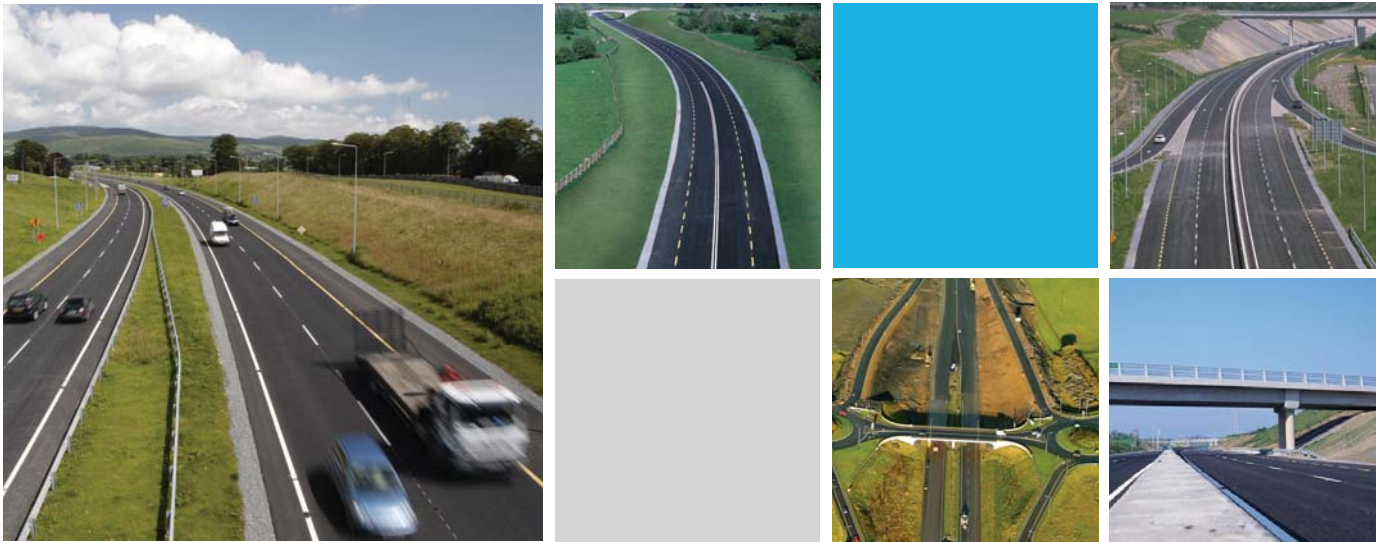


# NATIONAL ROADS AUTHORITY

## Project Appraisal Guidelines

### Appendix 3 - Guidance on traffic modelling



<b>Guidance on traffic modelling</b>		
Version	Changes made to document since previous version	Date issued
1.0	-	01.03.2008

St Martin's House, Waterloo Road, Dublin 4  
 Tel:+353 1 660 2511  
 Fax +353 1 668 0009  
 Email: [info@nra.ie](mailto:info@nra.ie) Web: [www.nra.ie](http://www.nra.ie)

# Table of Contents

<b>1</b>	<b>Guidance on traffic modelling .....</b>	<b>2</b>
	Introduction.....	2
	Structure and contents .....	3
<b>2</b>	<b>Types of model.....</b>	<b>6</b>
	Introduction.....	6
	Isolated junction modelling.....	6
	Linked junction modelling.....	8
	Micro-simulation modelling.....	9
	Road traffic assignment modelling.....	10
	Variable demand modelling.....	12
<b>3</b>	<b>Scope of the model .....</b>	<b>16</b>
	Introduction.....	16
	Junction modelling .....	16
	Assignment modelling.....	16
<b>4</b>	<b>Data availability .....</b>	<b>20</b>
<b>5</b>	<b>Survey requirements .....</b>	<b>22</b>
	Introduction.....	22
	Turning counts .....	22
	Queue length surveys .....	22
	Link counts .....	23
	Journey time and speed surveys .....	23
	Origin destination surveys.....	23
	Public transport surveys.....	24
<b>6</b>	<b>Model building.....</b>	<b>26</b>
	Introduction.....	26
	Network building.....	26
	Matrix building .....	27
<b>7</b>	<b>Model calibration and validation .....</b>	<b>30</b>
	Introduction.....	30
	Model calibration .....	30
	Model validation .....	30
	Validation standards.....	31
<b>8</b>	<b>Forecasting.....</b>	<b>34</b>
	Introduction.....	34
	Growth in travel demand .....	34
	Changes to the network .....	34
	Parameter changes .....	34
	Management of the modelling process.....	34
	Content of the traffic modelling report.....	35
<b>9</b>	<b>Enquiries.....</b>	<b>38</b>



# 1 Guidance on traffic modelling



# 1 Guidance on traffic modelling

## Introduction

### *What is a transport model?*

- 1.1 A transport model is a computer-based representation of the movement of people and goods (trips) around a transport network. It is intended to provide an indication of how trips will respond, over time, to changes in that transport network. These changes may be due to growth in the number of trips or due to changes in the transport network itself i.e. the building of new roads or public transport infrastructure.
- 1.2 In order to try and predict what will happen over time, it is necessary for the model to make assumptions about how people will react to these changes. A model can therefore never be precise about the future and should never be presented as such.
- 1.3 The creation of a transport model can be costly and time consuming particularly in terms of the collection of the necessary data. Thus, it is sensible to consider whether a model is required at all and if so, what form or scale that model should take.

### *What is the purpose of a transport model?*

- 1.4 A transport model can serve several functions. It can aid the design of a scheme, it can help determine what the most appropriate option for a scheme is and it can provide the necessary outputs for the economic and environmental appraisal of a scheme.
- 1.5 Within the context of these guidelines, the primary function of a transport model is to inform the economic appraisal of a scheme.
- 1.6 One of the benefits of using a transport model is that it can ensure that a variety of schemes, or scheme options, are considered on a consistent basis. An objective of these guidelines is to ensure that all National Road Schemes evaluations follow the principles discussed herein and therefore enable the NRA to consider schemes on a like for like basis.
- 1.7 The modeller must always remember that studies are carried out to enable investment decisions to be made and explained, as well as providing information for environmental appraisal, and any work which does not further this objective is wasteful. The practitioner also has a duty to the decision maker to provide information that is robust and does not imply levels of accuracy that are not achievable in practice. They must also ensure that any differences identified between alternatives are real and not a product of the techniques used in the appraisal.
- 1.8 Furthermore, it is important that the scope for using existing models and data is carefully considered and that new models and data are up to the task. Careful consideration should be given, before resources are committed to data collection and model building, to the nature of the options which are likely to be tested and the required level of detail of the analyses. In short, the model must be fit for purpose and unnecessary complexity should be avoided.

### *What does a transport model need to reflect?*

- 1.9 A transport model needs to be capable of reflecting, to an acceptable degree, the existing transport situation as observed on the ground. This can be measured in terms of trip patterns, numbers of vehicles on roads, journey times experienced and the location and extent of any queuing.
- 1.10 Additionally, the model needs to have a mechanism whereby it can reflect forecast growth in the numbers of trips being made and also the changes in transport infrastructure (e.g. new roads) which occur over time.

1.11 In considering the scope of the transport model, the following basic questions need to be addressed:

- What is the nature of the scheme to be assessed?
- Where is the scheme located and in what sort of environment?
- What is the likely area of influence of the scheme?
- What modes of transport are likely to be affected by the scheme?
- What outputs are required from the modelling process?

1.12 The answers to these questions should lead towards a decision as to whether a model is required and, if so, what form it should take.

*Context*

1.13 The first stage is to clearly identify the existing problems and to provide an indication of how these will change over time if nothing is done. It is important that the definition of the problem is as objective as it can be and is not expressed in such a way as to point to only one solution.

