGINEERING

Optimising map-matching algorithms for the tracking and positioning of criminals. *J. Ashraf,, M. Quddus and W.Y. Ochieng.*

This research proposes to investigate ways of optimising current Map-Matching algorithms like Geometric Point-to-Point and Geometric Curve-to-Curve for the application of tracking and navigation of criminals. Being able to achieve a high degree of accuracy in vehicle positioning is critical in determining criminal movement and activity for the UK Police Force. Map-Matching algorithms are one of the common devices used for vehicle positioning and the determination of the physical location of the vehicle on the road network. Current research in Map-Matching suggests that there are major limitations in evaluating results from such algorithms and more focus needs to be concentrated towards integrity issues such as quality checks and metrics which should in theory lead to greater levels of confidence in a map-matched position. Also, the application of Fuzzy Logic techniques for Map-Matching will need to be investigated further, which aims to place qualitative information into a quantitative context.

Integration of GNSS with Low-cost Dead Reckoning sensors for continuous navigation. *U. Bhatti, W.Y. Ochieng and S. Feng.*

This research project will contribute to the realization of high accuracy high integrity lower-cost seamless positioning in all conditions and environments. It will develop techniques and algorithms to integrate space-based positioning systems with low-cost micro-electromechanical sensor (MEMS) dead reckoning (motion) sensors.

Seamless positioning in all conditions and environments *W.Y. Ochieng and S. Feng.*

Satellite positioning via Global Navigation Satellite Systems (GNSS) such as GPS have been adopted in a wide range of applications including multi-modal transport navigation; synchronisation of telecommunications networks; geodetic survey; and asset management systems. However, to access increased accuracy, integrity and availability, the various weaknesses inherent in such systems such as signal attenuation and masking; error modelling and integrity monitoring must be addressed. This proposal will address these weaknesses and deliver 'Centimetres Everywhere' with the appropriate levels of integrity for different applications. This is to be achieved through research leading to higher sensitivity algorithms for signal acquisition and tracking in harsh environments; exploitation of new signals; sensor error modelling; robust integrity monitoring algorithms; and the combined usage or integration of different sensor and data sources. It is envisaged that the models and algorithms developed will eventually be implemented in a 'test bed' whose requirements and architecture will be carried out within this project. The test bed is to be built in a subsequent project. The current vision is that the test bed should provide a benchmark for testing and referencing purposes. As a result, it will adopt as far as possible, an open architecture, to enable individual sensors to be added/removed/replaced as required. The

SPACE research team consists of Imperial College London, University of Nottingham, University of Leeds and UCL, and in collaboration with the main companies and government agencies in the field of positioning and navigation.

Free network mobile people and product location for enhanced personal and property security. *W.Y. Ochieng, and R Mautz*

The aim of this project is to develop a low-cost system capable of providing continuous tracking of people and property in all environments. The key objective will be to develop a system to locate ad-hoc networks of mobile users and equipment using current or near future wireless radio enabled equipment. The 'nodes' of the network could be people with suitably equipped mobile phones (or simple tags) or equipment (such as PCs, printers, etc.) with wireless radio connections. The location network should expand and contract 'organically' so that no central control points are required. In this way 'bottle-necks' in the system will be avoided when there are many users and location can be performed very quickly. The research is being carried out by Imperial and University of Leeds in collaboration with New Forrest Communications Limited, the Police Scientific Development Branch and the Forensic Science Services.

Review and definition of integrity algorithms for the GALILEO system *W.Y. Ochieng, S. Feng and U. Bharti.*

This research project carried out a detailed review of the existing algorithms for the monitoring of the quality (integrity) of the GALILEO navigation system, and developed investigated new approaches for the determination of the errors in the offset of the Galileo Sensor Station (receiver) clocks from the GALILEO System Time (GST). The error in the estimation of the clock offset is a key parameter in the integrity chain. The work was carried out by IC Consultants Limited and involved close collaboration between the Engineering Geomatics Group (ICEGG) at Imperial and the Department of Geomatic Engineering at UCL. The work was part of LogicaCMG's contribution to Phase CO of the GALILEO development programme.

Robust statistical framework for monitoring the integrity of space-based navigation systems, and preparing the marketplace for integrity-based services *I. Panagiotakopoulos (Supervisor: W.Y. Ochieng)*

Integrity monitoring of satellite navigation systems such as the Global Positioning System (GPS) offers a level of protection against potentially hazardous failures or malfunction. Existing integrity monitoring approaches rely heavily on statistical assumptions regarding the characteristics of the residual navigation errors after various error modeling and mitigation schemes have been applied. Some studies have pointed to the fact that in practice, residual

navigation errors although not very different from normal laws, may neither have normal tails nor zero mean. Furthermore, there has been insufficient data to demonstrate the nature of the distribution. The aim of this PhD research project is to test the assumption that residual navigation errors come from a normally distributed population with zero mean. Real GPS data from around the world will be used to test the statistical assumptions underpinning current methods with the objective of specifying a new and robust statistical framework that takes into account the spatio-temporal characteristics associated with the residual navigation errors. The research will follow this by studying the potential user services to be supported by systems employing the new statistical framework.

Reliable map-matching algorithms for land transport applications. *M Ouddus, W.Y. Ochieng and R.B. Noland.*

A range of transport telematics applications and services require continuous and accurate positioning information of the vehicles traveling on the road network. Two types of information are essential for such telematics applications and services. These are the determination of the vehicle position and the determination of the physical location of the vehicle on the road network. The most common devices used for vehicle positioning are based on GPS, Dead-Reckoning (DR) sensors, Map Matching (MM) and microwave beacons. The use of these devices either in isolation or combination depends on the Required Navigation Performance (RNP) parameter specifications (accuracy, integrity, continuity and availability). Furthermore, the capability to identify the physical location of a vehicle is a key requirement in transport telematics applications. In order to achieve the RNP, system and sensor complementarity, such as in the case of the integration of GPS, DR and digital map data could be used to enhance geometric positioning capability. MM not only enables the physical location of the vehicle to be identified but also improves the positioning capability if a good digital map is available. This research is developing novel map-matching algorithms that exploit all available information (quantitative and qualitative). Fuzzy logic techniques are used to address some of the vague qualitative information available.

Years: 2004-2007

Integration of GPS/DR/MM for transport telematics applications. *M.A. Ouddus, R.B. Noland and W.Y. Ochieng.*

A range of transport telematics applications and services require continuous and accurate positioning information of the vehicles travelling on the road network. Most common devices used for vehicle positioning are based on GPS, Dead-Reckoning (DR) sensors, Map Matching (MM) and microwave beacons. The use of these devices either in isolation or combination requires map matching. A key factor in the integration of

different devices is the knowledge of the various failure modes (error sources). The aim of this project is to develop two integrated positioning algorithms for transport telematics applications and services. The first is an Extended Kalman Filter (EKF) algorithm for the integration of GPS and low cost DR sensors to provide continuous positioning in built-up areas. The second takes this further by integrating the GPS/DR output with map data in a novel a map-matching process to both identify the physical location of a vehicle on the road network and improve positioning capability.

Determination of carrier phase observation ambiguity applying EGNOS message for precise point positioning. *X. Shi (Supervisor: W.Y. Ochieng)*

The objective of this project is to improve the performance of precise point positioning (PPP) which is based on the processing of undifferenced pseudorange and carrier phase observations from a single GPS receiver. The newly available EGNOS post-processed and real-time messages will be applied to describe and reduce the errors of the satellite based positioning. A new algorithm of the carrier phase ambiguity determination is to be developed. And finally the performance of this EGNOS aided PPP algorithm is to be evaluated. The work requires a good understanding of the current PPP algorithms and the modelling of error sources of satellite based positioning. The access and applications of the EGNOS messages need to be authorised by ESA.

