Second presentation to be made by Andrew Daly

3 Webinars on Transport Modelling in Australia and Europe

RAND Europe will discuss their work:

1. Introduction and Sydney model (24 September)
2. Models of European cities and countries (22 October)
3. Long-distance Models (19 November)

We are describing a practice developed over 35 years and adapted to meet a wide range of local circumstances

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In this second webinar we discuss 6 models of countries and conurbations in western and northern Europe. The intention is to show how the varying circumstances of each context determine the appropriate model design. Further we hope to show how the models have been changed over their lives to meet developing policy needs.

Six models in Scandinavia and Western Europe

- six different contexts

2 national **1** regional **3** conurbation models

- varying spatial settings and policy aims
- also variation over time
  - policy focus changes
  - new data available

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All of the models chosen are 15+ years old, as these models illustrate development over time.

These models follow the general lines of the Sydney model set out in the previous webinar

- tour-based approach
  - with treatment of non-home-based conditional on primary choices
- local estimation on disaggregate home interview data
  - maximum likelihood and judgement taking account of local issues
  - plenty of socio-economic disaggregation:
    all behaviourally important variables that are known are included
- nested logit models with frequency, mode and destination choice
  - and other choices as needed locally
- mostly pivot-point operation
  - depending on local data
- none of the models has remained static over time

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This is a reminder of the general features of the models.

Webinar 2:
European models

- The Netherlands
- Norway
- Stockholm (Sweden)
- West Midlands (UK)
- Copenhagen / East Denmark
- Paris

- Comparisons and conclusions

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We have selected these 6 models as typical of our practice and illustrative of the range of models and applications that can be made.

We have not included, for example, the UK national model or the pan-European model Transtools, with both of which there are a number of issues, partly arising from the restrictions of the data bases on which they were developed.

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Netherlands has about 17m people and high population density (like 2 * New Jersey (which has the highest density of US states)). It is very flat and has numerous smallish cities (50,000 – 200,000), both of which encourage cycling (25% of all trips). There are a few larger cities with extensive bus, tram and metro networks.

Administration is highly centralised, so a lot of transport policy is made by the central government.

Reserving space for future strategic network development (road and rail) is difficult and it was decided in 1983 to set up a National Model to address these issues. The model became operational in 1986 and has been used continuously since then to address strategic network issues and many others.

This was the first modern national model and has directly inspired a number of other European national models.

The model originated in the highways authority (Rijkswaterstaat)

- high-prestige engineering department
  - responsible for sea defence, inland flood control and canals as well as bridges and roads
- in the 1970s and early 80s, there was considerable pressure on land for residential and industrial use
  - e.g. in the ‘green heart’ of Holland
- transport corridors also needed to compete for land, so that well-justified reservations of rights of way were needed
  - in principle for rail also, but road was dominant
- a national model would allow right-of-way reservations to be justified
- after preliminary studies of transferability between regions, a decision was taken in 1982-3 to develop a national model: LMS (Landelijk Model Systeem)

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There was also a wish to import leading-edge modelling expertise into The Netherlands, which at that time had considerable resources for this type of development.

LMS design featured a highway base matrix from the outset

- because it would allow more accurate forecasts
  - and would give a fall-back if the model development failed
- extensive roadside interviews were conducted
  - also using mail-out surveys to cover motorway traffic
- however, the methods used to develop the matrix were inadequate and it had to be discarded
  - it relied too much on a very simple model
- later, maximum-likelihood methods were developed and these worked much better
  - using a better model plus inputs from counts and roadside interviews
- matrices for road (and occasionally rail) segmented by time period and aggregate purpose are used

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The mail-out procedure is no longer allowed, as it is considered a breach of privacy. Roadside interviews are used much less now as they cannot be done on motorways and cordons are therefore very 'leaky'.

The matrix estimation is described by Gunn et al, ETC 1999. See also van Vuren et al, ETC 2004.

‘Pivoting’ was developed to use with base matrices

- using the model to predict **changes** relative to the base
  - can be multiplicative (standard) or additive (special cases)
- then applied in other studies
  - such as Sydney as described in previous webinar
- car and train only
- a number of issues were found in the procedure and developments made to minimise the problems that arose
  - generally when the base and synthetic matrices differed
- question for train whether pivoting should be applied to zone-zone or station-station matrices
- road freight and international travel is forecast separately and added to passenger car driver matrices before assignment

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Pivoting formalised in Manheim in his 1979 textbook, but we had used it already in UK, as it is a natural approach to reduce forecasting error.

Our most recent ideas on pivoting are described by Daly et al, 2011, European Transport Conference.

Pivoting relates closely to a K-factor approach

- K factors to correct individual cells of a matrix have often been used in transport planning, but are not well regarded
- when disaggregation is the same and zeroes are maintained, pivoting and K factors give the same result
- K factors can be estimated statistically (given enough data) and this allows their significance to be tested
- but different disaggregations (purpose, time period..) mean that K factors can be clumsy
- also the treatment of zeroes in base data and forecast matrices limits the applicability of K factors
- for these reasons we preferred the use of pivoting in this work

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K factors are a traditional feature of transport planning. K factors and pivoting also relate closely to incremental models often used in UK practice. See Daly et al (ERSA 2005) and Daly et al (ETC 2011, ATRF 2012).