1.14 The creation of a transport model can be costly and time consuming particularly in terms of the collection of the necessary data. Thus, it is sensible to consider whether a model is required at all and if so, what form or scale that model should take.

1.15 Furthermore, it is important that the scope for using existing models and data is carefully considered and that new models and data are up to the task. Careful consideration should be given, before resources are committed to data collection and model building, to the nature of the options which are likely to be tested and the required level of detail of the analyses. In short, the model must be fit for purpose and unnecessary complexity should be avoided.

*Purpose of this document*

1.16 This appendix to the transport analysis guidelines is intended to provide the practitioners and auditors of NRA scheme appraisal work with an understanding of what modelling techniques are available, when they are suitable and what controls need to be put in place to ensure that the results from those models are reliable.

1.17 It is not intended to be a modelling textbook. If practitioners or auditors require further detailed advice on a particular topic then they are advised to consult one of the following:

- UK Design Manual for Roads and Bridges (DMRB) Volume 12 Section 1 and Section 2 Part1;
- The UK DfT Transport Appraisal Guidance website (WebTAG) - [www.webtag.org.uk](http://www.webtag.org.uk), or
- The Scottish Transport Appraisal Guidance website (STAG) - [www.transportscotland.gov.uk](http://www.transportscotland.gov.uk).

1.18 There are also a number of standard texts available such as “Modelling Transport” by Ortúzar and Willumsen and “Transport Planning and Traffic Engineering” by O’Flaherty.

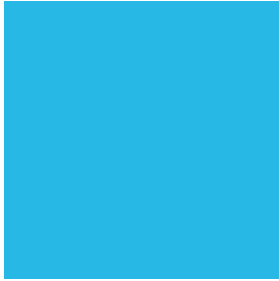
**Structure and contents**

1.19 The remainder of this appendix covers the following sections:

- Section 2 – Types of model;
- Section 3 – Scoping the model;
- Section 4 – Data availability;
- Section 5 – Survey requirements;
- Section 6 – Model building;
- Section 7 – Model calibration & validation, and
- Section 8 – Forecasting.



## 2 Types of model



## 2 Types of model

### Introduction

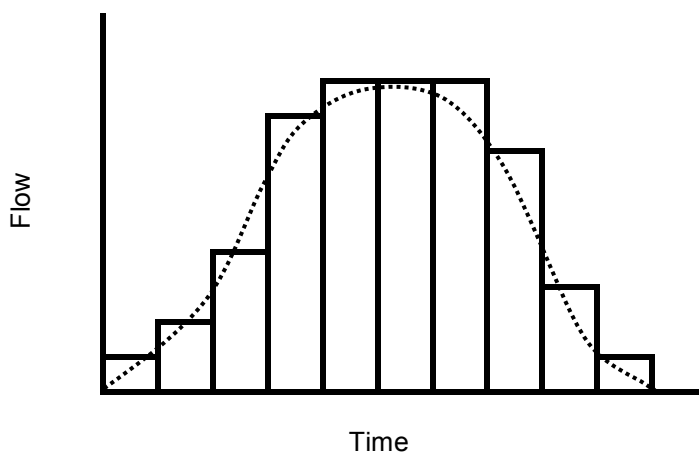
- 2.1 There is a wide variety of scheme types that may be subject to appraisal ranging from refurbishment of existing infrastructure, through minor junction improvements up to major new road schemes. It is clearly not sensible to adopt a 'one size fits all' approach when it comes to developing transport models to assess this range of schemes. Furthermore the geographical location of the scheme will also impact on the decision of what type of modelling is appropriate.
- 2.2 Within the context of this chapter, consideration is given to the various types of bespoke transport modelling software that are available. It is also possible in some circumstances to use spreadsheet or database techniques to develop relatively simple models but this approach is generally not recommended and would require approval in advance from the NRA prior to the commencement of any work.
- 2.3 The types of model that are considered are as follows:
- Isolated junction modelling;
  - Linked junction modelling;
  - Micro-simulation modelling;
  - Road traffic assignment modelling, and
  - Variable demand modelling.
- 2.4 In the following section, each is considered in terms of its modelling approach, suitability, data requirements, outputs and likely resource impact (i.e. time and expertise required).
- 2.5 Major schemes within dense urban areas which have competing modes of transport, such as Dublin, are likely to warrant a variable demand modelling approach. It is unlikely that micro-simulation techniques will be required for appraisal purposes although they may be used for operational assessments.

### Isolated junction modelling

#### *Modelling approach*

- 2.6 This type of software considers traffic as discrete packages of vehicles moving from one arm of the junction to another. They are based on empirical capacity, queuing and delay formulae and model time slices which the user defines. Typically three model periods will be considered, a morning peak, an average inter peak hour and an evening peak. Within that model period, the user can split the flow into time segments (e.g. 15 minutes) but the flow level is considered constant within each segment. The principle is illustrated in the following diagram where the dotted line represents the actual flow profile over a period and the solid lines indicate the various fixed level segments which approximate to the actual profile.

**Figure 2.1 Time segments in flow profiles**



2.7 By definition, there is no route choice within the models and they do not consider interaction with the rest of the network.

2.8 The most commonly used packages are:

- PICADY (for simple priority or 'give way' junctions);
- ARCADY (for roundabouts);
- RODEL (also for roundabouts);
- OSCADY (for signal controlled junctions), and
- LINSIG (also for signal controlled junctions).

*Suitability*

2.9 This kind of approach is suitable for schemes which are limited in scale to one junction and where there is little or no interaction between traffic at that location and adjoining junctions or other parts of the network. They are also appropriate for junction improvement schemes in more complex locations where the scale of the improvement is such that changes in traffic routing are likely to be minimal.

*Data requirements*

2.10 The empirical formulae which underpin isolated junction modelling are based upon junction geometry and so a prerequisite for this type of modelling is detailed geometry of the existing and proposed situations. Details of the precise measurements that are required are given in the relevant software manuals.

2.11 In terms of traffic data, a matrix of turning movements is required for whatever time period is being modelled. Any alterations to the pattern of movements, due to the improvement scheme, or to the magnitude of those movements, due to growth over time, needs to be determined exogenously by the user.

*Outputs*

2.12 Junction models will typically provide measures of performance such as the ratio of flow to capacity (RFC), or degree of saturation for signal controlled junctions. This indicates whether or not particular arms of the junction are operating at or in excess of capacity. This can be important in determining the likely robustness of the model output as most of the empirical formulations that are used will not hold when the level of demand greatly exceeds capacity.

2.13 They will also indicate the likely levels of queues, although this should be treated as an indicative result for an average situation.

2.14 The models will also typically provide estimates of delay per vehicle which is a key output for any subsequent economic analysis.

*Resource impact*

- 2.15 Whilst there is an inevitable learning curve with any new software, these packages are relatively simple to use and should not pose any problems to a competent transport professional. Each of the software manufacturers offers training courses on a regular basis and technical assistance is readily available.
- 2.16 The most significant cost requirement in terms of data is likely to be obtaining the base turning count information. This will typically involve a manual turning count together with some automatic traffic counts to determine day-to-day variations.