Structural stability monitoring using satellite positioning systems and GIS. *W.Y. Ochieng, A. Elghazouli and D. Walsh (University of Leeds).*

The objective of this project is to specify and demonstrate a system architecture for structural deformation monitoring based on satellite positioning and geographical information systems technologies, and to develop methods for using this data to understand structural behaviour. The work requires a multi-disciplinary approach combining advanced satellite positioning and geographical information systems technologies with background in structural analysis and assessment as well as external input from practicing engineering firms. The project is being undertaken with the support of English Heritage.

Assessment of the performance potential of a combined GPS and GEO ranging navigation system. *W.Y. Ochieng, and K. Sauer (with Alcatel Space).*

The objective of this project is to investigate the performance potential of a navigation system consisting of GPS and Geostationary Earth Orbiting (GEO) satellites with navigation payloads. The integration of measurements transmitted by different independent satellite systems should offer improvement in navigation performance. The results have shown considerable improvement

(over GPS) when positioning with GPS satellites augmented with additional ranging from just one GEO satellite. Further significant improvement is expected when additional GEO satellites become operational over the next year.

AIR TRANSPORT OPERATIONS AND MANAGEMENT

Analysis of controller overloads. *A. Majumdar and W.Y. Ochieng.*

The objectives of this research are to analyse the ATC complexity factors causing controller overloads, i.e. sector and air traffic factors; and to analyse the development of controller overloads over spatial and temporal dimensions. This analysis should help in identifying the conditions that occur in the ATC sector and with the air traffic pattern that cause major increases in controller workload, to the point of saturation. Requirements for this study include a number of controller overload reports for the last year and the associated: (i) radar picture and (ii) R/T telecommunications for each overload. In addition, typical traffic patterns for the sectors in which overloads occurred and the times at which they occurred will be analysed to enable the unique conditions associated with an overload to be determined. The results of this analysis can inform fast time simulation studies in providing a much more sophisticated understanding of controller tasks and consequent workload at capacity, and presenting an opportunity to derive a complexity indicator for en-route airspace capacity.

Cross-sectional time-series analysis of simulated controller workload data *W.Y. Ochieng and A. Majumdar.*

En-route airspace capacity in the high density European air traffic network is determined by controller workload. Controller workload is primarily affected by the features of the air traffic and ATC sector. This research considers the air traffic and ATC sector factors that affect controller workload throughout the whole day. Simulation studies using the Re-organized ATC Mathematical Simulator (RAMS) model of air traffic controller workload are conducted for a number of Upper Area Control Centres in Europe. A cross-sectional time-series analysis of the simulation output is conducted with corrections for temporal autocorrelation in the data. The results thus far indicate that a sub-set of traffic and sector variables and their parameter estimates can be used to predict controller workload in any sector of these regions in any given hour. Current research focuses on the use of controller interviews and the use non-linear estimation methodologies to obtain a greater robustness in the analysis.

Incident analysis of New Zealand airspace. *A. Majumdar, W.Y. Ochieng and M.-D. Dupuy.*

Research has been undertaken with the New Zealand Civil Aviation Authority (NZCAA) over the

last year on the analysis of controller caused incidents in New Zealand airspace. In addition, the CTS has over the past year engaged in discussions with a number of civil aviation authorities with respect to occurrence data. As a consequence of this, the CTS has managed to acquire occurrence data from a number of countries including Australia, the UK and the USA. Current research focus on the following: (i) Assessment of the reliability of reporting in the New Zealand ASMS incident reporting database, and (ii) Development of airspace safety indicators. The two objectives will rely heavily upon incident data from New Zealand and a number of other countries using the technique of benchmarking. A major feature of this research is the use of international data to inform this process. Achievement of these objectives should assist the NZCAA in its overall safety research and analysis objectives.

Hazard analysis of air traffic services. *W.Y. Ochieng.*

The objective of this project (on behalf of the UK Civil Aviation Authority) is to assess the level of safety of air traffic services (ATS). The initial phase of this has already been completed having identified the failure modes associated with the navigation component of ATS. The remaining phases are to be carried out in collaboration with the University of Leeds and Helios Technology Limited.

Airborne new and advanced satellite techniques and technologies in a system integrated approach (ANASTASIA). *W.Y. Ochieng*

The aim of the Anastasia project is to study on board space based Navigation and Communication technologies that should become available for aircraft between 2010 and 2020. The project will contribute to developing standards, and provide advanced insights into the optimal architectures and technologies for next generation navigation and communication architectures on-board aircraft. The consortium of European industry and research organisations is led by Thales. Imperial will lead the work to develop a navigation architecture and algorithms that exploit multi-constellation, multi-frequency space-based positioning systems, state-of-the-art electro-mechanical motion sensors and spatial databases.

Determination of the effects of GPS performance and failures on aviation applications. *W.Y. Ochieng, and S. Feng.*

The aim of the project is to answer the question - how do GPS Signal-In-Space anomalies, GPS receiver failures, and abnormal events (e.g. interference, ionospheric effects or satellite outages) affect navigation performance of an aircraft, and how does an air traffic service deal with such events in the operational environment? The initial phase of this has already been completed having identified the failure modes (or

anomalies) and models. Phase 2 is developing improved anomaly protection (or integrity) algorithms to be used in the assessment their effect on the navigation performance of an aircraft. The final phase will then address how air traffic service providers deal with the effects in Phase 2. The research is being carried out by Imperial, University of Leeds and Helios Technology.

Robust navigation algorithms for aircraft precision approach and landing using global satellite navigation systems. *W.Y. Ochieng.*

This research investigate ways of using the new signals (in addition to the development of various models for the error sources) proposed as part of the modernization of GPS and the new systems under development including EGNOS (the European Geostationary Navigation Overlay Service) and Galileo to characterize the levels of performance achievable with the carrier phase measurements and to correlate this with aircraft precision approach and landing requirements. Hybridisation with other non-space based sensors such as INS (Inertial Navigation Systems) will also be explored. The integration of data from different systems should enable high integrity, continuity of service and availability.

Robust conflict detection and resolution taking into account flight data uncertainty. *W.Y. Ochieng, J.W. Polak and A. Majumdar.*

This project, in conjunction with the University of Glasgow, aims to utilise aircraft flight plans, navigation system and pilot flight intent data to develop detailed conflict detection and resolution algorithms that take account of the level of uncertainty associated with the flight plan, navigation and intent data, for use especially in more autonomous aircraft operations in flexible airspace. Intent information refers to the pilot's intentions in flying his/her aircraft from the current time to some future time. Such algorithms implemented in the flight management system (FMS) of an aircraft, should enhance the safety of operation by civil aviation pilots. The project will also consider the wider organisational impacts of such position and intent data primarily in terms of their effect on en-route airspace capacity.

Recovery from system failures in Air Traffic Control (ATC) *B. Subotic (Supervisor: W.Y. Ochieng)*

The aim of this research is to analyze failure modes of technical systems that support air traffic controllers, controller response to such failures, and recovery processes. Its objectives are to identify hazards associated with ATC systems and to develop a predictive tool/method of system recovery and human recovery from those hazards. Appropriate attention will be given to the contextual factors surrounding occurrence of the failure and their impact as well. The developed method/tool could be used during the design process for better understanding of human reactions and performance during the low-probability equipment failures.

Conflict detection and resolution algorithms A.
Patel (Supervisors: W.Y. Ochieng and A. Majumdar)

The objective of this research is to develop robust conflict detection and resolution algorithms which take into account the uncertainty associated with flight planning, navigation and intent data. The algorithms will find practical application as part of an aircraft's flight management system (FMS) to enhance aviation safety in the future autonomous airspace. The research will also consider the wider organisational impact primarily in terms of their effect on en-route capacity.

FREIGHT TRANSPORT OPERATIONS AND PLANNING

UK freight modelling review J.W. Polak in association with Marcel Enchenique and Partners, RAND Europe, Parsons Brinckerhoff, MDS Transmodal, Katalysis, Oxford Systematics University of Leeds, University of Westminster.

