STAG Technical Database Section 17

Additional Information

May 2014

Transport Scotland

Version History

Changes since STAG Refresh, May 2008

Change number	Section updated	Date
1	Table 17.8 Classification of accessibility models by category	September 2008
2	17.2.16 Reference to LATIS added	April 2009
3	17.5 CO_2 Monetisation Spreadsheet - updated	December 2009
4	Update to web links and contact details and CO_2 Monetisation Spreadsheet in Section 17.5	April 2012
5	17.5 CO_2 Monetisation Spreadsheet and ASTs - updated	November 2012
6	Update to web links, contact details and PAF reference material. Note added to cover regarding future update.	December 2013
7	Rationalisation of text and references Updated for new webTAG	May 2014

17 Additional Information

17.1 Downloads and Worksheets

This section summarises the worksheets and tables which practitioners may need during the course of a STAG Appraisal.

STAG Worksheets

Appraisal Summary Tables

Part 1 Appraisal Summary Tables
Part 2 Appraisal Summary Tables

Option Summary Table

Policy Assessment Framework (PAF)

Policy Assessment Framework Spreadsheet
Policy Assessment Framework Guidance Note

Worksheets

Economy Worksheets - Economic Activity and Location Impacts
Environment Worksheets

Excel Spreadsheets

CO2 Monetisation Spreadsheet
Agglomeration Spreadsheet: TMfS Version
Agglomeration Spreadsheet: General Version

A copy of the DMRB Air Quality Screening spreadsheet can be downloaded from the Highways Agency website here. Note that the latest version of this spreadsheet gives outputs in terms of tonnes of carbon, which must be converted to tonnes CO_2 for reporting purposes in STAG.

A copy of the LAQ Excel spreadsheet produced by the Department for Transport is available from WebTAG here.

17.2 Useful References

Policy

Scotland's National Transport Strategy

Environmental Assessment (Scotland)

Climate Change (Scotland)

SEPA - Groundwater Protection Policy

Scottish Planning System

Environmental Assessment

Equality Act 2010 and Disability Discrimination Act 2005

European Legislation and Policy

Birds Directive and the Habitats Directive

Guidance

WebTAG

Design Manual for Roads and Bridges (DMRB)

Governance for Railway Investment Projects (GRIP)

Baseline Data

Civil Aviation Authority

> UK Airport Statistics
> UK Airline Financial Tables

Trip End Modelling Programme (TEMPRO)

UK Road Freight Statistics

Scotland's 2001 Census
Scotland's 2011 Census

Scottish Government Transport Statistics

Rail Fares Price Index

National Rail Passenger Survey

Scottish Household Survey

Air Quality in Scotland

DfT, National Rail Travel Survey

Office of Rail Regulation, Data Portal

Transport Scotland, Scottish Roads Traffic Database

Sustrans, Hands Up Scotland Survey

National Records of Scotland, Small Area Population Estimates

Scottish Government, Labour Market Statistics

Office for National Statistics, Nomis Official Labour Market Statistics

Registers of Scotland, Property Statistics

Scottish Government, Housing Statistics for Scotland

Relevant stakeholder organisations

Historic Scotland

SEPA

Scottish Natural Heritage website

Scottish Wildlife Trust Website

Macaulay Land-Use Research Institute

The National Trust for Scotland website

British Geological Survey

Council for Scottish Archaeology

Scottish Civic Trust

Architectural Heritage Society

Economy

Passenger Demand Forecasting Handbook (contact Transport Scotland)

HM Treasury Green Book: Appraisal and Evaluation in Central Government

National Travel Survey

Laird, J. Review of Economic Assessment in Rural Transport Appraisal

Flyvbjerg, B. Procedures for Dealing with Optimism Bias in Transport Planning

Accessibility and Social Inclusion

Transport Scotland – Access for All

Scottish Executive - Transport provision for Disabled People in Scotland (2004). Progress since 1998

Scottish Executive - Review of Accessibility Analysis Techniques and their Application (1999)

Scottish Executive - Rural Accessibility (2002)

Scottish Executive Women and Transport - Guidance and Checklist (2002)

Evaluation

Scottish Trunk Road Infrastructure Project Evaluation Guidance (STRIPE)

Transport and Land Use Modelling resources

Land Use and Transport Integration in Scotland (LATIS)
(including the Transport Model for Scotland (TMfS), the Central Scotland Transport Model (CSTM), Moray Firth Transport Model (MFTM), SEStran Regional Model (SRM))

Rail Passenger Forecasting Handbook – contact Transport Scotland

Rail Passenger Forecasting Handbook for Third Party Funded Local Rail Schemes

17.3 Modelling and Assessment Software- Summary

The development and application of models and software are important to many project appraisals for the following reasons:

- They provide an analytical framework to assess existing demands on the transport system, and to project these demands into the future to test the impact of transport and land-use options on a systematic basis; and
- They enable quantitative measures to be generated that act as key indicators in the appraisal process.

Some of these indicators can only be derived in a sufficiently robust, disaggregate manner by using a model.

At their most complex, models include:

- A road traffic assignment model;
- A public transport passenger assignment model;
- A mode choice model;
- Trip generation and trip distribution assumptions based on trip end data; and
- Modelling of transport and land-use interactions.

Demand models are most common and range from assignment only, to more sophisticated approaches involving the four main stages of generation, distribution, mode choice and assignment. Demand models come in two main forms:

- The operational form where the networks and systems are represented in detail; and
- Policy sensitive forms where the trip ends are represented in greater detail.

For many appraisals, the pattern of travel demand is unlikely to differ significantly for the transport options under consideration. In these circumstances, travel demands can be assumed to be fixed for each option and the assessment undertaken using only an assignment model.