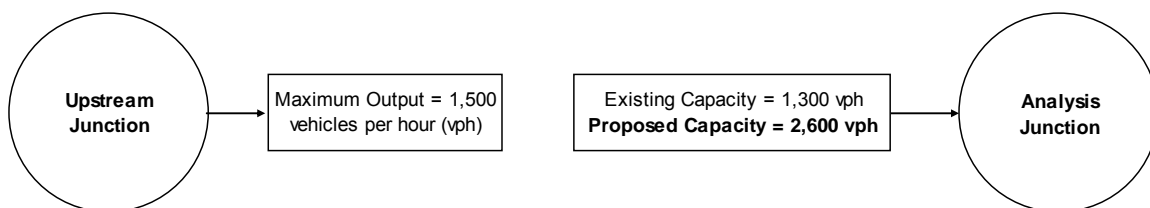
**Linked junction modelling**

*Modelling approach*

- 2.17 Where this type of situation arises, there are two possible solutions. Linked traffic signals can be modelled using TRANSYT, interacting junctions of various forms can be assessed using micro-simulation techniques. Micro-simulation is considered in the following section so here we focus on TRANSYT.
- 2.18 TRANSYT makes the following assumptions about the area which is being modelled:
  - Junctions within the network are primarily signal controlled (some priority junctions can be included);
  - All the signals have a common cycle time or a cycle time of half this value;
  - The details of each junction are known in terms of minimum stage times and stage allocations, and
  - Each individual traffic stream (e.g. flow between junction or turning movement at a junction) has a known flow rate that is constant over the relevant period.
- 2.19 The road network within TRANSYT is modelled as a series of ‘nodes’ (junctions) connected by ‘links’. Each distinct traffic stream leading to a node is represented by a link. The programme is then capable of determining the optimum set of signal timings for a network of junctions.
- 2.20 It should be noted however that whilst TRANSYT will flag up where queuing back from one junction to another is an issue, it will still allow this to occur. This is because, in common with many transport modelling packages, it assumes ‘vertical queuing’ i.e. any vehicles queued at a node are contained at the node rather than stretching back along the link.

*Suitability*

- 2.21 There will be circumstances, particularly when considering signal-controlled junctions, where the flow arriving at one junction is directly linked to the capacity and green times available from the upstream junction. In these circumstances, it is not appropriate to consider each junction in isolation. This is because any predicted increases in throughput at a junction may not materialise if the upstream junction is operating as a bottleneck controlling the input flow. This can be illustrated by the following simplified example.



- 2.22 In this example, just modelling the analysis junction in isolation would suggest that the proposed scheme would increase capacity by 100%. In reality, the constraint imposed by the upstream junction means that the effective capacity is limited to 1,500 vph or an increase of just 15%.

*Data Requirements*

- 2.23 The data requirements are similar to that required for an isolated junction model but with the following additional elements:
  - Details of the signal controller constraints (e.g. minimum green and stage times), and
  - Information with regard to link lengths or distances between junctions.

### *Outputs*

- 2.24 TRANSYT provides similar outputs to junction models but to a greater level of detail given the nature of the programme. The main outputs are:
- Flow on link;
  - Saturation flow (i.e. capacity for an hour's worth of green time);
  - Mean cruise time (i.e. free flow link times);
  - Mean delay time (i.e. average value of total delay / flow on link);
  - Uniform delay, which relates to delay for under capacity links;
  - Random + over saturation delay, which equals random delay plus queuing delay for oversaturated links;
  - Cost of delay (based on user defined cost of delay per hour);
  - Mean stops (i.e. how often vehicles need to stop in the link);
  - Cost of stops (as per cost of delay), and
  - Mean maximum queue (estimate of average maximum queue).
- 2.25 Clearly the cruise and delay times can provide inputs to economic analyses.

### *Resource impact*

- 2.26 Some of the concepts within TRANSYT can be quite difficult for the inexperienced user to grasp and it also requires a fair degree of familiarity with the principles of traffic signal controllers. However there are training courses available and technical support from the software suppliers.
- 2.27 The scale of data collection required is clearly related to the scale of network that is being modelled. Experience has shown that it can be difficult to obtain details of signal timings for existing networks and if on street surveys are required, this can prove time consuming.

## **Micro-simulation modelling**

### *Modelling approach*

- 2.28 Transport models have traditionally provided an aggregated representation of traffic, typically expressed in terms of total flows per hour or some other time segment as referred to earlier. In such models, all vehicles of a particular group obey the same rules of behaviour. Micro-simulation models consider individual vehicles, the movements of which are determined by using various rules such as car following, lane changing and gap acceptance. They are becoming increasingly popular for the evaluation and development of road traffic management and control systems.
- 2.29 In theory, micro-simulation models provide a better, and 'purer', representation of actual driver behaviour and network performance. They are the only modelling tools available with the capability to examine certain complex traffic problems (e.g. intelligent transportation systems, complex junctions, shockwaves and effects of incidents). In addition, there is the appeal to users of the powerful graphics offered by most software packages that show individual vehicles traversing across networks that include a variety of road categories and junction types. This visual representation of problem and solution in a format understandable to layman and professional alike can be a powerful way to gain more widespread acceptance of complex strategies.
- 2.30 The packages originally worked on fixed, user-defined routes but the more sophisticated models now incorporate assignment algorithms which allow individual vehicles to determine their optimum route through the network. The principles of assignment are discussed more fully in a later part of this section.
- 2.31 There are a number of packages available but the most common currently used are:
- AIMSUN;
  - Paramics, and
  - VISSIM.

### *Suitability*

- 2.32 The techniques are particularly well suited to the detailed simulation and operational assessment of complex junctions, which cannot be covered by any of the junction modelling techniques described earlier. They can also be valuable in considering junction interaction as, unlike other model approaches, blocking back of queues is explicitly modelled.
- 2.33 The techniques were originally developed for looking at small urban networks and are still perhaps best suited to that type of environment although they have also been used for large-scale urban and inter-urban assessments.
- 2.34 It is not expected that micro-simulation will be used on NRA projects requiring appraisal other than as an operational tool or as part of a modelling hierarchy in heavily trafficked urban situations.

### *Data requirements*

- 2.35 The creation of input files which describe the layout of the network can be a very time intensive task. Link lengths and widths have to be measured, the number of lanes determined, junction layouts specified, signal locations and timings entered and public transport stops and priority lanes identified.
- 2.36 Given the level of detail required to accurately define the network, the magnitude of the data collection exercise can be considerable and therefore the scale of the model should be kept as small as possible whilst satisfying the needs of the study.
- 2.37 Once the geometry of the network has been defined, vehicles have to be added to the model. The number of vehicles is traditionally defined by specifying origin-destination (O-D) data. The collection of O-D data for input into micro-simulation models is a very time consuming and expensive task. It is usually done by placing observers on entrances and exits to the network to identify trip origins and destinations, either by number plate matching or roadside interviews.

### *Resource impact*

- 2.28 Micro-simulation modelling does require a degree of expertise and if this is not immediately available, then sufficient time will be required for training and staff development.
- 2.39 Given the complexity of micro-simulation models, it is not surprising that they take longer to run than standard junction models. The principles behind the operation of micro-simulation models also require that a number of runs are undertaken for each scenario that is being considered and this has an impact on the time taken to complete the assessment.

## **Road traffic assignment modelling**

### *Modelling approach*

- 2.40 Road traffic assignment models consider the transport system in terms of demand, in the form of trip matrices, and supply in the form of a road network. They are often referred to as macroscopic as they operate on the basis of aggregate traffic flow rather than individual vehicles. This approach assumes that average conditions apply and that all modelled vehicles making the same trip will experience the same conditions.
- 2.41 Trip matrices represent a simplified view of the patterns of movement across a study area. The area is split up into zones whereby each zone contains a similar land use (e.g. housing estate) and is of a suitable size so that all of the elements within that zone can be considered to arrive or 'load' on to the network at a common point. To use the housing estate example, if there are a number of minor roads which all access the main road at one junction then it may be suitable to group all those roads, and the houses therein, into one zone. Each zone will be an origin for some trips and a destination for others. In the earlier example, the housing estate will be an origin for many trips in the morning peak, as people leave their houses to go to work but will also be a destination for certain trips, such as the delivery of a household item. Hence, the use of the term origin destination (OD) matrices.