The aim of this study is to review current freight modelling techniques, and through assessing the suitability of the options potentially available, to make recommendations on the most appropriate techniques for use in Great Britain. The review will include road, rail and other freight modes and will also include the modelling of light goods vehicles.

Modelling decision making in the UK container industry. J.W. Polak, S. Farrell, with J.D. Woods and J. N. Carter (Department of Earth Science and Engineering), J. Darlington, A. Field and Y. Guo (Department of Computing) and B. Hutton (Napier University).

The aim of this project, which is jointly funded by DTI, EPSRC and a consortium of eight leading companies involved in various aspects of the container business under LINK Foresight scheme, is to develop a simulation model of UK container operations assess strategic infrastructure investment decisions in the UK container industry. The work involves two closely interrelated activities. The first is the identification of the principal actors, key information flows and essential decision making strategies that characterise the container transport market. The second activity is the translation of these understandings into a flexible and portable simulation tool that can be used by decision makers at various levels to explore the consequences of alternative business strategies.

UK freight panel. J.W. Polak, S. Glaister, R.B. Noland, D.J. Graham and R.J. Anderson in association with WS Atkins Consultants.

The aim of this study, which is being undertaken on behalf of the Strategic Rail Authority, is to provide the SRA with advice on a broad range of policy and operational issues. The contribution of Imperial College will focus particularly on freight demand models, freight demand research and

freight market structures.

Modelling freight supplier behaviour and response. K. Arunotayanun (Supervisor: J.W. Polak).

In recent years there has been a spectacular growth in the prevalence of third-party logistics (3PL) operators. In contrast to traditional freight forwarders, 3PLs typically provide a much wider range of services (e.g. warehousing, information technology, custom services, logistics management as well as basic transport) and offer shippers opportunities for efficiency improvements. However, little is currently known regarding how mode choice decisions are made by 3PLs. The objective of this research is therefore to develop an understanding of the factors that affect 3PL mode choice and to develop advanced discrete choice models to characterise this decision process.

Performance measurement and benchmarking of container terminals. K. Bichou (Supervisors: M.G.H. Bell, J.W. Polak and R. Cochrane).

Most practical and theoretical approaches to port performance and benchmarking are reducible to three broad categories: physical indicators, factor productivity indicators, and economic/financial indicators. However, despite the variety of tools and instruments available, there is no established framework for efficiency measurement and competitive benchmarking for ports. There are several obstacles to such a framework, most importantly the cross-functional and multi-institutional dimensions of ports. This research will adapt and apply quantitative logistics techniques and balance scorecard models to port operations and management. Using a survey and/or case study methods, the research will focus on optimising container terminal operations in relation to other elements of the transport and logistics chain (shipping lines, 3PLs, inland transport operators, etc.).

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RESEARCH AT UNIVERSITY COLLEGE LONDON

This section summarises the research carried out by staff and research students of the Centre for Transport Studies at UCL (including the ESRC Transport Studies Unit) during 2004. Updated information is listed on the web pages via www.cts.ucl.ac.uk.

SAFETY AND SECURITY

Pro-active integrated systems for security management by technological, institutional and communication assistance (PRISMATICA)

EC, DG-TREN. *Maria-Alicia Vicencio-Silva, Richard Allsop and Nick Tyler with Sergio Velastin (Kingston University), Pierre Lagrange (RATP Paris) and 12 other partners.*

Work to determine users' needs for improved personal security in public transport environments and develop innovative tools and processes for delivering this has been completed. In collaboration with public transport operators in 6 countries, a selection of tools and processes have been developed, tested and evaluated in terms of their impact on personal security and their scope for improving social inclusion. The work and its potential for technical implementation have been reported in deliverables to the EC.

Reports: Velastin, Lo, Sun, Vicencio-Silva and Khoudour (2004)
Sun, Velastin, Lo, Vicencio-Silva and Khoudour (2004)

Road safety

Research for thesis: AQ Memon.

This study is investigating the occurrence of road traffic accidents at a national scale. Data for the United Kingdom over several years are being analyzed and modelled using statistical techniques. Initial work has applied regression technique, based upon time, month, day of week and holidays. ARIMA time series methodology has also been applied. The results of this will be used in evaluation of road safety interventions.

Review for The National Police Agency, Japan of development of road safety policy in Great Britain
Kenzi Nagano (National Police Agency, Japan) and Richard Allsop.

The development of road safety policy and its implementation since the early 1980s in Great Britain was reviewed by means of documentary research, discussion with stakeholders, attendance by invitation at relevant meetings and participation in conferences. Particular attention was given to strategy development including the involvement of stakeholders, the role and setting of targets, the basis in research for safety strategy and measures, and mechanisms for implementation and for monitoring of progress.

Road safety policy and targets

Richard Allsop.

Continuing advice on the monitoring and reporting of progress towards the road safety targets for 2010 has been provided through the Statistics Subgroup of the Road Safety Advisory Panel. In particular, contributions were made to debate concerning allowance for regression to the mean in monitoring the effects of the safety camera programme on numbers of casualties. The rationale for a pragmatic alternative to Sweden's Vision Zero as a vision for road safety has been extended and promoted. A contribution is being made to an ETSC review of evaluation of national road safety strategies as part of its project concerning road safety in southern, eastern and central Europe – the SEC belt project. Input was made to an independent review for the New Zealand Land Transport Safety Authority of progress in implementing its road safety strategy to 2010.

Reports:

Allsop (2004a, b, c)

Advice on research to inform future speed policy

DfT. Benjamin Heydecker and Richard Allsop.

In an invited seminar contribution, potential was identified for research into the role of speed in deaths among car users and motorcyclists, the interpretation of contributory factors data in relation to the role of speed, issues in the estimation of effects of local speed management measures, the role of speed limits in speed management, the deterrent effect of cumulative penalty points, and the likely effect of raising speed limits on the number of casualties.

Evaluation of the Neighbourhood Road Safety Initiative

DfT. Heather Ward with Nicola Christie (University of Surrey), Ronan Lyons (University of Wales, Swansea), Elizabeth Towner (University of West of England) and Michael Hayes (Child Accident Prevention Trust).

The Neighbourhood Road Safety Initiative (NRSI) forms part of the Government's response to dealing with reducing inequalities in road traffic accidents. The initiative involves 15 local authorities with deprived districts that have high child pedestrian casualties. The project aims are to:

- reduce casualty rates in disadvantaged areas at a greater rate than across the local authority as a whole,
- evaluate the impact of this initiative on disadvantaged communities, and
- understand the causal chain that has resulted in the poor road safety performance of particularly disadvantaged areas.

The evaluation programme led by UCL aims to increase knowledge of causal links by monitoring changes in numbers of casualties and exposure of all road user groups, whether the injury gap is being narrowed, changes in lifestyles, perceptions

of safety, and levels of engagement by all sectors of the community. Partnership surveys will yield knowledge of barriers and facilitators to effective working by different agencies in these neighbourhoods, and provide guidance to enhance future collaborations.

Under-reporting of Road Traffic Casualties in London: matching Police STATS19 with hospital Accident and Emergency Department data. A fourth hospital.

TRL for TfL. Heather Ward and Sandy Robertson.

An initial investigation was undertaken using three hospitals to estimate the level of under-reporting of injury accidents to the Police in London. The level of under-reporting was lower at the Central London Hospital than at the inner and outer London hospitals. A fourth hospital was chosen to represent central London and their casualty data matched with corresponding STASTS19 casualty data. This confirmed the finding that reporting rates in Central London are higher than elsewhere in London.

Under-reporting of road casualties

DfT. Heather Ward and Sandy Robertson with Nicola Christie (University of Surrey) and Ronan Lyons (University of Wales, Swansea).