Demand model

- the focus for travel demand in the 1980s was to move to disaggregate modelling
  - i.e. look at travel by individuals, rather than aggregate flows
  - this was considered highly innovative
- disaggregation applies both to estimation of model parameters and application of the models for forecasting
- but the number of significant parameters means that there is a finite number of distinct combinations, i.e. segments
  - so we can apply the models a limited number of times by recognising these coincidences
  - more reduction for mode-destination choice than for frequency choice (fortunate because of run time concern)
- tree logit model for frequency, mode and destination

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Models were developed in the US and UK where analysis of the behaviour of individuals, rather than of flows of traffic, was used to estimate the parameters: hence the 'disaggregate' naming. For forecasting, it is only necessary to disaggregate individuals that are different with respect to model variables.

The model was specified to cover a range of policy

- based on a detailed model of the population, giving sufficient socio-economic detail for sophisticated modelling
  - age, sex, employment, household structure
  - car ownership and licence holding are part of the model but are constrained to exogenous forecasts
- attempt to include all land transport
  - internal air travel is negligible,
    water is very important for freight but handled separately
  - some difficulty with getting data on international travel
- initially 8 travel purposes modelled for 5 modes
- non-linear cost was found to be important in explaining choices

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This model pioneered many aspects of modelling that were picked up in other models, both by our team and by others. In a number of cases, explicit research was done to establish the feasibility of specific methods.

Amendments to the model have been numerous

- early amendments were typical of the period and stage of development of the model
  - provide highway capacity and iterate
  - provide capable assignment program
  - integrate business model with other models
  - move to PC
  - increase from 345 to 1308 zones
- subsequent changes were more connected with policy needs
  - extend assignment algorithm to look at ‘political’ issues of flow metering and blocking back
    - static emulation of dynamic assignment
  - introduce time period choice to allow tests of time-dependent road user charging
    - major change to the model and equilibration

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We note the focus on road issues: this work was largely driven by the needs of highway planning and rail planners developed their own methods. Rail work was done separately, with a separate detailed model, but is now being brought up to the standard of the road modelling.

Further improvements and updates have been needed more recently

- changes to demand model and assignment to accommodate policy on
  - road user charging (area-based, distance-based, cordon-based, availability of day passes...)
  - parking controls with diversion to park short distance from destination to accommodate land use policy (zoning as a function of transport provision)
  - walk and cycle priorities
  - highway management policy generally
- extensions to deal with issues raised by back-casting and ageing of model
  - student tickets, changes in work practices
- current project aims to improve rail representation
  - most previous applications have focussed on highway issues

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1. Detailed model of day pass for road user charging, based on SP, amendments to the assignment algorithm to allow cordon-based and link-based charging.
2. Utility calculations to redistribute traffic from over-parked destination zones to nearby zones (if they have space), adding walk disutility to final destination.
3. Speed-up for walk and cycle to represent traffic light priorities in specific areas.
4. Ramp metering, flow control etc. modelled to look at impact on congestion increases.

Back-casting was undertaken in two projects during the life of the model to check its performance

‘Back-casting’ is an excellent way to make detailed tests of a model

- the model is run with inputs appropriate for a past year
- outputs are then compared in detail with the known travel patterns of that past year
- of course, the past year has to be one for which this information is known
- this has been done twice for LMS
- generally, the results have been encouraging, but they have pointed to detailed corrections
  - need to model student travel (with zero train fares)
  - growth in train traffic underpredicted
    - this is true in several European countries and is not understood
  - smaller issues such as a failure to represent ‘Other’ travel growth exactly

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Applications number several hundred, for example:

- the model was first used for environmental planning
- then used to make do-minimum forecasts
  - this was in the context of the original motivation for the model (Second Transport Structure Plan)
  - very influential: showed that action was essential
- then, extensive investigation of ‘pull’ measures
  - land use (ABC policy), cycle priority, public transport investment
  - effective, but not effective enough
  - also ‘acceptable’ push by severe parking control was not adequate
- very extensive investigation (over several years) of road user charging
  - goals were changing! congestion, revenue, environment
  - ultimately nothing implemented, with predictable consequences

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The politics concerning road user charging was very complicated and several governments took different positions.

These policy investigations made use of the model amendments shown on the previous slide.

Regional models

- central government initiative for regional planning by offering models
  - some degree of pressure on regional planners
- existence of national model suggested ‘cut down’ regional models
- compatibility with national model should enhance policy consistency
- 4 regions defined
  - bus and cycle networks defined explicitly (these were ‘homogenous’ for the national model)
  - zoning more detailed
- national model delivers fixed external trip matrices to the region
  - all trips with origin or destination outside the region are taken from a suitable run of the national model
- consistent application software for national and regional models
  - with documentation, user guides, support, etc.

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Initially, scale factors were estimated for regional models, which were around 2% more sensitive than the national model scale. However, these have not been retained.

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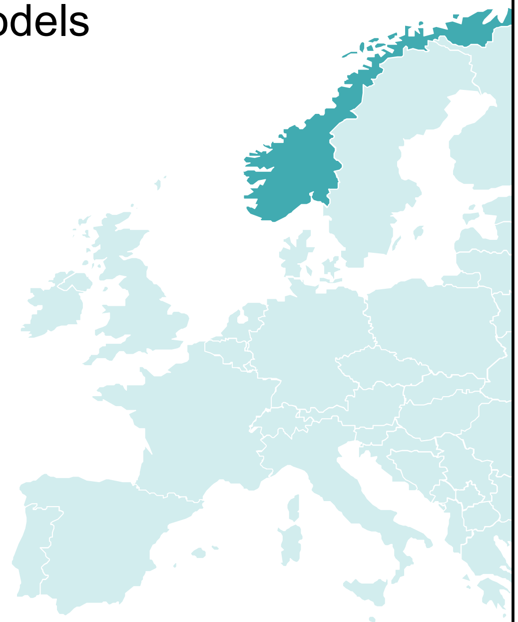

It looks very nice, but cold and dark in winter affect transport choices.