- 2.42 The trip matrices will contain all of the movements in the study area for the time period being considered (typically one hour). But there may also be more than one trip matrix for that area as it is common to distinguish between vehicle types, e.g. cars versus trucks, and also between trip purposes, e.g. commuting from home to work and leisure.
- 2.43 The network is represented by a series of links, or sections of road, between nodes, or junctions. Each link in the network will have an associated capacity based on the number of lanes available to traffic and usually a speed flow curve. This defines how the speed of vehicles on the road alters as the number of vehicles change. Clearly, as the number of vehicles increases, the speed decreases. The way in which junctions are handled varies between software packages. Some consider junctions as simple nodes with no associated delay; others mimic the way in which junction modelling software operates, albeit in a simplified fashion.
- 2.44 There are a number of ways in which the trip matrices can be loaded or assigned to the road network. The most common involves an iterative process whereby an equilibrium solution is sought before the assignment is complete. At each iteration, each OD pair (or conceptually each driver) considers all of the feasible routes to get from their origin to their destination and selects the best option, usually based on a combination of time and distance, based on the current network conditions. Those conditions are a function of the current flow levels and the link characteristics (e.g. capacity and speed flow curve).
- 2.45 The current most commonly used road traffic assignment packages are:
- EMME/2;
  - SATURN, and
  - TRIPS (now incorporated within CUBE).
- Suitability*
- 2.46 These types of assignment models are well suited to relatively large, typically inter urban, networks. They are capable of dealing with route choice and are therefore particularly appropriate when considering a new link or a significant junction improvement.
- Data requirements*
- 2.47 Assignment models require a definition of the network, in terms of link length, link standard (e.g. 2-lane motorway) and speed in terms of an appropriate speed flow curve, and a demand matrix of trips. As mentioned previously there may be a number of trip matrices depending on the trip categories which are required to be modelled.
- Outputs*
- 2.48 The exact nature of the output is specific to the type of software being used but the following are available from all standard packages:
- Flow on link (disaggregated by user class / vehicle type);
  - Time on link, and
  - Network wide performance statistics such as total vehicle kilometres and total vehicle hours.
- 2.49 There can also be comparisons available between the demand and actual flow on links. Where there are significant differences between these two figures, it means that network constraints are preventing all vehicles who wish to from reaching that point. This can be an important issue in terms of scheme design.
- 2.50 Most packages also have associated database or calculation modules which enable the user to generate indicators based on any combination of model output and network, or matrix, component.
- 2.51 For a fixed demand economic assessment using COBA, the primary output from the modelling process is a series of flows on links; COBA will then recalculate link times and vehicle operating costs itself together with accident statistics.
- Resource impact*
- 2.52 As the models are working at an aggregate level the network coding is not as critical as with more detailed models. Typically, it is possible to scale link lengths from maps although carriageway standard (e.g. number of lanes) may require site visits if aerial

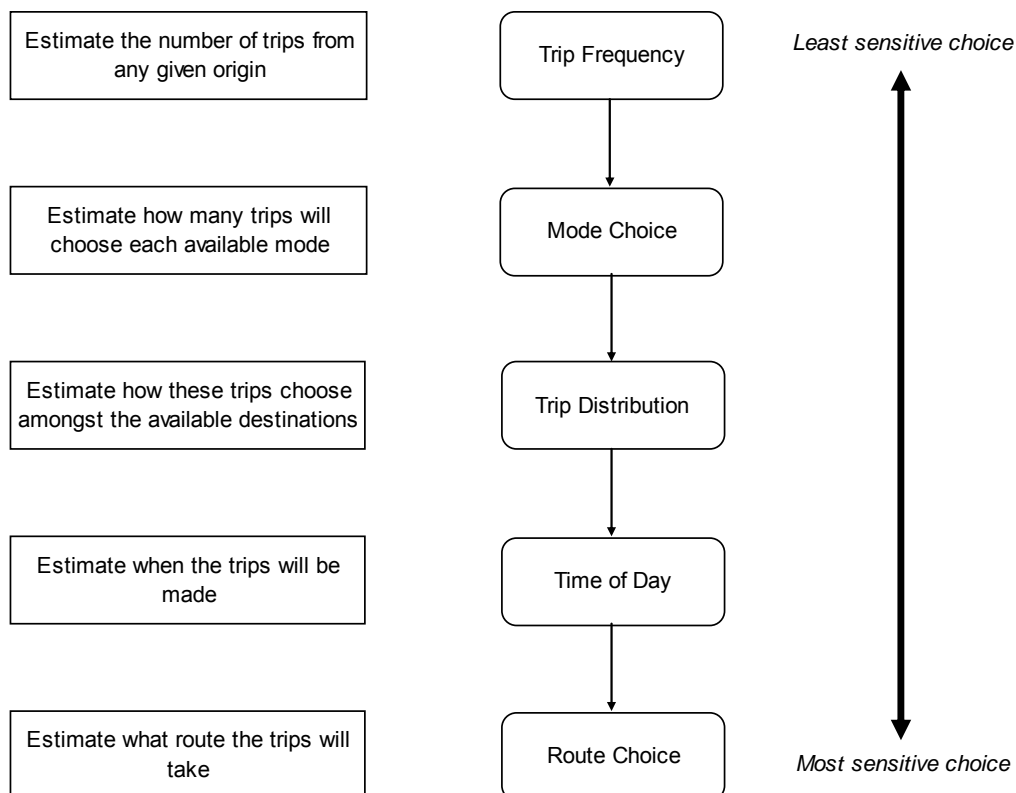
photography is not available. Similarly it may be necessary to undertake site visits in order to code up junction arrangements.

- 2.53 The development of a trip matrix can be a costly and time intensive process however if the modeller is starting from scratch. Roadside interview (RSI) surveys, where a sample of drivers are stopped and interviewed, are likely to be required which can then be supplemented by matrix estimation techniques which rely on link based traffic counts.

### **Variable demand modelling**

#### *Modelling approach*

- 2.54 All of the modelling approaches discussed thus far assume that the volume of trips using the road network does not alter as a consequence of the scheme being assessed. Traffic may change their route as a consequence of a scheme, if an assignment model is being used, but the volume of trips from A to B will not change.
- 2.55 Variable demand modelling works on the premise that any change to transport conditions will, in principle, cause a change in demand. Travel will become faster or slower, cheaper or more expensive, and this will be reflected in the generalised costs of travel for some journeys. Generalised cost is the sum of both time and money cost, and any modelling of demand will depend upon how the generalised cost of travel changes. As an example a road improvement which removes delays for those travelling by car means that the generalised cost of some journeys will reduce. Therefore some people will decide that the journey is now acceptable, whereas before they were less likely to make it so the total number of people taking advantage of the scheme will be more than would have travelled without the improvement.
- 2.56 The demand responses which are modelled within a variable demand environment are:
- Change of route (already covered in standard assignment models);
  - Change of destination or origin (trip distribution);
  - Change in the number of trips made (trip frequency);
  - Change from car to public transport or vice versa (trip mode), or
  - Change to time of travel (trip period).
- 2.57 They may be addressed using full demand modelling or by an elasticity approach. In full demand modelling, it is common to adopt a hierarchical approach in order that different responses have a different order of priority. An example is shown in the figure below.



**Figure 2.2 Hierarchical approach to full demand modelling**

2.58 In an elasticity or own-cost elasticity approach, all of these responses are considered as one. Furthermore it assumes that travel demand for any OD pair is a function of the cost for only that pair. The change in cost can take a number of forms but the most common is the power formulation because it is considered well behaved computationally and simple. It assumes that a proportionate change in trips is related to a proportionate change in costs.

2.59 The main shortcoming of an elasticity approach is that it cannot replicate the changes in trip lengths which are forecast by trip distribution models and there has been concern that they cannot adequately estimate mode or time period choice.

*Suitability*

2.60 Variable demand modelling is necessary when the following conditions are fulfilled:

- Mode choice is likely to be a significant issue, or
- Changes in trip costs are so large as make distribution a significant issue.