There is some concern that the trends in the serious injuries as recorded in STATS19 may not be an accurate reflection of the true situation. There is general recognition and acceptance that the STATS19 record is an underestimation of the actual number of road traffic accident casualties. The aim of the project is to assess the level of under-reporting and misclassification of casualties, and in particular to find out whether there have been any changes in reporting practices. The work started late in 2004 and will last 6 months. In this time we will provide a review of previous studies of under-reporting, investigate additional sources of health data that can be used to investigate the extent of under-reporting of road casualties, carry out analysis of available data to inform our knowledge and understanding of the extent of under-reporting, compare current information with the results of other studies of under-reporting, and make recommendations for further data collection.

Accidental Injury Prevention Research Programme Co-ordinator

Department of Health: Heather Ward.

The Department of Health has commissioned an accidental injury prevention research programme as part of its commitment to implement the recommendations of the report of the Accidental Injury Task Force and has appointed Heather Ward as its co-ordinator. There are three research streams and 10 research topics covering: children and young adults; older people; and framework for delivery and developing the infrastructure. The coordinator's role commenced with the scientific aspects of commissioning the initiative, and continues with monitoring progress on individual

projects; securing effective linkages between the ten research groups, the Department of Health, and other stakeholders; enabling learning to take place within the initiative; synthesising lessons emerging from separate projects; facilitating the communication and dissemination of findings in ways which contribute to policy and practice; and providing an independent source of advice to the Department of Health on managing the initiative and using its findings.

International survey of children's road safety

DfT. Heather Ward and Sally Cairns (UCL) with Nicola Christie and Elisabeth Towner.

There are clear differences between OECD countries in terms of child traffic accident death rates. This project has involved undertaking and analysing a major survey, aiming to account for the child road safety record of OECD Member countries through a comparative assessment of policy, practice and legislation. The survey has identified good practice, gaps in existing knowledge and recommended priorities for action.

Reports:

Christie, Cairns, Towner and Ward (2004)
Christie, Towner, Cairns and Ward (2004a, b)
Ward, Christie, Cairns and Towner (2004)

Advice to Department of Transport on Speed Management

DfT. Heather Ward.

Work has continued under this contract and during 2004 advice has been given on drafting the consultation paper on setting local speed limits and assistance on an OECD expert group on Speed Management. Advice has also been given to the Scottish Safety Camera Programme Office on safety camera site selection and to the England and Wales working group on developing the Safety Camera Partnership Handbook. In addition, a scoping exercise has been undertaken to assist the DfT develop a research programme into speed management. This included the commissioning of thinkpieces from researchers in the area, running a workshop with stakeholders to debate the issues and the writing of a report to DfT on the suggested content of a research programme in this area.

The history and development of speed camera use

Heather Ward with Amanda Delaney and Max Cameron (Monash University, Australia).

Monash University was commissioned by the Insurance Institute for Highway Safety to document the history of speed camera use in various countries around the world to provide a resource on the nature, extent and perceived acceptability of their use. The work conducted at UCL was to provide information on the British experience and controversies.

A scoping study of night-time accidents with particular reference to younger and older drivers

AA Motoring Trust and the Rees Jeffreys Road Fund. Heather Ward and Sandy Robertson with Nigel Shepherd and Mary Thomas (FaberMaunsell Ltd).

Only a quarter of all travel by car drivers is undertaken between the hours of 19.00 and 08.00, but 40 percent of fatal and serious injuries are sustained by drivers. Focus groups formed part of the research and a wide range of issues were raised. For younger drivers especially the males, there appears to be little concept of risk yet the figures show the risk is very high for this group. Some of the comments indicate they need to get their 'fingers burned' before the message will come home to them. Older drivers have few accidents at night compared with the day with more males being injured than females but this reflects a difference in exposure. However, the risk of death or serious injury to older females is very marked and given the low exposure of this group in the evening and at night, there is need for further investigation.

A methodology for systematic diagnosis of accidents in urban areas in Portugal

Research for thesis, Sílvia Costa.

In order to develop a realistic tool that Local Authorities can adopt to diagnose accident occurrence and support implementation of road safety engineering measures in urban areas in Portugal, this research has reviewed the existing situation in various countries and has developed a proposed methodology. This has been tested in a case study the Portuguese city of Almada and adapted accordingly. The work is now being finalised in a thesis.

Interactions between rail and road safety

EPSRC. AW Evans and Dr JD Addison.

This project aims to investigate the safety implications of policies that may result in changes in modal choice. The transfer of passengers in either direction between rail and road may be induced by safety and non-safety policy and expenditure decisions. The project will give a better understanding of the safety consequences for both the travellers concerned and for third parties. Work this year has focused on developing suitable models based on the National Travel Survey data. This has involved a thorough examination of the data available and the extraction of journey information with associated data individual and household data in a form to facilitate model building. Work is now progressing on the final specification of various models.

Analysis of safety camera operation under cost recovery

DfT. Benjamin Heydecker, Sandy Robertson, Heather Ward with partners from PA Consulting Group.

Speed and red-light enforcement cameras (referred to collectively as "safety cameras") were first deployed in the early 1990s. Several research studies conducted in the UK and abroad have shown that safety cameras can be an effective means of reducing speed and casualties. In 1998, the Department for Transport and other

Government Departments took a policy decision to allow local partnerships, subject to certain Treasury criteria, to recover the costs of speed enforcement from fine income. This study investigated the safety performance of cameras in eight pilot areas during the first three years of operation under these cost recovery rules. The results show that speeds were reduced and that the numbers of casualties killed or seriously injured at camera sites fell by 40 per cent compared to the long-term trend.

Reports:

Gains, Heydecker, Shrewsbury and Robertson (2004)

PUBLIC TRANSPORT

The Demand for Public Transport – A Practical Guide

EPSRC. Helena Titheridge, Roger Mackett, with Richard Balcombe and Neil Paulley (Transport Research Laboratory), John Preston (Transport Studies Unit, University of Oxford), Mark Wardman and Jeremy Shires (Institute for Transport Studies, University of Leeds) and Peter White (Transport Studies Group, University of Westminster).

The research into the factors that influence the demand for public transport has been completed and the report published. Effort has been put into dissemination of the findings. It is available over the internet and in printed form from TRL.

Reports:

Balcombe, Mackett, Paulley, Preston, Wardman, Shires, Titheridge and White (2004)
Mackett (2004a)

Paulley, Balcombe, Mackett, Preston, Wardman, Shires, Titheridge and White (2004)

Website:

<http://www.demandforpublictransport.co.uk/>

The demand for public transport

ESRC, INRETS. Joyce Dargay, Georges Bresson, Alain Pirotte and Jean-Loup Madre.

The recent work on modelling the demand for public transport has been concerned with comparing simplified models containing only three economic determinants (vehicle km, income and price) with those including structural determinants (i.e. population ageing, urban sprawl and growing car ownership). The analysis, based on a panel of 62 urban areas in France over a 20-year period, employs random coefficient models and shrinkage estimators so that separate elasticities are estimated for each urban area. The major conclusion is that the downward trend in public transport patronage is mainly due to increasing car ownership, and that this effect will be less and less important over time since the growth of the car stock is decelerating. In addition, the use of public transport is quite sensitive to the volume supplied and to its price as well as to the fuel price.

Reports:

Bresson, Dargay, Madre and Pirotte (2004)

Reducing children's car use: the health and potential car dependency impacts

EPSRC. Lindsey Lucas, James Paskins, Jill Turbin and Roger Mackett, with Mark McCarthy (Epidemiology and Public Health Medicine, UCL), Laurel Edmunds (University of Bristol), Neil Armstrong (University of Exeter), Environment Department, Hertfordshire County Council and Adrian Coggins (Royston, Buntingford and Bishop's Stortford Primary Care Trust).

TRAVEL BEHAVIOUR AND POLICY

This research has produced sound evidence why children should walk rather than go by car, by showing that the shift for children from informal out-of-home activities to formal ones has led to an increase in car use, by showing that children who walk to activities are more active when they arrive than children who travel by car, and by showing that initiatives such as walking buses can be effective ways to attract children out of cars, although having little effect on traffic levels. All these and other findings are very valuable contributions to the current debates about childhood obesity and about travel to school, which lie at the interface between transport, education and health policy.