Distances are large, density is low

- 1500 miles N to S
  - much of it Arctic
- only 5.2 million population
  - most people live in south
- main long-distance mode is air
- boat travel is also important
- rich: GDP/capita is 20% higher than US (PPP)
- equal: very low Gini coefficient

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About the size of California, though obviously much lower population: about 7 times fewer people. All the cities are on the coast.

Norwegian national transport model was intended to study CO_2 emissions

- commitments made to international climate meetings 1989-90
  - prime minister Gro Harlem Bruntland
- modelling approach was inspired by Netherlands model
- different objectives and density meant that assignment was not a priority
  - congestion is low anyway
- main output of travel demand model was passenger-kilometres by mode
  - to form input to emissions models
- modelling work was done jointly with local agency TØI

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This was a very different context from the other models being presented, though again there was an intention to transfer knowledge to the local researchers.

However, the structure of the demand side of the model was kept more-or-less as in The Netherlands.

Model design acknowledged Scandinavian practice

- separate models for trips under and over 100 km (62 miles)
- Scandinavian practice, also followed in data
- allows segmentation of purposes and modes for trip length categories:

	purposes	modes
short distance	commute, HB and NHB business, education, shop, social, other	car driver, car passenger, public transport, walk/bike
long distance	work/education, business, social, recreation, other	car, bus, train, boat, air

- but raises a concern about switching between long-distance and short-distance destinations

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Separate models for long distance have also been set up in other countries, as will be discussed in the next webinar.

The national travel survey data was not ideal for short-distance modelling

- destinations not recorded for short-distance trips, only trip length
  - most trips are within the same commune (454 in Norway)
- so the short-distance model was mode-distance choice
  - 7 distance bands
- cost and time had to be deduced from distance
  - error-prone for public transport
- nevertheless reasonable model parameter estimates could be obtained
  - for level-of-service and attraction variables
  - also for socio-economic variables
- it worked better for long-distance trips
- log cost appears in both long-distance and short-distance models
  - sometimes related to income
  - this was one of first models to use non-linear functions

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Non-linear cost functions found in The Netherlands were applied in Norway.

Licence, car ownership and travel frequency models were also estimated

- licence holding uses cohort models and disaggregate models
- simultaneous car ownership and use model
  - very early discrete-continuous model, 0/1/2+ cars
  - needed special software and theoretical development
  - gives possibility of obtaining national car ownership and car VMT without using main model set
  - could be useful when considering major cost changes
  - but doesn't take account of competition from other modes
- travel frequency models simple 0/1 choice per purpose
- accessibility appears only in long-distance model
  - presumably because of limited accuracy of short-distance model

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Car ownership approach based on de Jong thesis but extended (by de Jong) in original research for this project.

Application was by sample enumeration

- with prototypical sampling, as in The Netherlands
- but because of focus on global environment, spatially detained forecasts were not needed
  - emissions models gave CO_2 forecasts
- assignment was less important because of low levels of congestion
- quick, and even quicker if separate car ownership model used in isolation

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Applications were made by TØI.

The model proved useful after its initial applications

- later application for infrastructure planning, mainly roads and bridges
  - needed changes to the application system to get better spatial detail
    - i.e. more zones, more detail in local networks
  - base matrices were constructed: car, rail, air
- updating, based on new national travel surveys
  - work was done to reconcile inconsistent surveys
    (different sample frames gave apparently different trip length distributions)
- application for high-speed train project was not convincing
  - specific SP surveys were undertaken
  - new model application procedure was set up,
    with appraisal functions
- further projects are being set up to update the model once again
  - maintaining the long/short distance split

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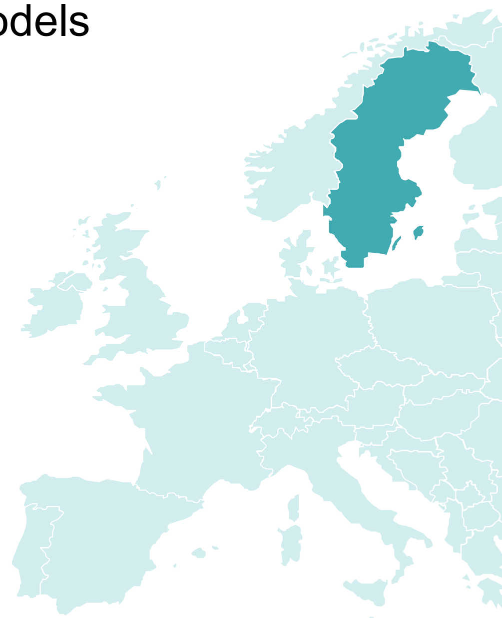

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Transport in Stockholm is impeded by many waterways, while the solid rock on which it is built makes tunnelling difficult. Temperatures are close to or below freezing 4 months of the year and there are 18 hours of darkness in mid winter.

Sergels Torg (photo) is the most central square and has the famous super-ellipse design.