2.61 It is not expected that variable demand modelling will be used on many NRA projects requiring appraisal other than for major new links in heavily trafficked urban situations.

*Data requirements*

2.62 The data requirements are dependant on the variable demand approach that is to be adopted. For an own cost elasticity approach, the only additional requirement over standard assignment model requirements is the provision of appropriate elasticity values. Advice should be sought from NRA on appropriate values to be used.

2.63 For full variable demand modelling, the complexity increases and suitable parameters need to be defined for each response. Research in the UK has suggested some illustrative values but once a variable demand model has been constructed, it is essential to ensure that it behaves "realistically", by changing the various components of travel costs and times and checking that the overall response of demand accords with general experience. If it does not, then the values of the parameters controlling the response of demand to costs should be adjusted until an acceptable response is achieved. This recognises the large and unavoidable uncertainties in some of the parameter values, and the importance of reflecting local conditions in relative values.

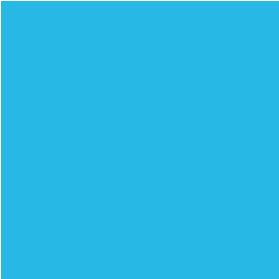
### *Outputs*

- 2.64 The outputs from variable demand models are similar to those for standard assignment packages but will additionally provide information on the demand responses for the scheme being assessed. So there will be outputs relating to the volume and location of trips redistributing, changing mode etc.
- 2.64 The economic analysis of variable demand is handled in a fundamentally different way to that for fixed and puts a greater onus on the ability of the assignment model. All of the required outputs for the economic element are matrix based and include:
- Trip matrices (disaggregated as required);
  - Time skims (i.e. origin zone to destination zone average trip times), and
  - Distance skims (i.e. origin zone to destination zone average distances).
- 2.65 If TUBA is to be used to undertake the variable demand economic assessment then it is vital that the correct economic parameters are used. A standard economic input file for use with TUBA is available as a separate appendix available for download from the NRA website.

### *Resource impact*

- 2.66 Building a variable demand model is a significant undertaking and should not be instigated without prior approval from the NRA. As stated above, there are considerable uncertainties in the appropriate parameter values to be adopted and homing in on suitable local values can take a considerable amount of time.
- 2.67 It is also not a task to be undertaken by any other than highly experienced modelling practitioners.

# 3 Scope of the model



# 3 Scope of the model

## Introduction

- 3.1 In considering the scope of the transport model, the following basic questions need to be addressed:
- What is the nature of the scheme to be assessed?
  - Where is the scheme located and in what sort of environment?
  - What is the likely area of influence of the scheme?
  - What modes of transport are likely to be affected by the scheme?
  - What outputs are required from the modelling process?
- 3.2 The answers to these questions should lead towards a decision as to whether a model is required and, if so, what form it should take.
- 3.3 The nature of the scheme, e.g. junction improvement versus new road link, will provide the first indication of what type of modelling is required, although it will also be important to consider the location and the prevailing environment. As an example, a fairly major junction improvement in a rural area with a sparse road network is likely to only require an isolated junction model. The same kind of scheme in a dense urban environment may cause significant re-routing effects and even, potentially, impact on other modes. As a consequence, a reassignment model would be the minimum requirement.

## Junction modelling

- 3.4 If it is decided that a junction model (isolated or linked) is sufficient, then the remaining issues with regard to scope will be:
- The definition of suitable model time periods, and
  - The choice of model years to be assessed.
- 3.5 As the modelling process will inform the design of the scheme as well as contributing to the appraisal, the model periods should cover the times when the impact of the improvement is going to be significant. This is likely to be, as a minimum, in the morning and evening peak periods but may also include the inter peak and, in certain circumstances, busy periods during the weekend. It should also be noted that any economic assessment needs to consider both positive and negative impacts. The addition of, for example, traffic signals to a junction may result in additional delays compared to the 'do-nothing' case and this should be considered when determining what time periods need to be modelled.
- 3.6 The model years need to include, in addition to the base year, the scheme opening year and a suitable design year as a minimum.
- 3.7 Additional years may be required if there are significant changes to the network or trip patterns (e.g. as the result of a development nearby) in the intervening period.

## Assignment modelling

- 3.8 If it has been determined that an assignment model is required then issues with regard to the scope of the model will include:
- The extent of the road network to be modelled;
  - The level of detail of road network required;
  - The definition of an appropriate zoning system;
  - The number of vehicle type / user class matrices required;

- The definition of suitable time periods, and
- The number of model years to be assessed.

3.9 All of these questions need to be addressed with reference to the basic purpose of the model: what is it trying to assess and what questions does it need to provide answers for?

*Extent and level of detail of the road network*

3.10 The extent of the road network will be a significant factor in determining the overall resource required to undertake the modelling work and so it should be kept as small as possible whilst still providing the necessary coverage. One of the main purposes of an assignment model is to investigate the extent and impact of changes of route as a consequence of a scheme. Therefore it must be of sufficient extent to allow all reasonable and significant reassignment movements to occur.

3.11 If there is an existing model of the area, even if it is quite old or of a coarse nature, then it should be possible to code in a representation of the improvement scheme to identify the extent of any reassignment effects and thereby the area of influence. The magnitude of the effects from an older model may not be quite correct but the routes themselves are likely to be reasonable.

3.12 If there is no existing model then the area of influence will need to be determined by judgement and local knowledge although there are tools available which can assist. For example, commercially available route planner software can be used to determine existing route times and distances. Based on a reasonable assumption of the proposed scheme's impact, likely re-routeing effects can then be determined.

3.13 The level of detail required will probably vary across the network. In close proximity to the scheme, it will be necessary to include all main roads, as well as those minor routes, or roads in residential areas, (including 'rat-runs') that are likely to carry critical traffic movements, either in the base year or in future years. Local authorities will normally be aware of the common 'rat-runs', but some independent assessment may also be required. Junction modelling will also be required in those areas close to the scheme where junction capacities have a significant impact on drivers' route choice, and where delays are not adequately included in the speed-flow relationships applied to network links. However, the network will often be sparser towards the boundary of the area and only needs to be capable of ensuring that traffic is using the correct main routes on the approaches to the scheme. Junction modelling is unlikely to be required in these areas unless there are particular key junctions where route choices are made and where the junction capacity is critical.

*Appropriate zoning systems*

3.14 The size and number of model zones is a critical factor in determining the realism and accuracy of the traffic model and also how long the model takes to run. If zones are too large, the model will be unable to estimate traffic flows to the required level of accuracy, however good the quality of the trip matrix data. On the other hand, if the zones are too small, the sample sizes in the cells of the matrix will be small also, affecting the accuracy of the trip and flow estimates.

3.15 It should also be noted that intra-zonal trips (i.e. those taking place entirely within the same zone) are not assigned to the model network. If zones are too large, this may lead to a significant underestimation of traffic flows, both on links and at junctions, and this in turn could seriously distort the pattern of flows and delays given by the assignment model. This is a particular problem in urban traffic models that use capacity restraint assignment techniques. Similar distortions, particularly in the modelling of junction turning movements, can also occur if zone sizes are not compatible with the level of network detail included in the model.

3.16 In a similar fashion to the network, zones sizes should generally be smallest towards the centre or focus of the model area and increase in size the closer to the model boundary they become. They should also seek to follow, or be capable of being aggregated to, administrative boundaries as this can prove useful when using other data such as population or household information.

*Vehicle type / user class matrices*

3.17 Where a fixed trip economic appraisal is to be undertaken, COBA will determine the appropriate split of vehicle type and journey purpose for each link in the study area and apply these to the total vehicle flows as output by the traffic model.

3.18 It is therefore only necessary to provide sufficient disaggregation of matrices to ensure the model can accurately reflect route choice and provide whatever additional output may be required for operational or other analyses. In that context, it is unlikely to be necessary to provide anything more than car and heavy goods vehicle matrices. The route choice of these two users can be very different and details of heavy goods vehicle patterns may be required for other environmental purposes.