Accessibility models represent the transport supply in relation to the spatial distribution of land-uses. It is often assumed that road network supply is available to all locations so the modelling is regularly restricted to public transport supply. However in some circumstances it is helpful to compare the standard of transport supply for road and public transport users so in these cases travel times and costs using the road network are also modelled.

Land-use/transport interaction (LUTI) models cover a wide range of types of model representing aspects of the interaction in different levels of detail. At their simplest level they are sometimes taken to include policy sensitive demand models or accessibility models as described above, but in true LUTI models patterns of land-use are modelled rather than simply represented as a data input.

17.3.1 Modelling and Assessment Software Appendix Structure

This Appendix consists of six sections. Following this introductory section, 17.3.2 Transport Demand Modelling Software summarises the range of transport modelling software available and discusses its application. Typical data requirements, model outputs and functionality of the various program packages are also presented. For information on demand modelling and land-use/transport interaction models, the reader is referred to WebTAG.

Assessment software that could be used for economic or environmental appraisals is summarised in 17.3.3 Economic Assessment Software and 17.3.4 Environmental Assessment Software In particular, these sections describe the different types of assessment and discuss the capabilities and application of each program. Accessibility Modelling is discussed in 17.3.5 Accessibility Modelling.

Summary information on various Scottish transport models is contained in 17.3.6 Summary of Existing Scottish Transport Models.

17.3.2 Transport Demand Modelling Software

There is a variety of software packages available for modelling transport networks. The software applications range from local junction assessments of road traffic to strategic road traffic and public transport assignment modelling as well as pedestrian interaction modelling.

The choice of which software package to use will depend on many factors, including the application, available data and the type of assessment to be carried out.

17.3.2.1 Assignment Methods

A number of assignment techniques exist and generally, each package will differ in terms of the methods available. The choice of which assignment method to use will depend on a number of factors, including study purpose, study area, the range of alternative routes, the zoning system and the detail and quality of the available data. The assignment methods in common use are as follows:

- All-or-nothing – Single route assignment;
- Multi-routeing – Using stochastic methods;
- Capacity restraint – Drivers long-term knowledge of congestion utilised; and
- Dynamic – Drivers short-term knowledge of congestion utilised.

The majority of packages covered in this guidance contain one or more of the above assignment methods. The choice of which package is best suited to a study will be significantly influenced by the assignment methods inherent within it. For example, a package which only accommodates all-or-nothing routeing may be suitable for a route corridor study covering several kilometres, but would be insufficiently detailed to model a much smaller urban area where multiple alternative routes are available.

17.3.2.2 Model Types

There are a large number of software packages used in the UK for modelling transport networks. The software packages available have been categorised under the following model type headings to simplify presentation:

- Road Traffic Assignment;
- Public Transport Passenger Assignment;
- Traffic Microsimulation;
- Junction Models; and
- Pedestrian Models.

Road Traffic Assignment

Road traffic assignment models allocate vehicle trip matrices to a road network to reproduce or estimate traffic flows on links. This is done by determining traffic routes using the cost of travel between zone pairs. For the base year, the model calibration and validation process enables the level of fit to be verified by comparison against observed traffic flows and journey times. Traditional road traffic assignment models operate on the basis of traffic flow being considered as a single entity flowing through the road network, analogous to fluid flowing through a pipe.

Generally, in congested assignment routines, it is assumed that some form of equilibrium – whereby drivers cannot reduce their travel cost by changing route – involving a number of iterations, has to be achieved before the assignment process is complete. These capacity restraint techniques involve feasible routes being considered at each iteration based upon current network conditions. Convergence or equilibrium is

reached when changes in route cost (and hence the likelihood of alternative routes being used in successive iterations) reach negligible levels, based upon pre-defined criteria. This type of assignment method is particularly useful for reflecting drivers' learning effects of congested network conditions over long periods and is therefore suitable for modelling average traffic conditions in congested areas.

Less congested networks can be modelled using simpler methods such as all-or-nothing or stochastic assignment where the prescribed cost, and/or individual drivers' perception of the cost, determines route choice. Stochastic methods are used to produce a more realistic spread of traffic across competing routes where all-or-nothing methods are too simplistic. Congestion effects are not accounted for in these assignment routines and, therefore, their application is more suitable for situations where route choice is not significantly affected by congestion.

Traditional road traffic assignment models are often referred to as macroscopic since they operate on the principle of aggregate traffic flow. Broadly, the macroscopic approach assumes that average conditions are modelled and that all drivers making the same trip will experience the same conditions and will therefore have the same journey cost. Some models attempt to break down this flow into smaller elements by assigning the travel demand in smaller increments throughout the simulation period. These models may be categorised as mesoscopic, as they still represent aggregate traffic flow and not individual vehicles, but do take some account of the variations in traffic demand and network conditions.

Public Transport Passenger Assignment

Public transport passenger assignment models involve the assignment of individual passenger trips to the network as opposed to the public transport vehicles themselves, which will generally be incorporated in the road traffic assignment process. This can involve both road and non-road based public transport trips, and will generally be encompassed in the wider context of modelling all person/vehicle movements within a study area. The demand response of mode choice can therefore be incorporated in the modelling process to forecast the effects of transport proposals across all modes.

Traffic Microsimulation

Traffic Microsimulation models have become more widely used during the last few years. Their application ranges from large-scale urban and inter-urban assessments to operational models of a single junction. Key strengths of this type of software include the modelling and visual representation of individual vehicles together with a comprehensive range of model outputs.