STM was developed in an academic framework

- two PhD theses
  - it was possible to take time for development
- nevertheless funding agencies wanted a practical model
  - local government and transport operator (SLL and SL)
- intention to focus on behavioural issues in local context
  - high rates of female employment and licence holding
  - relatively few 2-car households, so car competition important
  - timing constraints also important, e.g. for shopping
  - household interactions also prominent in thinking
    largely because of car-sharing issues
- many aspects of activity-based modelling at relatively early date (1985-95)

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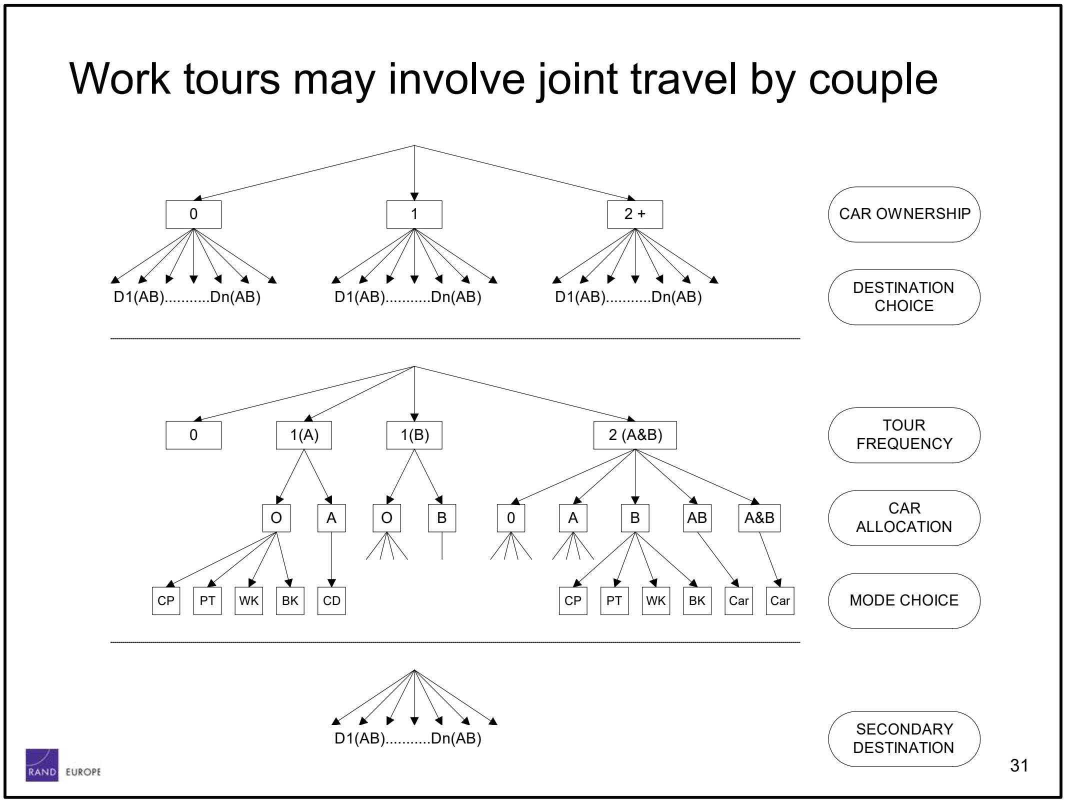
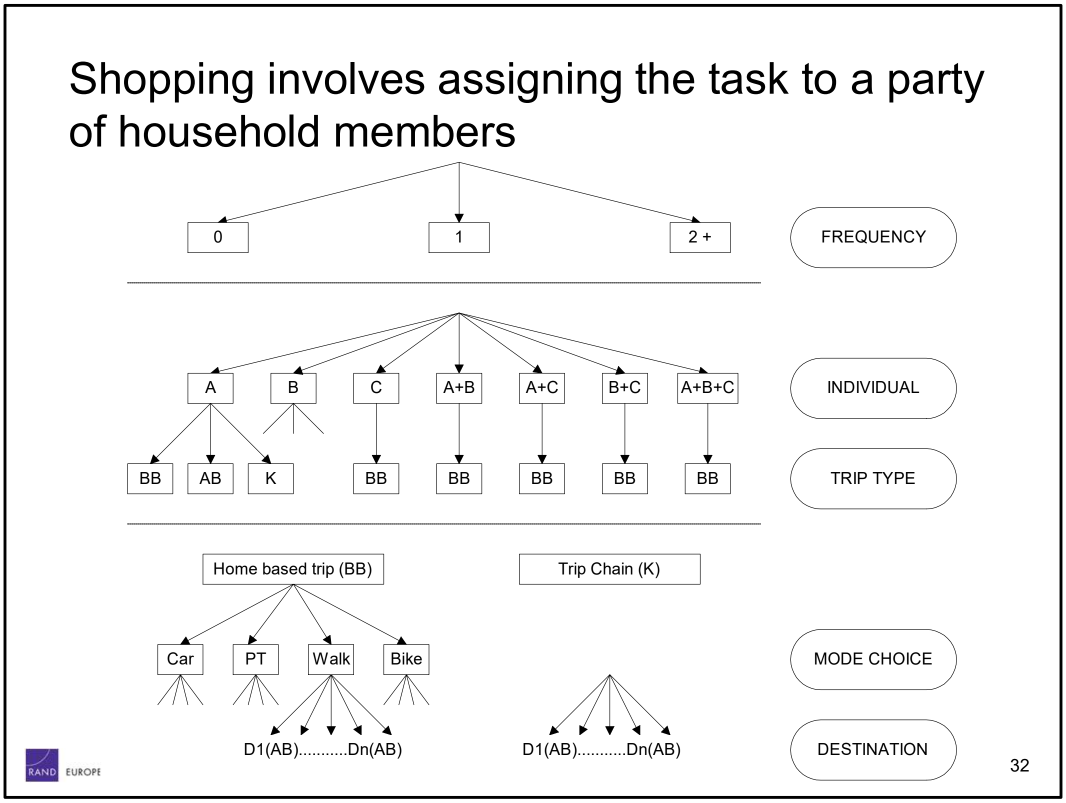
Stockholm County (SL) has a population of 2.2 m. in 2500 sq. miles.