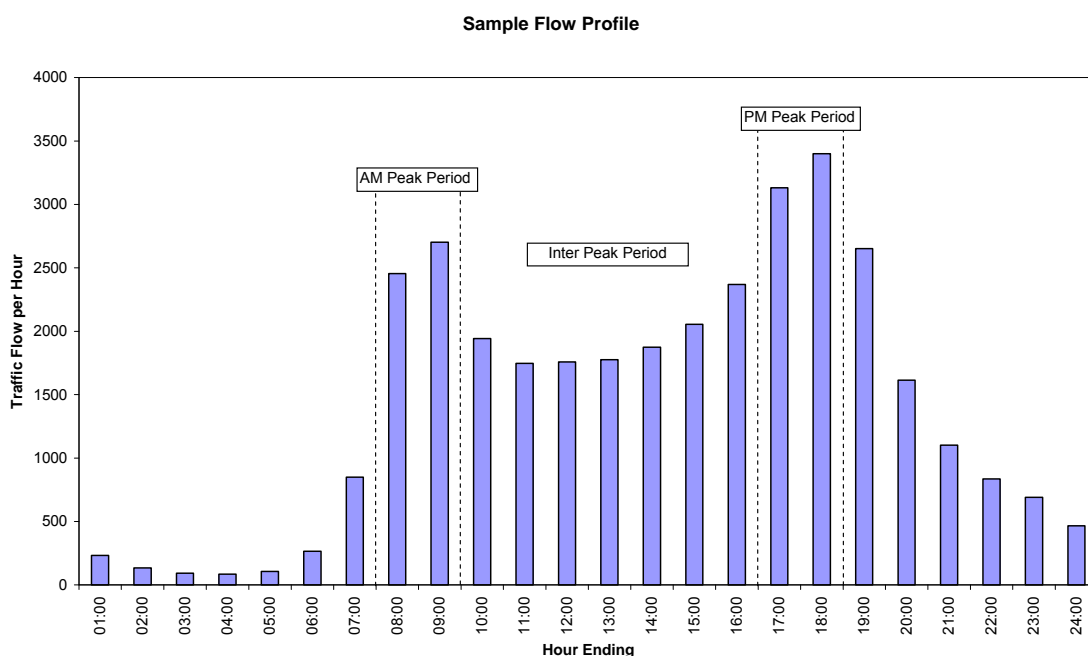
*Model time periods*

3.19 In order to facilitate an accurate cost benefit appraisal, the model needs to provide as accurate an estimate as possible of 12 hour or 24 hour flows on the network. In most instances, the traffic patterns will be significantly different for the morning and evening peaks and different again for the inter peak period. It is recommended that most assignment models should therefore include:

- An AM Peak Hour (weekday);
- An average Inter Peak Hour (weekday), and
- A PM Peak Hour (weekday).

Variable demand assignment models should also ideally include an off-peak (weekday) model, and a weekend model. This is due to the fact that the appraisal software of choice, TUBA, cannot calculate benefits for periods which are not modelled.

3.20 The choice of which hour(s) to use in each case will be informed by an analysis of traffic flow data in the area, particularly in close proximity to the scheme. This analysis will also inform how the model flow periods are combined in order to provide daily flow estimates. In those areas where the AM and PM peak lasts longer than one hour, it is best practice to use multiples of the peak hour to calculate the peak period flow and combine this with the inter peak to produce 12 hour and then daily flow estimates.



**Figure 3.1 – Example of daily flow profile**

*Model years*

3.21 The model years need to include, in addition to the base year, the scheme opening year and a suitable design year as a minimum. Additional years may be required if there are significant changes to the network or trip patterns (e.g. as the result of a development nearby) in the intervening period.

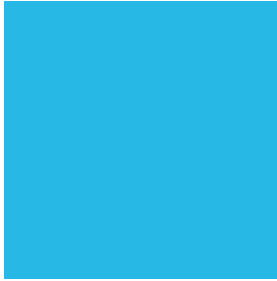
# 4 Data availability



## 4 Data availability

- 4.1 Any model is only as good as the data on which it is built and it is important that the modeller understands the quality of data that is being used. It is also fair to say that data collection can be a costly exercise in terms of both time and money.
- 4.2 This means that no traffic survey should be planned unless it is clear why the information is needed, that there are no alternative sources for this information, and that the cost, timing and location of the survey are reasonable. A review of current data available, and planned data collection, both nationally and locally, should be undertaken to ensure that the requirement for data cannot be met from an existing source. This review should include consideration of any existing transport models which may be able to provide a basis for, or supplement, the proposed modelling approach.
- 4.3 Where large-scale traffic surveys are planned, discussions should be held with the NRA at an early stage to ensure that the proposals are going to be suitable for use in any subsequent model development or appraisal.

# 5 Survey requirements



# 5 Survey requirements

## Introduction

5.1 The scale of data required is clearly related to the type of modelling work that is being proposed. The amount required is also significantly affected by the degree to which modelling has been undertaken in the past. The following table gives an indication of the type of surveys that will be required depending on the nature of the modelling work that is being undertaken. The nature of each type of data collection is discussed briefly in the following sections.

**Table 5.1 Survey requirements**

Data Requirement	Model Type			
	Junction Modelling	Micro-Simulation Modelling	Assignment Modelling	Variable Demand Modelling
Turning Counts	√	√	√	√
Queue Length Surveys	√	√	X	X
Link Counts	X	√	√	√
Journey Time Surveys	X	√	√	√
OD Surveys	X	√	√	√
Public Transport Surveys	X	X	X	√

## Turning counts

5.2 Turning count surveys are designed to provide the turning movements at a junction. Their complexity reflects the nature of the junction that is being surveyed. Simple priority T-junctions can be undertaken by a small number of enumerators on site who directly record each movement e.g. Arm A to Arm B etc in a given time period (typically 15 minute intervals) and according to a specified vehicle classification.

5.3 More complex or large-scale junctions may require video surveys or number plate matching techniques in order to obtain an accurate result. In the latter case, registration plate numbers are recorded at all arms into and out of the junction. Proprietary software can then match the numbers to provide a matrix of movements through the junction. With this type of approach it is often only possible to provide a maximum of two classifications, cars and goods vehicles.

## Queue length surveys

5.4 This type of survey is typically undertaken to calibrate a junction model or a micro simulation model. They are also sometimes undertaken to provide a proper estimate of demand at a junction which is operating in excess of its capacity. In this instance, a standard turning count would effectively measure throughput or capacity (i.e. how much traffic can get through the give way line or stop line) rather than demand. So the addition of the queued vehicles in each time period provides a more accurate picture.

5.5 Whilst these surveys are simple in principle, they can be difficult to undertake with any degree of consistency. It can be very difficult for an enumerator on site to distinguish between slow moving and queuing traffic. It is also often the case that the queue will grow quickly as capacity is exceeded, in busy situations, and it can be hard for the enumerator to determine where the end of the queue is. This difficulty is of course compounded when queues tail back through upstream junctions.

### Link counts

- 5.6 Link or passing counts are the simplest form of survey and can be undertaken manually or automatically. In the manual method, an enumerator records each vehicle passing their location by direction and according to the agreed classification.
- 5.7 Automatic link or traffic counts (ATC) can be temporary or permanent. Where the requirement is to collect a few weeks of data, pneumatic tubes are laid across the road, either singly or in pairs. A counter at the side of the road then records when a vehicle passes over the tube by detecting the pulse of air. Where a pair of tubes are used, at a known distance apart, this type of survey can also record speeds.
- 5.8 A permanent ATC involves cutting loops in the road which are then connected back to roadside cabinet containing the traffic counting equipment. Depending on the nature of the loop arrangement, and the capability of the traffic counter, these installations can record vehicle number, type (either a simple length classification or a more complex profile) and speed. This type of survey is usually undertaken to assist in long term monitoring of traffic growth. Either type of ATC can provide useful supplementary information to a turning count or roadside interview (which are usually undertaken on one day only) as they can indicate whether that survey day was typical or not.