The more sophisticated microsimulation models incorporate road traffic assignment algorithms for wide area or strategic studies. Microsimulation models also use all-or-nothing and stochastic assignment methods. For congested conditions, some microsimulation models have dynamic assignment capabilities whereby drivers can alter their route as they travel through the network, based upon current levels of congestion or delay. Generally, these techniques do not assume equilibrium, but rely on the feedback of delay information to a proportion of the driving population at intervals defined by the user. These techniques are particularly suited to the detailed simulation of congested traffic networks to represent in-day variations of traffic flow resulting from the build up of queuing and delay.

Junction Models

Junction models are generally used to evaluate the operation of a single junction or localised group of junctions. Key strengths of these packages are their ease of use and

limited data requirements. These models are based upon empirical capacity, queuing and delay formulae, and in common with macroscopic assignment models, consider traffic as a fluid flow or platoon of vehicles travelling through the network.

Pedestrian Models

Pedestrian models can be used to assess the design and operation of walking infrastructure such as transfer (e.g. rail/bus) stations, airports, shopping malls and sports stadiums. As well as assessing the pedestrian flow through known thoroughfares in buildings, such models can also be used to examine the relationship between pedestrian flow and transport service timetables. Additionally, evacuation scenarios can be examined in the design process.

17.3.2.3 Model Applications

The types of study and assessment which would utilise the network assignment and junction software described above can be categorised as follows:

- Transport Corridor Studies;
- Strategic Transport Assessments;
- Public Transport Assessments;
- Local Transport Strategies;
- Local Area Development Studies;
- Local Junction Assessments; and
- Pedestrian Assessments.

Transport Corridor Studies

Transport Corridor studies are specifically targeted at investigating problems on or with all modes of transport. In particular, they are expected to focus on problems on the road, rail and bus systems, including access to ports and airports. Transport Corridor studies can also include analysis of problems of air transport, coastal shipping and inland waterways. Generally, such studies consider strategic scenarios and plans by assessing the impact on modal transfer, the demand for travel and major public transport and roads schemes. These studies therefore, require the ability to model a wide range of demand responses (e.g. re-distribution, modal transfer and trip re-timing) in addition to the routeing of vehicle or person trip movements.

Examples of Transport Corridor Studies include the Central Scotland Transport Corridor Studies which examined the A8, A80 and M74 corridors.

Strategic Transport Assessments

The assessment of strategic transport schemes can be undertaken using a number of software packages. In addition to modelling operational effects, there will be a requirement to undertake economic and environmental assessments. Typical schemes can range from major infrastructure improvements on a corridor or junction (e.g. grade-separation or on-line widening/upgrading) to new major roads or railways or re-alignments designed to improve current route standards. Whilst these schemes may be significant in terms of scale and cost, their impact on travel demand would not justify modelling demand responses other than re-assignment.

Examples of Strategic Transport Assessments include the Strategic Transport Projects Review.

Public Transport Assessments

A public transport assessment is necessary for any scheme or proposal designed to improve public transport services or infrastructure. This would apply to new Light Rail systems and quality bus corridors. The operational assessment for such schemes would encompass the changes in cost associated with public transport operators and users as well as general road traffic. This could involve public transport passenger and/or road traffic assignments.

Local Transport Strategies

Local transport strategies prepared by local authorities provide a framework for meeting wider policy objectives. A strategy will typically encompass the full spectrum of transport issues in the local area including freight movements, local public transport services, local road infrastructure, cycling and pedestrian facilities, set in the context of both central and local government policy objectives. Hence, studies related to the development of a local transport strategy may consider single or multi-modal issues in the local context.

Local Area Development Studies

Local area development studies typically investigate the operational impact on existing infrastructure of traffic generated by the opening of new developments. These studies often involve a localised assessment of operational conditions at a limited number of junctions in the vicinity of the development (i.e. traditional traffic impact assessment). Larger studies could involve assessing the operational impact of proposed developments along a strategic corridor or within the wider context of a town or city.

Local Junction Assessments

Local junction assessments generally concentrate on operational issues associated with single junctions or small groups of junctions. Applications could include assessment of existing problems and their solutions such as geometric improvements or traffic signal optimisation. The impact of proposed capacity alterations at junctions, such as bus or cycle priority measures, could also be assessed.

Pedestrian Assessments

Pedestrian assessments generally concentrate on operational issues associated with pedestrian thoroughfares or pedestrian infrastructure such as rail stations and airport terminals. Applications could include assessment of existing infrastructure and potential measures to improve pedestrian flow (e.g. increased number/changed location of ticketing facilities etc.). Additionally, evacuation facilities for emergency situations can be assessed.

Table 17.3 shows the model types that could be applied to each of these assessments.

Table 17.3: Model Applications

Model Types	Multi-Modal Studies	Strategic Transport Assessments	Public Transport Assessments	Local Transport Strategies	Local Area Development Studies	Local Junction Assessments	Pedestrian Assessments
Road Traffic Assignment (With Capacity Restraint)	✓✓✓	✓✓✓	✓	✓✓	✓	-	-
Road Traffic Assignment (Without Capacity Restraint)	-	✓✓✓	✓	✓✓	✓	-	-
Public Transport Passenger Assignment	✓✓✓	✓✓✓	✓✓✓	✓✓	-	-	-
Traffic Microsimulation	✓	✓✓	✓	✓✓✓	✓✓✓	✓✓✓	-
Junction Model	-	-	-	-	✓✓	✓✓✓	-
Pedestrian Model	-	-	-	-	-	-	✓✓✓

Key: ✓✓✓ Ideally Suitable   ✓✓ Suitable   ✓ Acceptable   - Unsuitable

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17.3.2.4 Model Review

The type of model chosen, and the level of detail modelled, will vary by application. The following sections summarise the main functions, inputs and outputs for the various model types. These are key factors to be considered when selecting a software package to meet the objectives of the study in question. The suppliers should be contacted for a more comprehensive list of individual software functionality.