Reports:

Mackett (2004b, c, d, e)

Mackett, Lucas, Paskins and Turbin (2004a, b)

Mackett and Paskins (2004)

Paskins, Mackett, Lucas and Turbin (2004a, b, c)

Web site: www.cts.ucl.ac.uk/research/chcaruse

Making school travel plans work

DfT. Sally Cairns with Carey Newson, Adrian Davis, Geoff Gilbert, Paul Osborne, Tara Garnett, Jo Cleary, Rhian Barnes, Lynn Sloman.

This project has involved an assessment of what school travel plans can achieve, and how, and will result in fresh guidance for local authorities. From an initial survey of over 100 nominated schools, 30 case studies of good practice have been selected, and detailed interviews have been carried out with both the schools and their associated local authorities. The results suggest that good school travel plans can result in substantial cuts in car use on the school run, and also achieve a range of other, associated benefits. A number of lessons for good practice have emerged.

Reports:

Potter, Lane, Parkhurst, Cairns and Enoch (2004)

Accessibility and use needs in transport in a sustainable urban environment - Scoping Study (AUNT-SUE)

EPSRC. James Paskins, Helena Titheridge, Roger Mackett and Nick Tyler, with Graeme Evans, Steve Shaw and Juliet Solomon (London Metropolitan University), Mark Porter and Ruth Sims (Loughborough University).

The main task of this scoping study was the preparation and submission to EPSRC of the main proposal for this research, which was carried out

successfully. As part of the preparatory work for the main study, a number of studies were carried out, for example on the ways that central government requires local authorities to incorporate social inclusion into their policy instruments and identification of the ways in which social inclusion is incorporated into policies in Local Transport Plans (LTPs). A second element of the project specified the requirements for the two 'testbeds' in which policy implementation would be studied in the main project. The testbeds are areas in London and Hertfordshire where the research team will be able to study the way in which policies are developed at a macroscopic level and the way in which even detailed design of the street environment could affect the extent to which they could increase social inclusion.

Reports:

Mackett, Paskins and Titheridge (2004)

Mackett and Titheridge (2004)

Titheridge (2004)

Web site: <http://www.aunt-sue.org.uk>

Benchmarks And Policies Towards Inclusive Sustainable Transport (BAPTIST)

EPSRC. Shepley Orr, Helena Titheridge, Roger Mackett, with Juliet Solomon (London Metropolitan University) and the Environment Department, Hertfordshire County Council.

This is one of the three main work packages of the AUNT-SUE project being funded under the EPSRC SUE (Sustainable Urban Environment) programme. This involves the development of a computer-based policy analysis tool which can be used by local authorities and others to assess the extent to which their policies increase social inclusion. This is done by calculating the change number of people who are socially excluded who would reach benchmarks that indicate a 'reasonable' level of accessibility as the result in the introduction of a policy. Surveys are currently being designed to determine the benchmarks. A conceptual model of the transport policy-making process is being developed, using Hertfordshire County Council as a case study.

Children's Activities, Perceptions And Behaviour in the Local Environment (CAPABLE)

EPSRC. James Paskins and Roger Mackett, with Mike Batty, Kei Kitazawa and Yi Gong (CASA, UCL), David Banister, Belinda Brown and Stephen Marshall (Bartlett School of Planning, UCL), Dorothy Einon (Psychology, UCL), the Environment Department, Hertfordshire County Council, the Children's Play Council and Groundwork UK.

The objective of this project is to explore how children use the local environment, how it can be improved to meet their needs better and to help produce a safer environment for them, thereby benefiting all of society. A major element of this will involve the fitting of a sample of children with GPS (Global Positioning Satellite) equipment and activity monitors, and asking them to keep a travel and activity diary. From this it will be possible to

analyse and model how they interact with the local environment. Questionnaire surveys of the children and their parents will produce information on their perceptions and the constraints that prevent children from going out unaccompanied. Currently effort is being put into the design and piloting of the research instruments.

How children experience and understand their local environments

Research for thesis: James Paskins.

Spatial cognition is a process that underpins most day-to-day activity. This research aims to investigate how children's style of interaction with the environment can influence the knowledge they gain about their surroundings. Different modes of travel impose different styles of interaction. For instance, there is a difference in the relationship between a child and the environment when a child is walking and when a child is a passenger in a car. There are other differences; one being the level of independence granted by parents, whether a child is allowed to travel or play without being accompanied by an adult for instance. A number of techniques, including questionnaires and sketch mapping tasks, are being employed to investigate whether these and other differences in the way that children use their local environments translate into significant differences in their spatial knowledge. Early results point to an advantage for children who are allowed to travel more independently, as they appear to have more accurate representations of their local environment.

Reports:

Paskins (2004a, b)

Household location modelling

DfT. Roger Mackett, with David Simmonds Consultancy, School of Geography, University of Leeds and Peter Headicar (Oxford Brookes University).

The objective of this work is to develop a model of household location and how it is affected by changes to the transport system. The work draws upon three streams of household modelling already carried out by members of the team. These are the SimLeeds and SimBritain systems developed at the University of Leeds, the MASTER model developed by Roger Mackett at UCL, and the DELTA land-use/economic modelling package developed by David Simmonds Consultancy. The project will use part or all of the SWYMMS (South and West Yorkshire Multi-Modal Study) area as a case study, but will also look at the processes of longer-distance relocation on a national scale. The study will deliver both a report describing an improved understanding of household location and a working model system making that understanding available to the Department as a practical tool.

Evaluation of newly introduced modes

AQ Memon with K Sano.

An incremental logit model was used in order to measure the change in the behaviour of commuters after the introduction of new proposed transport mode of a magnetic train. Direct and cross elasticity were also calculated for the existing and future modes. Policy sensitivity analysis in terms of decrease in total travel time and total cost was analyzed. It was proposed to enhance the bus system for existing and Magnetic train for future by reducing 10 percent total travel time which will increase the modal share of bus to 46 percent and the bus riders will increase by 12.5 percent and that of magnetic train to 42.2 percent and its riders will increase by 5.4 percent.

Reports:

Memon and Sano (2004a)

Risks in public-private partnerships.

European Investment Bank. F Medda.

Risk transfer from the government to the private sector, and consequently its efficient allocation, plays a paramount role as benchmark in the decision on whether a PPP agreement is the more cost-effective alternative to the public provision of public services. When public sector guarantees have higher value than financial loss, and this is justified by being regarded as an incentive for the private sector to enter into partnerships with the public sector, the behaviour of the private sector is strategic and we may be confronted with potential moral hazard problems.

Reports:

Medda (2004a, b, c)

Public-private partnerships in the rail industry.

RETF Grants Pump-Priming Award. F Medda, with E Pels (Free University Amsterdam) and N Castillo (University of Reading).

Railway service provided by an operator is typically a network product where capacity may be provided by a different agent such as local or national governments. This capacity may be in the form of physical inputs (tracks), or the necessary land to develop nodes (stations) or tracks). Both the private rail service provider and the public network operator have different interests in network capacity investments. The private sector's objective is to maximize his profit while the public sector aims to maximize the welfare function. This project addresses the question of how the public sector together with the private sector can meet final passenger demand by providing sufficient infrastructure capacity. The decision procedure is modelled in a game-theoretic setting.

Reports:

Medda and Pels (2004a, b)

Rail policy and research advice

Strategic Rail Authority. Sally Cairns

This project primarily involves assisting the SRA with a 'research audit', to bring together all the research studies commissioned by the SRA during its existence. This audit forms part of the hand-over of rail research responsibilities to the Department for Transport. The audit involves

compiling a comprehensive list of studies, and summarising the main research work in a format suitable for wider dissemination, including providing details of the context of the studies and what flowed from them.