The automatic traffic count data is accessible via the NRA website at: <http://www.nra.ie/NetworkManagement/TrafficCounts/TrafficCounterData/>.

### Journey time and speed surveys

- 5.9 The majority of economic benefits from road improvement schemes typically come from timesavings. It is therefore important that models accurately reflect the speed observed in reality. Knowledge of the prevailing journey speeds on links is also important when trying to code model networks such that subsequent assignments reflect drivers' route choices accurately.
- 5.10 As mentioned earlier, ATC surveys can provide speed measurements as can other techniques such as radar. But these are 'spot' speeds and do not reflect the variation in speed that may be experienced when traversing a network i.e. the journey time. This can be obtained either using number plate matching techniques as described earlier (each number plate is time stamped) or by moving car methods. The latter is more common and simply involves a survey team driving along a route at the prevailing speed of traffic. A number of timing points, usually significant junctions in the network, are chosen in advance and the time from the start to each point is recorded.

### Origin destination surveys

- 5.11 Origin Destination or OD surveys involve stopping drivers at the side of the road and questioning them about their trip hence the term roadside interview or RSI. They provide the best sort of data for building assignment models but can be costly and difficult to implement safely in certain situations e.g. high-speed roads.
- 5.12 The purpose of the surveys is to obtain a sample of the population in the study area who are travelling along relevant routes / corridors and obtain detailed information about the nature of their trip. This can include questions about:
- Trip origin;
  - Trip destination;
  - Trip purpose;
  - Number of people in the vehicle, and
  - Vehicle type.
- 5.13 As the survey involves stopping vehicles at the roadside, the location and layout of the survey site is extremely important and Garda permission and assistance will need to be sought. A standard form is available from the NRA website.

### **Public transport surveys**

- 5.14 These are unlikely to be required for any NRA scheme appraisals but advice should be sought from the NRA if they are being contemplated.

# 6 Model building



# 6 Model building

## Introduction

- 6.1 As previously discussed, the development of junction models is a relatively straightforward task and the software manuals will provide the user with all of the guidance they require. This section considers the two elements of building of assignment models: network building, and matrix building.

## Network building

- 6.2 Network descriptions for assignment models will often need to include both link and junction details. Links are generally described in terms of:
- Nodes at the end of the link (i.e. junctions or changes in standard);
  - Link length;
  - The speed-flow relationship (if any) appropriate for the link;
  - Link capacity (if not defined by the speed-flow relationship, or junction details), and
  - Any restrictions to particular vehicle types using the link.
- 6.3 In urban areas it may also be necessary to consider the impact of traffic management measures such as bus lanes, traffic calming, parking controls and cycle lanes on the capacity and operating characteristics of individual network links.
- 6.4 The usual requirements for junction coding, where this is required, are:
- Junction type (traffic signals, roundabouts, priority);
  - Number of approach arms, and their order (in terms of entry link references);
  - Number and width of traffic lanes on each junction approach, and the lane discipline adopted (including prohibited turns), and
  - Any additional data required to describe the operational characteristics of the junction (e.g. saturation flows, signal timings and phasing, turning radii and gap acceptance characteristics).
- 6.5 The level of network detail required will be greater in the core area close to the scheme and decrease as the distance from scheme increases. In the core area it will be necessary to include all main roads, as well as those more minor routes that are likely to carry critical traffic movements, either in the base or future years. Capacity restraint should usually be applied throughout the core area and separate junction modelling will also be required in those parts of the model where junction capacities have a significant impact on drivers' route choice, and where delays are not adequately included in the speed-flow relationships.
- 6.6 In the wider model area, the network description will need to cover all routes necessary to feed traffic to the boundary of the core area in a realistic way (i.e. with realistic distances and speeds). Care must be taken not to encourage unrealistic reassignments to routes that could avoid the core area, especially if fixed speeds are specified on external network links and no capacity restraint is applied, as is sometimes the case.
- 6.7 In most packages, special links (usually referred to as 'zone connectors') are used to load traffic onto the model network. The position of these connectors is often a critical factor in achieving realistic results from the assignment model. In the core area, they must be located as realistically as possible, and in particular must not be connected directly into modelled junctions, unless a specific arm exists to accommodate that movement. If zones are significantly larger than implied by the detail of the network, it will often be impossible to locate zone connectors realistically. This may lead to distorted traffic flows on nearby links, and turning movements at nearby junctions, which may themselves distort traffic

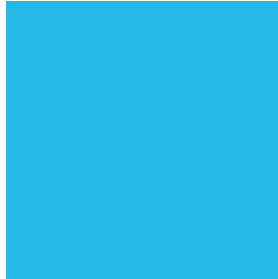
patterns elsewhere in the network. In urban areas in particular, zones should be small enough to avoid this type of problem.

### Matrix building

- 6.8 The production of base year trip matrices forms the foundation for the forecast year trip matrices used in scheme appraisal. They can be created from scratch but will often be based on an existing model which may be an older one from the area, or from a regional model, or a model from an adjacent scheme.
- 6.9 There are two ways of storing trip matrix information.
- 6.10 When matrices are constructed from roadside surveys, the trips are defined by the place the trip started and the place the trip finished, and the trip purpose of each end. This is known as an Origin-Destination (O/D) based matrix. Assignment models use this form of matrix.
- 6.11 An alternative way of looking at the pattern of trips is to consider the factors that produce or attract trips, i.e. on a Production-Attraction (P/A) basis, with home generally being treated as the "producing" end, and work, retail etc as the "attracting" end. Trip production is usually defined as the home end of a home based trip or the origin of a non home-based trip. Trip attraction on the other hand is defined as the non-home based end of a home-based trip or the destination of a non home-based trip. Changes in these P/A trip end forecasts over time or by scenario will lead to changes in the trip pattern. This definition of the trip matrix has normally been used in modelling travel demand and is a prerequisite for full variable demand modelling but it is expected that most NRA appraisal modelling will involve OD matrices and these will be created directly from the time period data.
- 6.12 Base year trip matrices are typically assembled using some combination of the following procedures:
- O/D data factoring, whereby old origin to destination data is scaled, preferably to new traffic counts at the old RSI locations or at screenlines;
  - Matrix construction, whereby new OD data is used to calculate the observed movements of a trip matrix;
  - Matrix infilling, which relates to the estimation of unobserved trip movements, either by using parts of another matrix, or by the use of a model (e.g. gravity model);
  - Matrix manipulation where observed and infilled parts of a trip matrix are combined, and
  - Other matrix manipulations required to obtain origin to destination matrices for assignment such as matrix estimation techniques.
- 6.13 There is an important difference between these techniques. Matrix construction and infilling can be carried out separately for different trip purposes and/or vehicle types, but matrix updating based on count data can only be applied to vehicle types.
- 6.14 There are two main methods of deriving trip matrices for individual time periods:
- Constructing matrices directly from the origin to destination data relating to the specific period, or
  - Constructing matrices by combining specified proportions of the all day (12 or 16-hour) Production/Attraction matrices for each trip purpose.



# 7 Model calibration and validation



# 7 Model calibration and validation

## Introduction

- 7.1 Validation and calibration are separate concepts although they are frequently confused with one another. Two accepted definitions are as follows:
- Calibration - the estimation of the parameters of a chosen model by fitting to observations, and
  - Validation - the assessment of the validity of a calibrated model, either by the qualitative comparison of estimates produced by the model with information not used as a constraint in the model calibration, or by the direct estimation of the accuracy of model estimates.
- 7.2 It is important that the information used in calibrating the model, including count data for matrix estimation, is kept separate from that used for validation if the validation is to be a true independent test of the model.
- 7.3 In reality these two elements are part of an iterative process. If the results of the validation checks are not satisfactory, then the modeller will review the inputs and coding within the model and adjust as required in order to achieve a better representation of reality. The number of iterations required is usually proportional to the complexity of the model.