The model types outlined in Table 17.3 (see previous section) will be defined in terms of:

- Purpose;
- Software Packages;
- Inputs;
- Outputs;
- Applications.

Road Traffic Assignment Models

Assignment models with capacity restraint have been used extensively to represent traffic conditions across relatively large road networks. These models have been used for towns and cities where the effects of congestion are prevalent. The assignment facilities within these models have also been utilised in more strategic studies where route choice decisions over a wider area are a principal element of the modelling process.

Assignment models with capacity restraint in general use within the UK include:

- CONTRAM;
- EMME/2;
- SATURN;
- CUBE Voyager
- VISUM.

These models typically require the following data inputs:

- Physical network description – link length, link travel speed, junction details;
- Operational network description – signal timings, lane markings, saturation flow/capacity;
- Demand matrix;
- Public transport routes and frequencies.

Model outputs can include:

- Assigned link and turning flows;
- Demand link and turning flows;
- Junction capacity indicators;
- Junction delays, queue lengths – maximum, average;
- Link travel times, speeds;
- Network summary statistics – vehicle kilometres, hours.

Table 17.3 (see previous section) provides an overview of the application of assignment models with capacity restraint. These models are ideally suited to the assessment of transport strategies or schemes in congested urban and peri-urban areas.

Some of the modelling packages outlined above (e.g. EMME/2, SATURN and CUBE Voyager) can also utilise simpler assignment methods which do not explicitly account for the possible effects of traffic congestion on drivers' route choice. These simpler methods

would include all-or-nothing assignment and multi-routeing methods using stochastic techniques. The principal applications of such techniques would be for operational, economic and environmental appraisal of schemes which primarily influence road traffic and do not have significant impacts on travel demand across modes.

Along with the software packages outlined above, single and multi-routeing facilities are also available in NESA. This program was developed specifically to perform a cost benefit analysis of new or improved road schemes in Scotland and incorporates the modelling and assessment routines within a single package. This package includes a traffic assignment model which can apply single or multi-route options. Link travel times are calculated from speed-flow curves and junction delays from TRL junction capacity formulae.

Public Transport Passenger Assignment Models

The assignment of public transport passenger trips (i.e. a person trip as opposed to a vehicle trip assignment) is an essential component of any model which is specifically developed to assess public transport schemes or modal responses. The operational interactions of public transport schemes may be assessed using road traffic assignment models. However, if the modelling of demand responses such as mode shift and re-distribution are to be investigated, then a public transport passenger assignment would normally be required.

The packages with public transport passenger assignment capabilities most widely used in the UK are:

- EMME/2;
- CUBE Voyager
- VISUM.

The use of public transport passenger assignments may be as part of a wider multi-modal study where demand responses across all transport modes are modelled. Alternatively, this element may be used to look at schemes affecting public transport in isolation.

The public transport information required as input to this type of model is significantly more detailed than would be necessary for the assignment of public transport vehicles alone. Data inputs include:

- Person trip matrix for public transport (possibly derived from a multi-modal model);
- Detailed information on public transport routes, services, fares, frequency and capacity;
- Interchange times between modes or services.

Model outputs are broadly similar to the road traffic assignment models, including passenger volumes, travel times and costs. These outputs however will often be supplemented by additional data on public transport operating costs, fare revenues and overcrowding.

Traffic Microsimulation Models

Traffic Microsimulation models simulate individual vehicles travelling through a transport network. Microsimulation models offer the ability to simulate at a greater level of detail compared to macro-models. This increased level of sophistication can be advantageous, particularly in congested situations.

Microsimulation packages currently in use in the UK include:

- AIMSUN;
- CUBE Dynasim;
- Paramics;
- VISSIM.

The underlying simulation models and data inputs are relatively similar and generally car following, lane changing and gap acceptance models combine to allow individual vehicles to travel through the network.

As for traditional modelling packages, there is a wide range in the level of functionality and assignment methods available across the various microsimulation packages. The choice of which package is most suitable will depend on the scope and purpose of the study. All microsimulation modelling packages enable individual or groups of junctions to be modelled. The more sophisticated packages include dynamic assignment routines and are also capable of accommodating wide area or strategic studies covering several hundred junctions.

Whilst all microsimulation packages focus on representing and visualising individual vehicles, the simulation methods and range of applications vary between packages.

The other more advanced packages (e.g. AIMSUN, Paramics and VISSIM) are applicable to a wide range of network conditions and undertake the simulation/assignment at an individual vehicle level without using macro or mesoscopic models in part or as a starting point. The assignment procedures in these microsimulation models vary from all-or-nothing to stochastic multi-routeing and dynamic (in-day) assignment.

A microsimulation model requires the following data inputs:

- Physical network description – junction details, link characteristics;
- Operational network description – signal timings, lane markings;
- Demand matrix;
- Public transport routes and schedule;
- Driver behaviour characteristics.

Microsimulation models can provide similar outputs to macroscopic models. A range of additional model outputs is available, although this varies between packages. Additional model outputs can include:

- Visualisation captured on movie file;
- Detailed operational output by individual trip or route;
- Pollution emissions.

Microsimulation models offer significant benefits in providing graphical outputs of the vehicles being modelled. Current computer hardware means that this can be achieved for networks of significant scale representing city areas or major inter-urban routes. Applications and key features of microsimulation models include:

- Blocking back effects on congested networks;
- Detailed operational design;
- Public consultation;
- Visualisation of output from macro and mesoscopic models.