This model was estimated sequentially because of computer limitations at the time (up to 1990). It represents the travel to work of the joint heads of a household (assuming there are two such people).

- The first (lowest) stage estimates secondary destination choice, so logsums can be passed up.
- The second (middle) stage estimates models of choice of mode (for those going to work) jointly with car allocation (for those with at least one car), including car competition or joint car use when both people go to work.
- The third (highest) stage estimates joint choice of car ownership and destination choice for both people.

Note frequency is BELOW destination choice, which is for the usual workplace.



Again sequential estimation was used.

- The lowest stage represents mode and destination choice, but for detours (K in Swedish) the mode is constrained by the choice for the primary destination.
- The middle stage models the choice of individual (head couple A and B, any other person C) and the trip type home-based (BB), work-based (AB) or detour (K) as a function of the accessibility of these combinations to the combinations of people.
- The top stage just models the number of shopping activities to be undertaken.

This model shows that tour-based and ABM models are not clearly distinguishable

- the Stockholm model STM includes many ABM features
- ABMs must model tours in any case
- issues with calculation speed, sampling and approximation apply in any case
- an attempt was made to compare expected tours and simulation applications of this model
  - but resources were inadequate for a full comparison

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This model led me to conclude that ‘ABM’ is not a completely clear concept.

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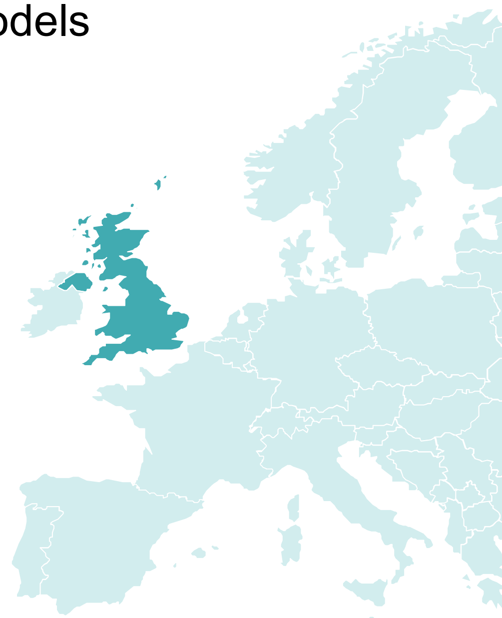

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West Midlands is a Metropolitan County in central England, population 2.8 m, centred on Birmingham. It is an old industrial area, based on mining and manufacturing. It lies at the heart of the UK motorway network, and as such half the funding for model development was from the Highways Agency.

The original model design was determined by a scoping study undertaken in 2002

- review of available data, including recent household interview, and implications for model design
- basic design similar to other models, but with particular features added driven by local policy requirements
  - metro improvements key, so represented as separate mode
  - park-and-ride important, so separate sub-models
  - large international airport in study area, so special models developed for business and leisure passengers

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The original home interview didn't collect income data, in an attempt to improve response rates.

Park-and-ride predicted using models of access mode and station choice

- model two linked choices
  - access mode to train: P&R, K&R, and 'other' (walk and/or bus)
  - for car access, choice between 3 possible access stations
- for car access, approach considers level-of-service on both the access and train legs, e.g. choice between
  - nearby station with a stopping service
  - or a more distant service with an express service
- simultaneous structure gave estimation of sensitivity of access mode and station choices relative to main mode and destination choices

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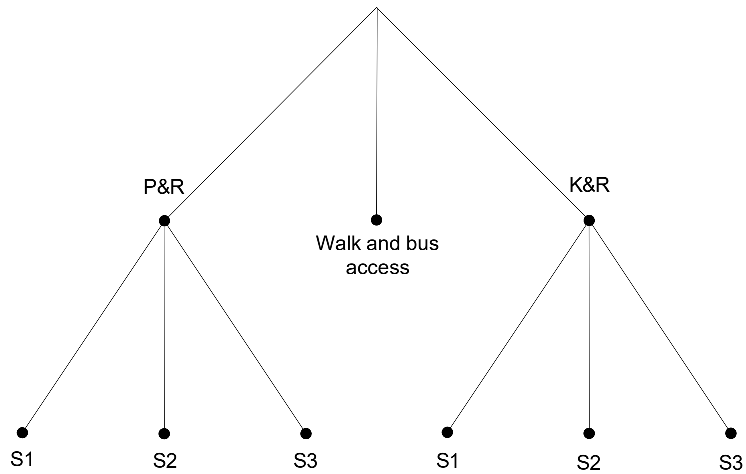
This work was original research.

Access mode and station choice structure



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Bus and walk access are modelled by the assignment software (VISUM).