## Model calibration

- 7.4 As briefly described above, the calibration process involves the estimation and subsequent adjustment of parameters used with a model to fit observations.
- 7.5 For a simple junction model, this may involve adjustments to theoretical saturation flows to ensure that observed queues and delays are reflected in the model. In the case of more complex assignment models the number of parameters and data elements clearly increases and the following represent some of the more common elements that may require adjustment:
- Route choice parameters (the balance of time versus distance);
  - Link capacities;
  - Speed flow relationships;
  - Junction capacities, and
  - Trip matrix elements.
- 7.6 The final element, of adjustments to the trip matrix, is often undertaken using matrix estimation techniques available as part of most assignment software packages. These techniques take a prior estimate of the trip matrix and then adjust that in order to match a set of 'target' observed counts.
- 7.7 Care must be taken with this sort of approach as matrix estimation will almost inevitably result in a solution but it is rarely a unique one. It is therefore necessary to ensure that sufficient count data is held back from this process to enable an independent check to be undertaken as part of the validation process.

## Model validation

- 7.8 The process of model validation determines how well the model estimates compare with reality as reflected by observations made on the ground.

- 7.9 When presenting validation evidence, the estimated accuracy of the survey observations should be quoted whenever possible and that of model estimates where available. Providing information on the estimated accuracy will allow meaningful conclusions to be drawn (e.g. the average of the model estimate lies within the 95% confidence interval of the independent observation).
- 7.10 In order to determine a model's suitability, clear thinking is required about the intended use. The accuracy of any model, indeed even count data, cannot be expected to represent reality except within a range or tolerance. Moreover, it is often not necessary to go to great lengths to reduce that range and seek apparently greater precision. It is far more important to ensure that:
- The degree of accuracy is adequate for the decisions which need to be taken;
  - The decision makers understand the quality of the information with which they are working, and
  - That they take the inherent uncertainties into account in reaching decisions.
- 7.11 The types of validation checks which may be undertaken on a model are dependent on the model form but typical examples include the comparison of model outputs and observed data for:
- Turning proportions at junctions;
  - Flows on individual links;
  - Flows across screenlines or cordons;
  - Queues at junctions;
  - Journey times along critical routes, and
  - Routing through the network.

**Validation standards**

- 7.12 The output from an assignment model can be used to assess the performance of the whole modelling process although it should be remembered that any poor performance may be due to a number of factors including:
- Errors in the trip matrix;
  - Coding errors in the network, and
  - Incorrect route choice parameters.
- 7.13 The two elements of assignment validation are comparisons with traffic counts and journey times. The count comparisons can be done at an individual link level or by looking at groups of links as screenlines.
- 7.14 When comparing model and observed counts, the magnitude of the observed volume is clearly important when deciding on what is a reasonable error. Therefore, in addition to considering percentage or absolute differences, the GEH statistic (a form of the Chi-squared statistic) is also used as it incorporates both relative and absolute errors. The GEH statistic is:

$$GEH = \sqrt{\frac{(M - C)^2}{0.5 \times (M + C)}}$$

where *M* is the modelled flow and *C* is the observed flow.

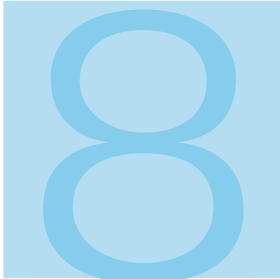
The following table provides an indication of acceptability guidelines for flow and journey time comparisons.

**Table 7.1 Validation criteria**

Criteria and Measures	Acceptability Guideline
<u>Assigned hourly flows compared with observed flows</u>	
1. Individual flows within 15% for flows between 700 & 2,700 v/h.	More than 85% of cases
2. Individual flows within 100 v/h for flows less than 700 v/h.	
3. Individual flows within 400 v/h for flows greater than 2,700 v/h.	
4. Total screen line flows (> 5 links) to be within 5%	
5. GEH statistic:	More than 85% of cases
(i) individual flows – GEH < 5	All or nearly all
(ii) screenline totals – GEH < 4	
Notes: Screenlines containing high flow routes should be presented both with and without such routes.	
<u>Modelled journey times compared with observed times</u>	
6. Times within 15% or 1 minute if higher	More than 85% of cases

- 7.15 It is important though to note that these are purely guidelines. A model that does not meet these criteria may still be considered acceptable if the discrepancies are within survey accuracies and the more significant discrepancies can be shown to be not important to the scheme. Similarly, a model that meets the criteria but which has significant discrepancies on the key links may be considered unacceptable. The onus is on the modeller to use the Traffic Modelling Report as a means of making the case to the sanctioning authority that the results of the modelling work are robust and fit for purpose.
- 7.16 Fitness for purpose will be influenced by the stage the project has reached. As an example, at route selection, the model must be capable of providing a platform whereby alternative schemes can be assessed on a consistent basis but it may not be necessary to be of sufficient quality that it could provide robust detailed turning movements at the scheme junctions.
- 7.17 Conversely, when the model is to be used to determine the preliminary design, and the requirements of land acquisition, the ability to identify the appropriate scale of junction will clearly be important.

# 8 Forecasting



# 8 Forecasting

## Introduction

- 8.1 There are various elements which need to be considered when producing forecasts from a transport model. These include:
- The growth in travel demand (or numbers of vehicles);
  - Changes to the road network (other than the scheme itself), and
  - Changes in modelling and economic parameters (such as value of time, cost of fuel etc).

## Growth in travel demand

- 8.2 There are a number of factors which drive growth in travel demand such as population growth, general economic growth and increases in car ownership. In order to assist in the development of traffic forecasts for individual schemes, national traffic growth forecasts are available from the NRA website. These are updated on a regular basis and will be suitable in most cases for scheme appraisal.

## Changes to the network

- 8.3 In addition to the scheme which is being appraised, there will be changes to the network which are forecast to occur irrespective of whether or not the scheme progresses. It is important that these changes are reflected in any network coding for assignment models or junction arrangements for junction modelling.
- 8.4 The NRA provides regular updates on the progress of major road schemes on its website and this should be consulted to see if any schemes are relevant to the study area. Further details on timing for major schemes in the future that are currently under consideration should be sought from the NRA. The local authorities should also be consulted in order to determine if there are any projects or plans locally which may impact upon the scheme under consideration.

## Parameter changes

- 8.5 Most of the parameters which are subject to change over time, such as the price of fuel, are of more direct importance to economic appraisal rather than modelling per se. However, if any of these have been used in the development of the base model, e.g. to determine the appropriate balance of time and distance for route choice parameters in assignment models, then changes to these should be reflected in the future year assignments. Guidance on the change of such parameters is available in the Cost Benefit Analysis section of this document.

## Management of the modelling process

- 8.6 The outputs from the modelling process are fundamental to the appraisal of any scheme. Therefore it is critical that the modelling process is transparent and that quality control is maintained throughout. It is also important that the NRA is consulted at key decision points through the process in order that abortive time, due to requests to alter inappropriate modelling approaches, is minimised.

### **Content of the traffic modelling report**

8.7 The detailed requirements of the TMR are specified in the TMR Checklist (Appendix 2), available to download via the NRA website, but the structure of the document should, as a minimum, cover the following elements:

- Introduction;
- Data collection;
- Network development;
- Matrix Development;
- Model calibration & validation, and
- Forecasting.



# 9 Enquiries



# 9 Enquiries

All enquiries should be directed to:

Transport Economist,

National Roads Authority

St Martin's House

Waterloo Road

Dublin 4.