TRANTEL: transport and IT innovations to help young unemployed people in a remote rural area

Helena Titheridge with Joanna Williams, David Banister, Carly Vince, Shen Cheng, Sam Maxted, Marcell Bischoff, George Man, Mike Batty, Gloucestershire Development Agency, The Home Office Partnership Associates, and Royal Forest of Dean College.

This large-scale EPSRC study explored the preferences of young unemployed people in the Forest of Dean for a variety of policies designed to ease their access to jobs - support for private transport (car sharing, driving lessons etc), public transport (better or customised services, bus and taxi subsidies) and IT improvements.

Report:

Titheridge (2004)

Web site: <http://www.trantel-epsrc.org/>

Counselling skills for researchers

Maria Alicia Vicencio Silva.

Current work investigates the use of counselling skills to enrich interactions between researchers and the public, through listening techniques and improved social awareness. Next step will explore the impacts of the use of these techniques on the reliability of the data collected and then, a methodology may be derived for the systematic application of these skills. Also, the use of image processing techniques and image understanding methods to qualify qualitative data collected through interviews will be investigated.

Value of Time

ESRC, Phil Goodwin.

If a skewed distribution of values of time is approximated by a single (correct) mean value, and this is used in forecasting revenue for a toll road, there is a likelihood that the revenue will be overestimated - fewer people than expected will have a value of time saving greater than the toll.

Report:

Hensher and Goodwin (2004)

Elasticities of demand for road traffic

Department for Transport, Phil Goodwin, Joyce Dargay and Mark Hanly.

A review of new literature, reinforced by a meta-analysis and some new empirical analysis, suggests that the elasticity of demand for road traffic with respect to various prices is more sensitive than had been assumed in the DfT's forecasts.

Report:

Goodwin Hanly and Dargay (2004)

Traffic congestion and rail freight

Rail Freight Group, Phil Goodwin.

The variability of traffic speeds caused by traffic congestion imposes significant costs on freight travel. There are potential benefits from a transfer of some freight from road to rail.

Report:

Goodwin (2004a)

Valuing the Small

CPRE, CTC, Living Streets, Slower Speeds Initiative, Sustrans and Transport 2000, Phil Goodwin.

There are some significant distortions in the way in which transport projects are appraised, leading to an underestimate of the value of smaller, cheaper, less dramatic but very effective local policies and initiatives. A method of shortlisting such schemes is suggested to enable more of them to be carried out.

Report:

Goodwin (2004b)

Smarter choices - changing the way we travel

DfT. Phil Goodwin and Sally Cairns with Lynn Sloman, Carey Newson, Jillian Anable, Alistair Kirkbride

This project has investigated the effects of 'soft' policy measures on car use, namely workplace and school travel plans; personalised journey planning; public transport information, marketing and ticket incentives; travel awareness campaigns; car clubs; car sharing schemes; teleworking; teleconferencing; and home shopping. It has involved a review of both national and international literature, and detailed investigation of 24 case studies of individual soft policy initiatives, drawn from the UK. Results relate to the scale at which each measure is being implemented, the recorded effects on car use, and the costs of achieving such results.

Reports:

Anable, Kirkbride, Sloman, Newson, Cairns and Goodwin (2004, 2005)

Cairns (2004a, b, c)

Cairns, Sloman, Newson, Anable, Kirkbride and Goodwin (2004)

Changing Travel Behaviour

ESRC and other agencies, Phil Goodwin, Sally Cairns, Joyce Dargay, Mark Hanly, Graham Parkhurst, Gordon Stokes and Petros Vythoulkas.

In a synthesis of some of the more important strands of research carried out under the research programme of the ESRC Transport Studies Unit, at Oxford and UCL, from 1994 to 2004, the extent, sources, nature and policy implications of changes in travel behaviour are explored.

Report:

Goodwin, Cairns, Dargay, Hanly, Parkhurst, Stokes, and Vythoulkas (2004)

Web site: www.cts.ucl.ac.uk/tsu/conference

A framework to assess the usability of pedestrian crossing places.

EPSRC. Sandy Robertson, Roselle Thoreau and Richard Allsop.

This study of informal crossing places and their use in relation to zebra crossings has continued

with completion of workshops with users of crossings near to 5 sites for observation of the use of zebra crossings and nearby refuges with dropped kerbs but without crossing markings. With the co-operation of the responsible Local authorities, video-recordings were made at these sites and analysed in terms of patterns of use and user behaviour. Outcomes of these activities and earlier phases of the study have been brought together to identify aspects of usability and relevant observables, and to enable development of a framework to help designers to take account of these along with engineering considerations in the design of crossing places.

Reports:

Robertson and Thoreau (2004)

Robertson, Thoreau and Allsop (2004)

Web site: <http://ucl.ac.uk/transport-studies/usaped.html>

TRAFFIC CONTROL, MANAGEMENT AND MODELLING

Optimisation of isolated traffic signals

Research for thesis: Woo-Young Ahn.

The operation of traffic-responsive signals at isolated road junctions depends on the way in which data that are available from traffic detectors are used. In this research, methods have been developed to use detector data to update a detailed model of vehicular movement, including acceleration and braking, on the approach to a traffic signal. Mean rates are used to estimate arrivals at times beyond the range covered by the detector, and a penalty was included for residual queues at the end of the planning period. This model is then used in a dynamic programming approach to optimisation of signal timings over a rolling horizon. Results from this show that performance of the resulting signal control is better than fixed time or System D vehicle actuated, and is competitive with other methods. Comparisons with vertical queueing models show that most of the important effects can be captured by using an appropriate start lag at the beginning of green. Investigation of sensitivity of the results to use of different elements of the data show that the most important one relates to the vehicles that have been detected individually. The research is now completed, and the degree of PhD has been awarded.

Report:

Ahn (2004)

Distributed adaptive control for traffic signal systems

EPSRC. Jeanan Sha'Aban, JD Addison, Benjamin Heydecker and Richard Allsop with Andy Tomlinson and Larry Bull (University of the West of England).

This project is investigating the use in traffic management and signal control of evolutionary algorithms. These are based on a Learning Classifier System (LCS), which develops effective rules to deal with complex sequences of decisions and is applied here to a traffic signal control

system. The LCS has been integrated into the latest version of the SIGSIM microscopic simulation model. SIGSIM provides simulated detector data and measures of performance. The LCS uses these measures to develop and evaluate signal control strategies. Investigations have used the mean rate of delay at each junction as a measure of performance. Tests on a range of examples have shown that this LCS approach can give better performance than standard signal control policies such as System D vehicle actuated and fixed time signal control.

Reports:

Heydecker (2004a)

Bull, Sha'Aban, Tomlinson, Addison and Heydecker (2004)

Modelling the dynamic effects of transport improvement on urban shape.

F Medda with P Nijkamp (Free University Amsterdam) and P Rietveld (Free University Amsterdam).

We assume a mutual dependence between transportation costs and urban real estate value, and by applying the morphogenetic algorithm, we determine the dynamic processes that this relationship induces to spatial urban changes. The objective of the The model describes the spillover and cumulative effects present in the urban growth process which had been missing in other studies. The numerical simulation of two case studies depicts how the entire urban shape can be modified in different ways by a transport improvement that either happens randomly or at a specific location.

Report:

Medda, Nijkamp and Rietveld (2004)

An analysis of the effects of urban land use on transportation.

STELLA/EU and US National Science Foundation. F Medda, with M Boarnet (University of California at Irvine).

Rather than address how transportation affects land use, as is typically seen in the literature, we have examined how land use influences transportation. We find that land use – and specifically urban morphologies – determines impacts on how we travel and how much we travel. We have shown both empirically and theoretically that urban land use is a determinant in our travel behaviour, in particular when walking, and in the allocation of road when we require zero congestion levels.

Report:

Medda and Boarnet (2004)

Cities programme.