Junction Models

Software for modelling single junctions has been widely used throughout the UK for the past 25 years. Each software package models traffic queues and delays at either a signal controlled intersection, a roundabout or a priority controlled junction.
Signalised Junction
- LINSIG
- OSCADY
- TRANSYT
Roundabout
- ARCADY
- RODEL
Priority Junction
- PICADY

These packages use empirically derived formulae to determine junction capacity, queue length and queuing delay. The signal junction software can also optimise traffic signal settings for a given set of traffic flows.

A junction model typically requires the following data inputs:

- Turning counts;
- Physical network description – geometry, visibility;
- Signal staging and saturation flows (signalised junction only).

Model outputs can include:
- Junction capacity;
- Approach capacity – degree of saturation or RFC;
- Maximum and average queue lengths;
- Queuing delay;
- Optimum cycle time and signal settings (signalised junction software only).

Junction models are generally used to evaluate the operation of individual junctions in detail. The software can be used as part of the design process or to test small-scale improvement measures at an existing junction or a localised group of junctions.

Pedestrian Models

Specialised software for modelling pedestrian flows and interaction is available in the UK and overseas. This is a developing field and consequently, only a small number of modelling packages are available. Examples of software available in the UK are:

- FATHOM;
- PEDROUTE/ PAXPORT;
- PEDFLOW.

These packages use a simulation module, similar to a traffic microsimulation model, to simulate the interaction of pedestrians in stations and other buildings and on pavements. Other pedestrian modelling packages are in development overseas such as SIMVOET and NOMAD.

A pedestrian model typically requires the following data inputs:

- Network description (i.e. station/terminal layout, location of stairs/escalators, location of obstacles etc.);
- Walking behaviour parameters (e.g. speed, size, age, sex, impatience, grouping etc.);

- Activity scheduling and route choice parameters (e.g. location of doors, ticketing/waiting areas etc.);
- Evacuation/emergency parameters.

Model outputs can include:

- Graphical animation of pedestrian simulation;
- Service levels/pedestrian densities;
- Delays;
- Pedestrian flows;
- Pedestrian characteristics;
- Visibility;
- Accessibility.

Pedestrian models are generally used to evaluate the design of existing or influence the design of proposed pedestrian infrastructure. This type of model can be used to influence the layout of stations/airports, the location of ticketing facilities and pedestrian barriers/access routes. Additionally, the effectiveness of evacuation facilities during emergency situations, can be assessed.

17.3.2.5 Summary

In summary, the assignment model software available offers a wide range of features and has a diverse range of data requirements and model outputs. To assist in the selection of a suitable software package, the following tables summarise the outputs and functionality of the model types.

Typical model outputs for each category of model are shown in Table 17.4.

Table 17.4: Model Outputs

Model Types	Flows, Journey Times, Queue Lengths etc.	Classified Output	Routeing Paths / Costs	OD Based Output	Link Based Output	Pollution Emissions	Pedestrian Visualisation
Road Traffic Assignment	✓✓✓	✓✓	✓✓✓	✓✓	✓✓✓	✓	-
Public Transport Passenger Assignment	✓✓	✓✓	✓✓✓	✓✓	✓✓✓	-	-
Traffic Microsimulation	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓
Junction Model	✓✓✓	✓	-	✓	✓	✓	-
Pedestrian Model	✓✓	✓	✓✓	✓✓	-	-	✓✓✓

Key: ✓✓✓ Full Range of Output   ✓✓ Selected Outputs   ✓ Little Output   - No Output

Typical assignment methods available with each model type are shown in Table 17.5.

Table 17.5: Assignment Methods

Model Types	Dynamic (In-Day)	Equilibrium	Stochastic	All or Nothing
Road Traffic Assignment (With Capacity Restraint)	No	Yes	Yes	Yes
Road Traffic Assignment (Without Capacity Restraint)	No	No	Yes	Yes
Public Transport Passenger Assignment	No	Yes	N/A	Yes
Traffic Microsimulation	Yes	Not Standard	Yes	Yes
Junction Models	No	No	No	No
Pedestrian Models	Yes	No	Yes	Yes

The extent to which public transport is represented in each model type is summarised in Table 17.6.

Table 17.6: Public Transport Capability

Model Types	PT Modes / Routes	Bus / LRT Priority	Passenger Loading / Vehicle Occupancy	Impact of Dwell Times, Vehicles Manoeuvres	Response to Overcrowding
Road Traffic Assignment	Yes	Yes	No	No	No
Public Transport Passenger Assignment	No	Yes	Yes	No	Yes
Traffic Microsimulation	Yes	Yes	Yes	Yes	No
Junction Models	No	No	No	No	No
Pedestrian Models*	Yes	No	Yes	Yes	No

*Note: Detail and application of PT information likely to be station / terminal specific for pedestrian modelling

17.3.3 Economic Assessment Software

17.3.3.1 Assessment Categories and Applications

There are a variety of software packages available for undertaking the economic assessment of transport schemes. The software applications range from separate modules to assess outputs from other transport models to fully integrated economic assessment transport models. The choice of software package will depend on many factors, including the type of assessment and the nature of the scheme to be assessed.

Assessments are required across the full spectrum of transport schemes and hence, the nature and complexity of the assessment can vary greatly between schemes. The capabilities of the different assessment software packages also vary and hence different packages will be suited to different types of assessment. The types of assessment can be categorised in accordance with the recommendations in the SACTRA report *Trunk Roads and the Generation of Traffic* (HMSO, 1994) as follows:

- Complex scheme assessments;
- Intermediate scheme assessments;
- Simple scheme assessments.