Model has been used to test a wide range of local policy

- Black Country study, with focus on regeneration
- road pricing policies, which necessitated ‘reverse engineering’ income into the model
- Advanced Traffic Management on motorway network, involved hard-shoulder running
- metro and bus-rapid transport schemes
- Birmingham City Centre land-use study
- ‘soft measures’ aimed to increase PT or walk share, or to discourage car use
- in 2008, total value of funding attracted from Central Government for schemes tested using PRISM was £160 million

Model was recently updated to reflect more recent travel behaviour

- building on lessons from first version of model, income data was collected in household interview
- survey interviewers also carefully briefed to ensure employer's business and non-home-based travel were properly recorded
- income data allowed cost sensitivity terms to be estimated by income band in mode-destination models, as well as allowing local car ownership models to be developed
- treatment of non-home-based travel improved
  - using data for all modes in the tour-based framework

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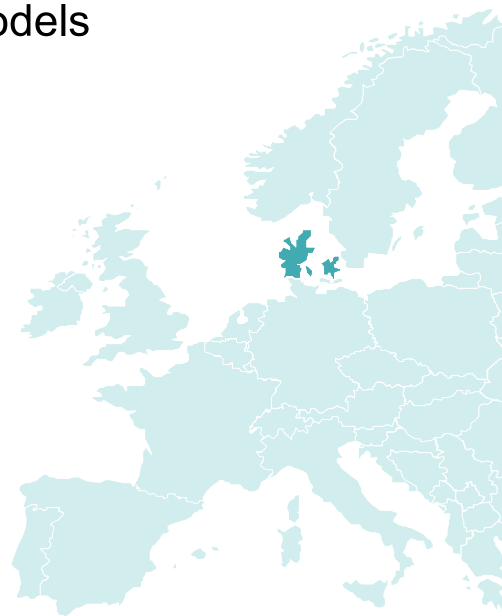

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Copenhagen metro area has population of 2 m. Cycling has grown enormously in recent years

The model was originally created to investigate connection to new Ørestad development

Ørestad is an office and residential development on the island of Amager, which is the south-east part of city, near the airport and the new road/rail bridge to Sweden.

Possibilities were various forms of light rail: they eventually chose metro. The idea was to use profit from land sales to fund the rail development, which in turn created a large part of the land value.

Ørestad traffic model (OTM) was based on RP and SP data

- RP data was taken from the national travel survey (TU)
- SP from Ørestad-specific surveys
  - investigating three different light rail technologies for providing service to the new development
  - giving insight into features of the systems, such as security at stations
- simultaneous estimation using both data sources
- the model could then be used to test which technology was best

- of course many other issues were relevant to the decision

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Model was then extended by SP for two other major projects

- Harbour tunnel would give access to the north of Amager, connecting the two parts of the harbour, and allow completion of the ring road
- but it had to be funded by tolls
- specific SP was carried out for freight and passenger movement
  - also taking account of peak effects
- very early mixed logit model estimation
  - applied in assignment with distributed VOT

- Copenhagen-Ringsted heavy rail project, a major capacity increase
  - further SP
  - further model extension to the west, covering all of East Denmark

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Ringsted is in the centre of the island of Sjælland, which forms the east of Denmark. The main lines west from Copenhagen run through Ringsted to the west of the country and to Germany.

The model was applied for other projects up to 2005.

Later version of the model (2006) used SP value of time data together with the TU data

- Danish national value-of-time study was conducted 2004-5
- the SP data was used to define the relative sensitivity of travellers to in-vehicle time by mode
- the data was also used to account for variations in cost sensitivity by personal income band
- this information was incorporated into the mode-destination models, which were estimated from choices observed in the TU data

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The 2006 model was used to assess the Metro City Ring project

- €2 billion infrastructure project for the fourth phase of the Copenhagen metro network
- credibility of model was checked by validating for the 2004 base year, and by backcasting to 2000 – there were significant changes in PT over this period, in particular the metro system opened late 2002
- backcast exercise showed model predicted overall impact of changes on PT demand well, but there were some discrepancies in the results for individual PT modes – PT sub mode split handled in the assignment using a simple frequency-based approach
- for car traffic, model predictions across key harbour crossings matched count data pretty well

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Recently, time period choice was added to the model to assess congestion charging policies

- model was extended to model time period choice for car drivers
- alternatives defined for possible combinations of outward and return time period, with some aggregation where data was sparse
- relative sensitivity of time period choice was estimated from the data where possible, but for commute and business relative sensitivities were imported based on SP results from other studies
- highlights difficulty in estimating time period choice models from RP data for these purposes – travellers appear to prefer travelling in the peak periods!

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The recent academic project ACTUM has used OTM as its basis

- activity-based extension of the model
- would be the first practical activity-based traffic forecasting model in Europe
- particularly interesting in Copenhagen because of extensive public transport network and widespread use of bicycles
- project has sponsored numerous papers and a model is operational
  - using US DAYSIM implementation software
- but further investment is required to make the model acceptable for practical use
  - requirements for validation in Copenhagen are very strict

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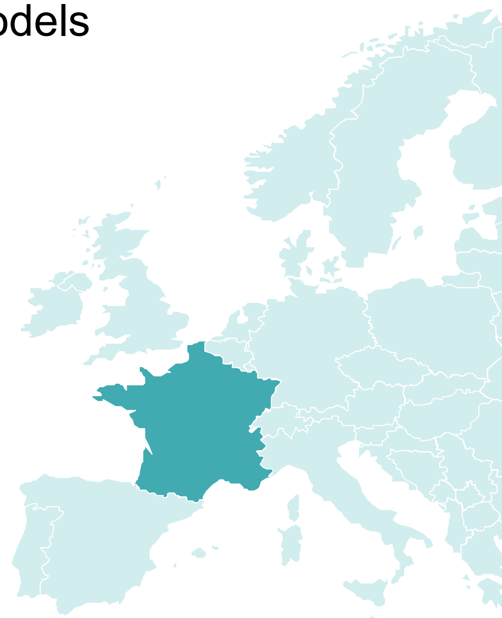