ESRC. F Medda, with P Cheshire (LSE), S Magrini (Universita di Venezia), V Monastiriotis (LSE).

The project investigates the relationship between regional economic growth and commuting patterns in four European countries (UK, Italy, France, Germany).

Report:

Cheshire, Magrini, Medda and Monastiriotis (2004)

Blocking-back at traffic signals

Research for thesis: Ioanna Spiropoulou.

For signal-controlled junctions in urban road networks, queues can become so long that they block traffic at upstream junctions. This phenomenon is being studied using several different traffic models with distinct characteristics, ranging from microscopic to macroscopic. The capabilities and weaknesses of the models have been identified, and comparisons made between the parameters that they require. In addition, the way these models represent blocking back has been investigated and analysed to identify similarities between estimates given by certain models and substantial differences between others. The research is now completed, and the degree of PhD has been awarded.

Report:

Spiropoulou (2004)

A bid-rent network equilibrium model

Research for thesis: ORS. Su-Eun Chang.

In this PhD research, a new model for investigating the relationship between transport and the location of activities has been developed. The work has been carried out in three stages. Firstly, the structural features of the relationship, which are the characteristics of the locations, the decision-making processes of households, and the interaction between land-use and transport, were identified, and the relevant literature reviewed. Secondly, a bid-rent network equilibrium model was developed to represent the competition for locations, using a hedonic approach to overcome difficulties associated with the unique characteristics of locations, namely heterogeneity and indivisibility. The final stage of the work was the application of the model to real-world data, using the city of Ansan in Korea as a case-study. Two-policy tests were conducted with the model: the introduction of congestion charging and the release of land for housing development.

Report:

Chang (2004)

The effect of thresholds of perception on travel choice

V Cantillo, JdeD Ortuzar and BG Heydecker.

Some changes in the attributes of travel options can be so small that travellers do not respond to them. In this work, we formulate a discrete choice model that incorporates thresholds in the perception of attribute changes. The model considers multiple options and allows changes in several attributes. We postulate that if thresholds exist they could be random, differ between individuals, and even be a function of socio-economic characteristics and choice conditions. Our formulation allows estimation of the parameters of the threshold probability

distribution starting from information about choices. The model is applied to synthetic data and also to real data from a stated preference survey. We found that where perception thresholds exist in the population, the use of models without them leads to errors in estimation and prediction, and show that where thresholds exist, models that do not represent them can overestimate benefits substantially.

Report:
Cantillo, Heydecker and Ortuzar (2004)

Dynamic traffic management

Research for thesis: Andy HF Chow.

This study aims to develop a general framework for analysing and implementing dynamic road pricing strategies. Following the previous analysis of travellers' route choices and departure time choices in a congested road network, we are investigating the implementation of time-varying tolls to operate the road network optimally. We are currently exploring the necessary conditions for an optimal toll and efficiencies of different pricing strategies.

Reports:
Chow (2004, 2005)

Dynamic departure time and user equilibrium assignment

Y Lim, S Lee and BG Heydecker.

This study has developed and analysed a various models logit-based combined departure time and dynamic stochastic user equilibrium model. In order to calculate the equilibrium, we propose a solution algorithm that can solve the problem directly, without appealing to an equivalent mathematical programme. An efficient solution method has been developed that works within a reasonable path set and a novel invariant quantity of DDSUE assignments has also been established. Solutions have been calculated efficiently for a range of examples. This approach has been applied to represent travellers' choice of response to changes in the design or a road network We have solved the resulting formulation for peak periods in small example networks.

Report:
Lim, Heydecker and Lee (2004)

Dynamic traffic assignment

JD Addison, BG Heydecker and RE Allsop.

Travellers' choice of departure time and route through a network depend on the particulars of their need to travel and the state of the road network. In this work, a joint choice of departure time and route is integrated with a representation of the values to the traveller of remaining at the origin and of spending time at the destination. According to the equilibrium model of travel behaviour, travellers within a homogeneous group will depart so that the network is loaded in a way that balances out the temporal variations over time in benefit by complementary ones in the cost incurred by travel. This approach has been applied to a simple example network to

investigate the nature of the solutions.

Report:
Heydecker (2004b)

Modelling modal share

MA Qadeer, with K Sano.

The multinomial logit model was used to calibrate the utility functions for alternative modes and to estimate the modal share of the new magnetic train. Stated Preference approach was used. Random sampling was used for survey. Incremental approach was used to develop the model, for which different socioeconomic and travel mode characteristics were used. The most suitable multinomial logit model based on model specification refinement process was selected. The results indicated that the modal share of public transportation will be 78.99 percent after magnetic train will operate and the modal share of new mode will be 39.50 percent.

Report:
Memon and Sano (2004b)

STRATEGIC TRANSPORT POLICY ASSESSMENT AND PLANNING

Road transport: international studies

ESRC. Joyce Dargay, Dermot Gately, New York University.

This is an ongoing project which investigates aggregate relationships of relevance to transport demand on the basis of dynamic models and data for different countries or groups of countries. Data have been collected to extend earlier empirical work car ownership and fuel consumption, and estimation of various types of models is currently being carried out.

Pseudo-panel analysis of dynamic transport demand relationships

ESRC. Joyce Dargay.

Pseudo-panel analysis of dynamic transport demand relationships ESRC. Joyce Dargay This project analyses the factors determining household car travel, and specifically the effects of household income and the prices of cars and motor fuels, and explores the intertemporal pattern of adjustment. The question of asymmetry in the response to rising and falling income is also addressed. Such asymmetry may be caused by habit or resistance to change or the tendency to acquire habits to consume more easily than to abandon them. Repeated cross-section data from the annual UK Family Expenditure Surveys and a pseudo-panel methodology is employed. The estimated elasticities indicate that car travel is sensitive to its cost, but not highly so. Car travel is more affected by car purchase costs than by fuel prices, implying that once obtained, cars are used despite rising variable costs for their use. This is not surprising since the marginal cost of car travel declines at higher utilisation. On the other hand, car ownership is more sensitive to car purchase costs than to fuel prices, as would be expected. The predominant impacts of both types of costs

on car travel arise through their effects on use per car rather than on car ownership. As expected, the results confirm that car use responds more rapidly to changes in income and prices than does car ownership.

Report:
Dargay (2004)

Panel data analysis commuting and car ownership

ESRC. Joyce Dargay and Mark Hanly.

This project has two objectives: to examine the volatility of travel behaviour over time and consider the factors explaining this volatility; and to estimate the factors determining car ownership and commuting by car. The analysis is based on observations of individuals and households over a period of up to eleven years obtained from the British Household Panel Survey (BHPS). Year-to-year changes in car ownership, commuting mode and commuting time for individual households are examined and these changes are "explained" in terms of factors such as moving house, changing job and employment status. The factors determining car ownership and commuting by car are analysed using dynamic panel-data models, which allow for state dependence and heterogeneity specified as in a random effects model. Regarding commuting, it is found that part-time workers and those in single-adult households are less-likely to commute by car, while the self-employed and those with children are more likely to commute by car; commuting by car increases with individual and household income, and decreases with population density, car purchase costs and petrol prices; women and men are equally likely to commute by car, *ceteris paribus*.

Report:
Dargay and Hanly (2004a)

The car in Europe: changes in ownership and use

ESRC and ADEME (the French Agency for the Environment and Energy Savings). Joyce Dargay with French and German partners.

This project compares car ownership and changes in car ownership over time on the individual household level in a large number of European countries. Of particular interest are those households who reduce car ownership and their reasons for doing so. In addition, the intention is to compare the distribution of car ownership in the various countries, particularly in relation to income, but also in relation to other factors such as residential location, age and household structure, and to investigate how these distributions change over time. Dynamics models of car ownership will be estimated to determine the influence of various factors on car ownership and the differences amongst countries. The study is based on the European Household Panel Survey (EHPS) which contains data for 15 countries for the period 1994 to 2001.