Schemes are classified into the above categories and assessed against the following criteria:

- Are the existing roads in the study area operating close to capacity, or are they expected to do so within the design life of the scheme? In these circumstances, congestion is likely to lead to suppression of traffic effects, and schemes may result in the release of some of the suppressed traffic;
- Is the potential change in overall traffic flows high with respect to changes in travel times or costs? This is likely to be the case where there are good alternatives available for the movements affected by the proposed scheme, e.g. other routes or public transport alternatives; and
- Will the implementation of the proposed scheme cause large changes in travel costs, road capacity or both? These conditions are likely to occur where the scheme or improvement bypasses extended lengths of low standard or congested network, or where new road links or public transport systems cause major changes in accessibility (e.g. estuarial crossings, LRT network).

This systematic approach to scheme/assessment classification is intended to identify the nature of transport proposals in terms of their effects arising from changes in traffic flow, journey times/travel costs and road capacity compared to existing conditions. The assessment of these criteria involves both qualitative and quantitative factors and schemes are designated a low, medium or high ranking in terms of the above criteria which in turn defines the scheme classification and hence, the assessment requirements. Advice on the classification of schemes is contained in 'Induced Traffic Appraisal' (ref. DMRB 12.2.2), however a brief summary is provided below.

Complex schemes are those where a high marking is merited in more than one of the criteria outlined above. Generally, a variable trip matrix assessment is appropriate for this type of scheme, however, a fixed trip matrix assessment should be undertaken for comparison purposes.

Intermediate schemes are those where one of the criteria merits a high marking or more than one merits a medium marking. Variable trip matrices may be appropriate for these schemes but may only be necessary for sensitivity testing on a fixed trip matrix analysis.

Simple schemes are those where low markings are given for all criteria. Fixed trip matrices are sufficient for these types of schemes since the pattern of travel demand is unlikely to differ significantly between the base and improved networks.

The following paragraphs provide an overview of the scheme classifications within which different study and assessment types can be considered.

Complex Scheme Assessments

Complex scheme assessments encompass multi-modal studies, certain public transport assessments and some aspects of local transport strategies. By their nature, multi-modal studies will invariably involve an investigation of a range of responses which ensures that they justify a complex classification. Certain public transport assessments may require consideration of impacts across transport modes (e.g. major public transport improvements or new LRT schemes) and would therefore be classified as complex. Local transport strategies consider policy measures across all modes of transport. Studies aimed at meeting the objectives of the local transport strategy may therefore be required to consider sufficient variables to justify a complex classification.

Intermediate Scheme Assessments

Intermediate scheme assessments could be either strategic/trunk road assessments or those related to local transport strategies. Strategic/trunk road assessments generally consider the benefits of operational improvements due to road schemes, where the main focus is on savings in journey times, vehicle operating costs and accidents. The demand responses of such schemes would not be expected to have a significant impact on mode choice, but may justify a variable trip matrix method due to the improvements themselves, hence the justification of an intermediate classification.

Simple Scheme Assessments

Simple scheme assessments relate to all other schemes which are not expected to have significant effects in terms of modal shift or other demand responses and hence, a fixed matrix is suitable in all cases. This may apply to strategic/trunk road assessments such as on-line improvements or grade separation where mode or demand responses are marginal. Equally, specific public transport assessments, local development studies or small elements of local transport strategies could be classified as simple. Local junction assessments will rarely require a full appraisal and would generally be considered as simple in such circumstances.

17.3.3.2 Overview of Economic Assessment Software

The assessment programs outlined in this appendix can be used to provide economic inputs to the Part 2 AST detailed in Section 6 of this Guidance.
A number of assessment packages are available for assessing the performance of schemes in economic terms. These packages analyse output from an operational assessment and produce various measures that can be used to compare or rank the economic and sometimes operational aspect of projects against each other on a consistent basis. Some packages contain both the operational and economic analysis routines within a single module, whilst others are designed to interface with outputs from separate operational models.

The following sections provide an overview of available economic assessment programs and their application.

17.3.3.3 Economic and accident assessment Programs

Economic and accident assessment programs are used extensively in the UK to quantify the costs and benefits associated with a range of transport strategies and schemes. Applications include infrastructure improvements, public transport schemes and assessment of roadworks. The assessment programs in use in the UK are as follows:

- COBALT   (Highways Agency)
- MyRIAD   (Highways Agency)
- QUADRO   (Highways Agency)
- TUBA   (UK Department for Transport)
- NESA   (Transport Scotland)
- PEARS   (Transport Scotland)
- AIRE   (Transport Scotland)

The capabilities and outputs of these programs vary and, hence, certain applications will be better suited to individual programs.

Table 17.7 provides an overview of the capabilities of each program. All of the programs listed in Table 17.7, use the methodologies and parameters outlined in WebTAG, though not necessarily those published within the most recent version of WebTAG. Practitioners should refer to latest model release notes and documentation prior to application.

Table 17.7: Economic Assessment Program Capabilities

Program	Role	Owner/Maintainer	Integral/Ancillary	Variable Trip Matrix assessment
TUBA (Transport User Benefit Analysis)	CBA/Economic Appraisal and CO2 emissions, not accident benefits	UK Department for Transport	Ancillary	Yes
NESA (Network Evaluation by Surveys and Assignment)	CBA and accident analysis in Scotland	Transport Scotland	Integral	No
COBA (COst Benefit Analysis)	CBA including accident analysis for some road types.	Withdrawn/ Not supported	Ancillary	Yes
COBALT (COBA accident analysis)	Accident analysis consistent with COBA for major road schemes. *To form update to DMRB 13 in late 2013/early 2014.*	Highways Agency	Ancillary	Yes
MYRIAD (to replace INCA 4.1 - Incident Cost Benefit Assessment)	To assess the impact of incidents on motorways and dual carriageways in terms of delays and journey time reliability.	Highways Agency	Ancillary	No
PEARS 2011.1 (Program for the Economic Assessment of Road Schemes)	Economic appraisal. For use with microsimulation models.	Transport Scotland	Ancillary	No
AIRE (Analysis of Instantaneous Road Emissions)	Emissions analysis. For use with microsimulation models.	Transport Scotland	Ancillary	No