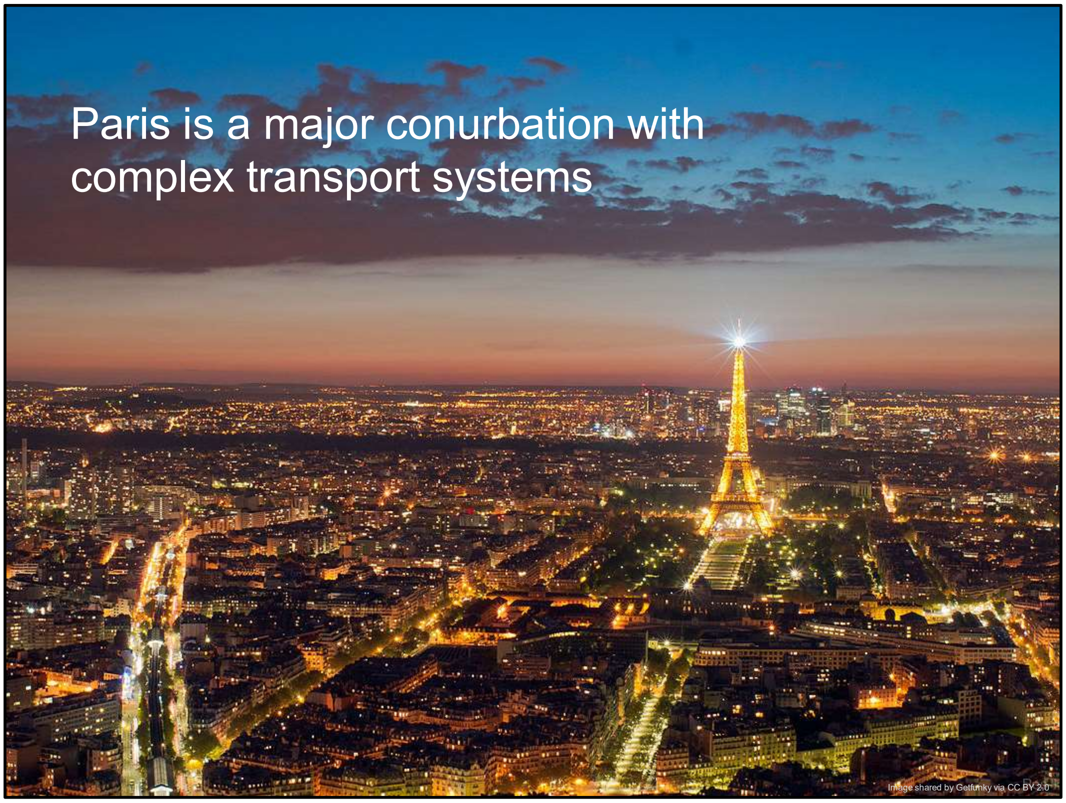

The Paris area, Ile de France, contains 12 million people, with almost all of the French national functions and the HQs of 30 of the Fortune 500 companies. Transport systems include bus (>1500 lines), tram (8 lines, was 122 in 1925!), metro, RER (express metro), commuter and intercity rail and TGV (high-speed rail), with additional ‘light metro’ connections to the airports. Facilitating interconnections between these systems is a key issue.

The ANTONIN model was commissioned by the public transport authority

- to make studies of public transport projects in the Île de France (Paris region)
- to provide forecasts to other agencies
- many detailed network issues in the region
  - multiple public transport modes
  - interchanges and interactions between them
  - ticketing is an important example
  - access by car important in many areas
- model design was based strongly on Netherlands model but adjusted to public transport rather than road focus

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Tuinenga, Meret-Conti and Pauget, European Transport Conference 2015.

10 public transport modes were modelled

Rail	**Rail-Bus**	**Car-Rail**
Metro	**Metro-Bus**	**Car-Bus**
Bus	**Rail-Metro-Bus**	**Car-Rail-Metro**
Rail-Metro		

- possession of PT passes modelled explicitly
- three private modes were also modelled
  (car driver and passenger, walk/cycle)
- this very detailed treatment maximises the insight into traveller choice
- but presents issues for route choice modelling
- these modes were modelled as MNL, nesting not tested
- 10 travel purposes modelled
  - split blue/white collar commute, durables/routine shopping

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Model is primarily used for public transport projects

- using the very detailed PT modelling structure
  - PT use is up 25% in last 15 years
- 4 new metro lines being planned, 2 lines being extended
  - Grand Paris Express 2030: focus on peripheral movements
  - several variants being considered
- more recently the model was updated and extended to address these projects
  - original model using 1991 data, then updated to 2001
  - most recent version is based on 2010 data
- preliminary runs of the model indicate that the project will maintain accessibility throughout the area
  - despite growth and dispersion of population and jobs
  - and with (modest) reduction in car travel

Newest model introduces some changes

- single PT mode in choice model
- PT sub-mode choice in assignment
  – improves route choice modelling
  – representing crowding in PT assignment
- but requires careful adjustment of PT parameters
  – calibrated against observed route choice
  – some variation by person type