The Impact of Land Use Patterns on Travel Behaviour

ESRC. Joyce Dargay and Mark Hanly with US and Dutch partners.

ACCESSIBILITY

COCCINELLA

Leverhulme Trust. Rana Imam, Nick Tyler, with Helen Lloyd (National Trust).

The research into the interactions between wheelchairs and carpets reported last year finished during this year. Following a data collection exercise on a range of different floor surfaces in historic houses, analysis of stereoscopic images of carpet waves and folds revealed the different effects on carpet waves and folds resulting from using different types of underlay. This suggests that the traditional underlays using hair and/or jute tend to amplify the problem, whereas thinner polyester underlay tended to provide a more acceptable performance. The outcomes from this research are being produced in the form of guidelines to property managers in the National Trust.

Dynamic Assistive Information System (DAISY)

EPSRC/Department for Transport, Hackney Community Transport. Marcela Wainstein, Nick Tyler.

DAISY follows on from the original feasibility project DIMPLE (reported last year). DIMPLE established the importance of location-based instructions for people with learning difficulties. DAISY is developing a portable hand-held device designed for enhance independence of people requiring pre- and in-trip information about pedestrian and public transport journeys. This year we have investigated the possibility of a linked GPS-mobile phone arrangement which will provide a basic location information. The greater precision required by pedestrians is being investigated by a number of experiments designed to test the accuracy offered by the use of photographs to provide a visual confirmation of precise position.

Evaluation and Measurement of Mobility and Accessibility (EMMA)

Nick Tyler, Craig Childs, with Peter Jones, Tim Eyers (University of Westminster) and David Metz (London School of Hygiene and Tropical Medicine).

EMMA follows from the feasibility study conducted last year. An accessibility audit tool is being developed, which incorporates the principles of the Capability Model (Cepolina & Tyler 2004). The tool is being implemented on a Tablet PC so that data can be recorded easily and directly into a database.

Transport Research Uncovered Using Multimedia for Public Education and Training (TRUMPET)

EPSRC Public Awareness of Science Programme. Chris Cook, Nick Tyler.

Moving on from the recording of travel experiences in the form of illustrated stories reported last year, the project has been working with the school students to develop a new game to help with travel training in relation to road safety.

As with the bus game research reported in 2002, the intention of this research is to help students feel more confident in using the street environment, even if they are unable to travel independently.

Training Opportunities for Community Centred Accessible Transport Applications (TOCCATA)

Nick Tyler, Paulo Silva (Universidade de Brasilia).

This Project is working to train engineers in the University of Brasilia to become more aware of accessibility issues in the design of transport systems. In addition, the project is working with a local school to develop awareness in young students. Currently, the school students have been providing useful insights into the design of the public realm near to their school.

Social Inclusion for Disabled People and their Carers

Nick Tyler, Martha Caiafa, Juan Carlos Dextre and Victoria Ramirez (Universidad Católica del Perú).

A course was run in Cusco for the Municipality of Cusco and the surrounding municipalities attended by over 100 people. The course discussed the issues of developing an integrated accessible transport system between the regional cities and the city of Cusco. It is intended to run a longer course on this topic in the near future.

Accessibility Research Reaching Outward (ARROW)

EPSRC. Martha Caiafa, Maria Alicia Vicencio Silva, Chris Cook, Nick Tyler.

This project is funded as an EPSRC Platform Grant in recognition of the Accessibility Research Group's international status in the field. ARROW continues to support other projects and has enabled us to investigate the public participation processes in transport decisions, social justice in transport policy, working on communication techniques with young people with learning difficulties, and the study of semiotics and its application to public transport information systems in which the individual is seen as the centre of investigation. ARROW has also allowed Nick Tyler to develop links with the University of Pisa in the area of pedestrian behaviour and movement and its impacts on accessibility, resulting in the development of the Capability Model.

Reports:

Brown and Tyler (2004)
Cepolina and Tyler (2004)
Tyler (2004)

A Framework for a User-oriented Transport Booking System

Research for thesis: Patricia Idaewor.

The work reported last year has now been completed. A comprehensive list of travel attributes affecting transport-user satisfaction was derived from the literature and confirmed through interviews with users. For each of these attributes,

This project analyses the effects of land use characteristics on travel, mode choice and car ownership based on the National Travel Survey of Great Britain and econometric models. In summary, the results indicate that land use characteristics – population density, municipality size, local access to shopping and other facilities and accessibility of public transport - do play a significant role on travel, car ownership and mode choice. Car ownership and use increases and public transport use and walking decline as population density decreases. With the exception of London, municipality size is of little importance in determining mode share and car use. Proximity to local amenities encourages walking in lieu of car travel and discourages car ownership and particularly multiple-car ownership. A comparative study of the impact of land-use characteristics in the UK and US has also been carried out and the inclusion of the Netherlands is currently underway.

Reports:

Dargay and Hanly (2004b)
Dargay and Guiliano (2004)

Travel to Work

ESRC. Joyce Dargay and Jos Van Ommeren. Free University of Amsterdam.

Work this year has been concerned with the optimal choice of commuting speed. It has been based a structural model of optimal speed choice, which can be derived from a reduced form regression of speed on income and distance, applied to UK NTS data for the years 1989 to 1991 and 1999 to 2001. The results imply that the elasticity of speed with respect to income is approximately 0.13 and that total travel costs mainly consist of time costs. For the average commuter, the variable monetary costs are estimated to be about 14% of the total variable costs. Monetary costs of speed are a convex function of speed: at high levels of speed, monetary costs increase strongly (e.g. due to the increased risk of accidents, fines etc), so the marginal costs become essentially infinite. Differences in the value of time between individuals have little effect on the chosen speed level. Finally, it appears that the (marginal) monetary costs of speed are a positive function of population density and municipality size, *ceteris paribus*.

Report:

Van Ommeren and Dargay (2004)

The effects of transport pricing and investment

ESRC, EC, ECMT, TfL. Phil Goodwin.

Work has continued on the development of pricing systems which include proper allowance for external costs, including environmental effects and congestion, with allowance for the wider economic effects on competition and economic growth, and the short and long term effects on behaviour.

Report:

Goodwin (2004c)

a predictive model of satisfaction based on the level of service of the attribute, the user's prior transport experience and socio-demographic characteristics, was derived. An overall transport satisfaction model was developed from a combination of the individual attribute satisfactions. This was validated by comparing its output to an independent dataset. In addition, a framework for such a decision-making process for a community transport brokerage has been designed.

Report:

Idaewor (2004)

Pedestrian simulation on stairs

Research for thesis: Taku Fujiyama.

This research is attempting to model the circumstances surrounding the inclusion of people with different characteristics in the pedestrian flows within the environment of a railway station. An experiment has been conducted in a laboratory environment to examine walking speeds on stairs of people with different characteristics. The effects of stair characteristics have also been considered.

Reports:

Fujiyama (2004)

Fujiyama and Tyler (2004)

Pedestrian Accessibility and Movement Environment Laboratory (PAMELA)

EPSRC Craig Childs, Taku Fujiyama, Ian Brown, Nick Tyler.

The PAMELA project is developing a laboratory for research into pedestrian needs for accessible movement in the physical environment. Two main projects are contained within the PAMELA project: the development of better understanding of the needs of pedestrians in the pedestrian environment and the enhancement of the explicit pedestrian simulation model developed by Cepolina and described in Cepolina and Tyler (2004). The main activity this year has been the design and construction of the laboratory, which is due to be delivered in early 2005. The laboratory will be able to simulate a range of pedestrian environments under computer control, including gradients, slopes in several directions, different surfaces, layouts of obstacles, different lighting and noise conditions, all of which can be reproduced exactly and controlled so that experiments can be repeated and parameters adjusted in a controlled manner in order to investigate their effects on pedestrian behaviour, movement and accessibility. This will enable us to study the pedestrian's use of the environments in which they have to move in a more rigorous way than has hitherto been possible.

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