COBA (COst Benefit Analysis) was developed specifically to undertake economic evaluations of road based infrastructure improvement schemes and is applicable to inter-urban and rural scheme assessments. It is suitable for fixed trip matrix (FTM) analysis only and is therefore generally restricted to 'simple' scheme assessments. COBA can however also be used to carryout sensitivity tests on 'intermediate' schemes using a FTM analysis and can also be used to undertake the accident analysis for variable trip matrix schemes. The concepts and theory applied within COBA forms the Design Manual for Roads and Bridges (DMRB) Volume 13.

COBALT replaces the accident calculation formerly carried out by COBA (COst Benefit Analysis). It is maintained by the Highways Agency.

MyRIAD, the successor to INCA (INcident Cost-benefit Assessment) is a spreadsheet-based transport economic appraisal tool maintained and supported by Atkins Limited on behalf of the Department for Transport. The purpose of INCA is to estimate the impact of incidents on motorways and high standard dual-carriageway roads. The impacts of incidents in terms of delays and their effect on journey time reliability are compared between the with and without the proposed improvement scheme, and a monetary value is applied to calculate delay costs and travel time variability costs. Appraisers should consult Transport Scotland's Technical Analysis Branch in conjunction with the supplier, Atkins, when using INCA to produce estimates of reliability benefits for schemes for the purposes of appraisal.

QUADRO was developed specifically to undertake assessments of the impact of roadworks using similar economic concepts to COBA and NESA. This program assumes a fixed matrix approach and is only suitable for use on 'simple' schemes. The application of QUADRO is also limited by the fact that junctions are not explicitly modelled and that diversion routes are crudely represented.

TUBA (Transport User Benefit Appraisal) is a multi-modal, variable trip matrix (VTM) economic appraisal package maintained by the UK Department for Transport to undertake the economic appraisal of multi-modal transport projects. TUBA is capable of appraising highway and/or public transport projects using the outputs of fixed or variable matrix assessments. TUBA does not carry out any analysis of accident benefits and generally an accident only COBA or an accident only NESA assessment will need to be run to obtain these.

Network Evaluation from Survey and Assignment (NESA) is the Scottish equivalent of COBA and is primarily focussed on assessing inter-urban and rural road schemes. The economic concepts are the same in both COBA and NESA but NESA uses Scottish based traffic and economic parameters where appropriate. Like COBA, NESA is suitable only for fixed trip matrix (FTM) analysis and is therefore generally restricted to 'simple' scheme assessments. NESA can however also be used to carryout sensitivity tests on 'intermediate' schemes using a FTM analysis. It can also be used to undertake the accident analysis for variable trip matrix schemes.

The Program for the Economic Evaluation of Road Schemes (PEARS) is an economic assessment module which is designed to interface with outputs from microsimulation software. The economic concepts in PEARS are consistent with those contained in NESA and COBA. PEARS is suitable only for fixed trip matrix (FTM) analysis and is therefore generally restricted to 'simple' scheme assessments. It can however be used to carryout sensitivity tests on 'intermediate' demand scenarios using a FTM analysis. PEARS can carry out an FTM assessment using both link and matrix based outputs. PEARS does not carry out any analysis of accident benefits and generally an accident only NESA will need to be run to obtain these.

17.3.3.4 Summary

In summary, there is a wide range of transport assessment software available for the purpose of economic evaluation. These packages range from ancillary routines which interface with output from transport modelling software to fully integrated modelling and assessment programs. The functionality level varies by program and hence, certain packages are best suited to certain applications as outlined above.

17.3.4 Environmental Assessment Software

17.3.4.1 Overview of Environmental Assessment

Environmental assessment can incorporate a number of different elements, many of which are either physical, aesthetic or social in nature. The assessment of such elements is, to a certain extent, qualitative and beyond the scope of using mathematical and analytical models. Other factors however, can be analysed to enable quantitative assessments to be undertaken.

17.3.4.2 Environmental Assessment Programs

The principal environmental factors that can be quantified from transport models are as follows:

- Vehicle emissions and air quality;
- Noise levels; and
- Fear and intimidation.

Details of the procedures for assessing these factors are outlined in DMRB Volume 11 and webTAG. This guidance provides a broad outline of the inputs and outputs required for assessing the above environmental factors.

Environmental assessment programs make use of travel speed and traffic flow output from a transport assignment model. This data is then input to the procedures for estimating pollution levels/air quality, noise and fear and intimidation. The procedures generally make use of average speed or hourly flow information and therefore are not suitable for producing absolute values for a given time. They do however provide the mechanism to compare schemes on a consistent basis.

Most macroscopic assignment models are capable of producing output suitable for processing by an environmental assessment program albeit that the level of detail varies across the different modelling packages. For example, macroscopic or mesoscopic modelling packages will generally produce hourly flow and average speed information on a link by link basis.

The calculations used in environmental assessment are computationally simple and hence it is possible to use relatively straightforward programming routines or even spreadsheets. The ENEVAL program incorporates these routines within a single package to enable calculations for the above parameters to be undertaken. This package can output measures of local roadside air quality, regional air quality impact, noise levels and fear and intimidation factors that can be compared against pre-defined threshold levels.