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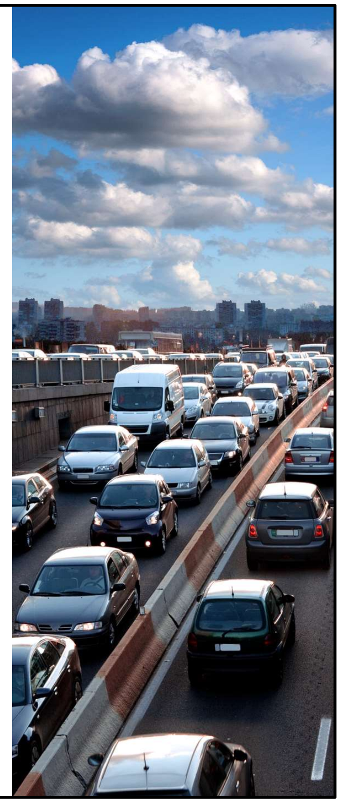
Webinar 2: European models

- The Netherlands
- Norway
- Stockholm (Sweden)
- West Midlands (UK)
- Copenhagen / East Denmark
- Paris

- **Comparisons and conclusions**

Which model components need to be included? and why?

- licence holding
- car ownership
  - company cars separated only in Sydney
- travel frequency choice - always
  - but there are some variants
- mode and destination choice – always
- time period choice
- access and station mode choice
- pass ownership choice
- other



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These model structure decisions are explained in the following slides.

Licence holding and car ownership are generally included

Area	Licence holding	Car ownership
Netherlands	cohort model + disaggregate distribution	disaggregate model with aggregate constraint
Norway	cohort model + disaggregate distribution	discrete/continuous choice model
Stockholm	not modelled	local choice model integrated with commuting
West Midlands	cohort model + disaggregate distribution	adjusted national model*, then local choice model
Copenhagen	not modelled	exogenous forecast
Paris	cohort model + disaggregate distribution	local choice model

* because home interview survey omitted income

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The reasons for these choices are often related to funding, the existence of a car ownership model favoured by the client, or the belief that licence holding is universal (not true!).

Frequency model variation is limited

the models are generally 0/1+ and stop/go, as for Sydney, with limited exceptions

Area	exception
Netherlands	accessibility effect added later
Norway	
Stockholm	linking from commute to other purposes and assignment of purposes to individuals
West Midlands	special structure for escort travel to drop off and collect schoolchildren (2 tours is very common pattern)
Copenhagen	applied at aggregate level, no income
Paris	no accessibility effect

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The Netherlands client did not think the accessibility effect was sufficiently important to include.

Mode-destination variation is more extensive

Almost all of these models have mode 'above' destination in the structure (or at the same level)

Area	treatment of mode-destination choice
Netherlands	5 modes, 1308 destinations later 6 modes
Norway	short: 5 modes, 7 distance bands long: 4 modes, 434 destinations
Stockholm	5 modes, 850 destinations
West Midlands	7 modes, 898 destinations
Copenhagen	7 modes, 601 destinations
Paris	13 modes, 850 destinations later 4 modes

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The main variations here are the treatment of PT, which may have sub-modes (bus, metro, train) identified in the mode-destination model or may be a single mode with sub-modes in the assignment. Additionally, taxi is represented where it is important, while walk and cycle are sometimes modelled together. Car driver and passenger are usually separated, except for long-distance choices.

Time period choice is needed sometimes

This is a difficult choice to model and include in the structure, so it is included only when the client is convinced of its necessity

Area	treatment of time periods
Netherlands	based on local SP data
Norway	not modelled
Stockholm	not modelled
West Midlands	based on local SP data
Copenhagen	no choice model
Paris	not modelled

The Sydney model does not include time period choice

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Assignment procedures determined by local preference and commitment

Area	assignment software
Netherlands	bespoke software developed to deal with excessive congestion (in some scenarios) and some road user charging policy
Norway	EMME
Stockholm	EMME
West Midlands	VISUM
Copenhagen	local assignment model with distributed value of time and link error terms
Paris	CUBE

The Sydney model also uses EMME

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There is often strong local commitment to a specific package.

Segmentation depends on modelling results and on local requirements

Area	segmentation variables
Netherlands	income, employment/occupation, age, sex, household structure
Norway	employment/occupation, age, sex, household structure
Stockholm	employment/occupation, age, sex, household structure
West Midlands	income employment/occupation, age, sex, household structure
Copenhagen	employment, car ownership
Paris	income, employment/occupation, age, sex, household structure

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The categories of variables are fairly standard, but the detailed specifications vary according to the detailed data collected in each area

Implementation procedures depend on local requirements

Area	implementation method
Netherlands	bespoke software to maximise speed for multiple applications originally FORTRAN, now Delphi
Norway	bespoke software, originally in Pascal
Stockholm	bespoke software, FORTRAN
West Midlands	applied using ALOGIT
Copenhagen	bespoke software, Delphi
Paris	CUBE scripts, Delphi

Sydney model is applied using EMME code

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The issues here are to maximise speed, minimise programming time and minimise implementation errors. Using the estimation software ALOGIT can reduce errors but it is not as efficient as bespoke programming. Note that the age of the models influences the choice of programming language, which can be an issue for maintenance.

Principal conclusions

- Model design can vary substantially
- And usefully
- Common modelling approach can be efficient but must always be subordinated to local circumstances

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