Microsimulation models can provide similar outputs. However, they can also produce data on the acceleration, deceleration and idle time of individual vehicles. This more detailed information is already being used to enhance the robustness and accuracy of environmental outputs using AIRE (Analysis of Instantaneous Road Emissions).

A screening process for environmental assessment is outlined in DMRB Vol.11 Section 3 Part 1. Formerly, a paper-based approach to the screening process (to determine whether a more detailed environmental assessment is required) was adopted. Recent amendments to DMRB have seen the production of a spreadsheet by the Highways Agency for this purpose. The reader is referred to the relevant section of DMRB (see above) for more detail on the screening process. Alternatively, the spreadsheet can be downloaded from the Highways Agency website at:
http://www.dft.gov.uk/ha/standards/tech_info/index.htm

17.3.4.3 Summary

Environmental factors are by their nature, less easily quantifiable than economic elements. The environmental assessment programs in existence generally use standard transport model outputs to calculate environmental factors such as emissions, air quality, noise and intimidation and fear using empirical formulae. These formulae are described in DMRB Volume 11 and, whilst not providing accurate representations of absolute environmental impacts, do enable schemes to be compared on a consistent basis.

17.3.5 Accessibility Modelling

Accessibility modelling can be categorised in many ways. For the purposes of developing the STAG indicators of public transport network coverage and local access by walking and cycling (and their distribution), there are three main categories of model:

- Category 1 - Accessibility models which analyse walk times to different tiers of public transport systems or to local facilities. In these models the PT systems are classified by mode, frequency, time of day, and types of destinations served and local facilities classified according to their function.

- Category 2 - Accessibility models which analyse travel times using PT systems. In these models PT networks are defined using journey planning techniques and destinations are described in terms of activities, opportunities or places (e.g. town centres)

- Category 3 - Models not primarily designed to calculate accessibility but which are used as part of the accessibility modelling process. These include: demand models which calculate accessibility change for input to economic appraisal; land-use models which explain the spatial relationships in terms of accessibility; and activity based models which estimate behaviour based on accessibility opportunities.

Most models are developed using standard GIS, spreadsheet, database, and journey planner packages and customisation for the purposes of accessibility analysis can be helpful in some instances. However it is also important to recognise that one of the strengths of accessibility analysis is its flexibility and custom solutions can sometimes hinder rather than help the accessibility analysis process.

Table 17.8 identifies a few of the well-known models under each category.

Table 17.8: Classification of Models by Category

Model Type	Examples
Category 1	PTALS Models (e.g. Hammersmith and Fulham), Glasgow City Council Bus Network Coverage Model, Accession (Citilabs Ltd), etc
Category 2	Accession (Citilabs Ltd), SONATA (Steer Davis Gleave), ABRA (Colin Buchanan and Partners), APTT (Halcrow)
Category 3	Land-use transport interaction models: e.g. DELTA, MEPLAN, LILT, TRANUS, etc. Four stage models used in conjunction with accessibility analysis processors - e.g. TMfS or SITM used in conjunction with the SPT accessibility model, ACCALC (Derek Halden Consultancy)

Some of the main features of each category of model are described below.

Category 1 - Local Accessibility by Walking and Cycling

Local walking and cycling opportunities are usually considered by distance. In their simplest form "crow fly" distances are used, and services are represented by some simple measure of availability. However most models refine the assumptions about: the characteristics of the PT networks or services, including frequency, reliability, destinations served, wait times, and time of day; and the definition of the walking networks to access the services.

Computerised road network data can be used to define walking routes on footpaths following the road network. GIS data sets can be purchased from various companies and custom approaches can be devised to define travel times using these networks. Alternatively custom drive time software packages can be used to calculate times by setting speeds to suitable walking and cycling speeds. In addition many of the category 2 models can also undertake these simple calculations.

Category 2 - Models which Analyse Transport Network Accessibility

Where transport network accessibility is being considered there are several main variants in modelling structure including:

The Transport System

- Representing the geography of the networks as a cost surface derived from public transport information data;
- Representing travel time through the network as routes between zones based on journey planning algorithms or derived from other transport modelling.

People and Places

- Representing origins and destinations in terms of people and activities;
- Representing origins and destinations as types of places e.g. town centre.

In their most highly developed form they can consider not just travel time though networks, but the scheduling of transport services and activities at trip destinations within time windows. This level of complexity in scheduling has only been applied to date in rural situations.

The main disadvantage of these models is that their ability to represent supply/demand relationships is weak or non-existent, and they cannot assist with forecasting future changes in land-use or transport.

Category 3 - Models Designed for some other Purpose but which can be used in the Derivation of Accessibility Indicators

Demand Models

Most demand models can output some form of accessibility index. Using time and cost skims between zones, accessibility indicators can be calculated by linking the land-use and transport data (generally using a logarithmic scale for the travel time/cost and readily available data on the land-uses and other activities available in each zone).

SPT have developed software to automate the links with the four-stage demand model SITM. Alternatively these calculations can be undertaken on a spreadsheet/database or using proprietary software (Table 17.8)

Land-use Transport Interaction Models

Land-use transport interaction models seek to represent the most essential processes of spatial development including relevant land-uses. A number of systems are in use and there are significant variations amongst the different models regarding overall structure, comprehensiveness, theoretical foundations, modelling techniques, dynamics, data requirements and model calibration.

Despite recent achievements in wider development and deployment these models, there remain some challenges to be met. The transport sub-models used do not apply activity based modelling techniques but rather the traditional four-step travel demand model sequence. They therefore have many limitations for modelling behavioural responses.

The derivation of the accessibility measures is therefore no more sophisticated than can be achieved with the four stage models but the models can output accessibility measures directly.