ROAD DESIGN, TRAFFIC MODELLING AND VISUALIZATION – A CASE STUDY

By Grant Smith[1] and Ryan Cooney[2]

1. The Problem

During the development and assessment of a infrastructure projects a large amount of data analysis is generally carried out. Because of the technical nature of the results, it is often difficult to convey the information in a meaningful way to councillors and the public, particularly if the project involves new roading. This note describes a recent study in Hastings where traditional transport planning and traffic network modelling has been combined with three dimensional roading design and three dimensional animation to present a visualisation of a new arterial, and the traffic movements that are forecast in twenty years time.

2. Traditional Data Display

Traditionally outputs from transportation modelling include data such as predicted traffic volumes, travel speeds, intersection delays, and intersection queues. Associated with this information a number of secondary outputs, such as network operating costs, emissions, change in volumes compared with a base, and level of service can be graphically presented as a static display. These displays are used as a means of conveying information on how the road network will operate once the facility is built and operating. An example of a typical traffic volume plot is shown as **Figure 1**.

Figure 1
Example Traffic Volume Plot

While graphical plots are simpler to understand than a presentation of numbers, it is often the case that presentation of technical data using plots and tables is difficult for many people to comprehend. With patient explanation and using comparisons such as similar roads/intersections in the vicinity, most people gain somewhat of an understanding. The use of comparisons, however, can also be misleading especially when the option being considered is unique for the area.

3. Animated Data Display

Within the Transportation Industry there has been a desire to transform transportation data into 3D animated graphics that can be readily comprehended. There are software packages around with the capability to generate the 3D animated graphics, however, to date they can cover only a limited geographical and (with one or two exceptions) have not been designed to integrate directly with transportation models.

---

[1] MG Smith BE(Civil), CEng, MICE, MIPENZ, Director Gabites Porter Consultants

[2] RJ Cooney BE(Civil)(Hons) Transportation Engineer Gabites Porter Consultants

Forum 8 (New Zealand) have recently developed a three dimensional animated software package called UC-win/Road (Road), and in conjunction with Gabites Porter have electronically integrated the animation software with the outputs of TRACKS. This package enables transportation modelling data, together with 3D road design data from packages such as Autodesk's Civil 3D and Bently's MXRoad to be bought together for the purpose of a 3D visual presentation. The resulting package allows animation of any part of a TRACKS transportation network. This is a powerful new tool in that traditional, well accepted transportation modelling can be carried out and the output data quickly and seamlessly animated for the purposes of presentation.

There are two methods for generating a 3D animation. The first and most basic method is to use the TRACKS transport network and traffic data to directly generate and begin the animation with no other data required. This method uses TRACKS network to generate the 3D road network and then applies the traffic data to it. The second and more detailed method allows for the creation of a detailed road network using 3D design data from 3D design packages, build up the 3D physical model and then directly apply the traffic data from the TRACKS network to the detailed 3D road network model.

3.1 Basic Output

UC-win/Road has been developed such that the road forms part of the 3D landscape can be generated directly from a TRACKS network. Information regarding link lanes, intersection approach lanes, and intersection form is imported along with aerial photographs if attached to the TRACKS network. This information is used to generate a road network in Road. The TRACKS network can be a 2D or 3D network with false or real coordinates. If the TRACKS network has real coordinates the network is placed in the correct location on a 3D landscape of New Zealand. This process is operated directly from the TRACKS network editor NEX.

Figure 2
Screen Shot from Basic Road-Hastings Northern Arterial Model

As an example of this process a Road model has been created from a TRACKS network created for assessment of a proposed Hastings Northern Arterial. The application is described in more detail later in this paper. **Figure 2** is a screen shot taken from the Tracks model internally invoking Road for animation.

3.2 Detailed Output

Should 3D design information be available for a new road alignment this can be used to automatically create a detailed 3D model of the road. Currently the Road software

can import from 3D design packages such as Autodesk's Civil 3D and Bently's MXRoad. The current version of Road also has the ability to real time synchronise with Autodesk's Civil 3D i.e. if a change is made in Civil 3D Road is updated in real time.

The existing roads and the cross roads (where no 3D design data is usually available) must then be coded into UC-win/Road manually. This involves creation of vertical and horizontal alignments using typical design data i.e. horizontal and vertical curve and transition curve data and cross sections. Cross sections are generated for each individual road cross section as are corners with super elevation, road side drains etc where 3D design data is not available.

Intersection form details are also not imported from the 3D design data and if required must also be coded into Road manually. The characteristics of each intersection such as roundabout dimensions, signal phasing, island dimensions, movements allowed, approach lane types can also be manually coded. Associated with the intersection are diverges and merges on the approaches and exits, and these can also be generated manually with the lengths of diverges/merges taken from the design data.

During the coding of the physical aspects of the road the surface textures are also developed and applied. This includes applying grass textures to the shoulders and drains, asphalt textures to the carriageway, and lane markings to the carriageway. For the intersections this involves creating a single image of the whole intersection with the appropriate lane markings. Additional markings such as lane arrow markings are added separately directly to the carriageway surface.

The user is also able to incorporate further details into the Road model. The default terrain that is available with Road in New Zealand is to a definition of ± 0.5 m and is available for the whole country. A terrain patch of more detail topographical survey can be incorporated. Aerial photographs can be used to provide guidance when manually coding road alignments and other details such as intersection forms and size, buildings, road furniture, trees, stationary vehicles, rivers, bridges etc.

Figure 3
Screen Shot from Detailed Road-Hastings Northern Arterial Model

Once the road network is created the traffic information can be imported from the TRACKS network with the common information being that all nodes in the TRACKS network are present in the Road model. This occurs automatically in the base application. As such each intersection and mid block node needs to be assigned the appropriate TRACKS node number. Following this the TRACKS loaded network traffic and network operation data is then imported into Road.

As an example a screen shot of a detailed UC-win/Road model generated for the Hastings Northern Arterial has been included as **Figure 3**. This screen shot is from a similar location as **Figure 2.**

4. Recent Application

Gabites Porter was recently engaged to carry out transportation modelling of a potential northern arterial bypass to the north east of Hastings between Napier Road and the Hawkes Bay Expressway. Opus International Consultants were engaged to carry out design of the arterial, along with estimating costs for input to the economic evaluation. **Figure 4** shows the location of the arterial with respect to Hastings.

Figure 4
Hasting Northern Arterial Location

The transportation modelling has been carried out for the purpose of providing the network operating costs in the benefit cost ratio calculation and to provide an understanding of how the arterial and surrounding network would operate. The 2D and 3D design information had been carried out to confirm technical feasibility and to enable the schedule of quantities to be prepared.

The Hastings District Council Staff had prepared a simple computer generated video by "flying" along the route with aerial photographs as the background. Given the availability of the modelling and design data a Road 3D model was prepared which would provide a significantly better tool for public consultation. The Road 3D model provided a readily comprehensible visualisation of the physical aspects of the proposed works, the predicted traffic volumes and effects of the vehicle interactions.

The issues of particular concern with the Hastings Northern Arterial were the visual impact of the new road and the way in which the new road would operate. Significant side drains are included as part of the design. These were of public concerns as issues such as the visual impact and the land requirements were not readily understood. The operation of the new road was also of concern, especially access and egress from private property separated by the arterial.

This Road model has been used for presentation of the proposed northern arterial during public open days and consultation with Councillors. For the public open days a continuously looping file was prepared that was left running so that the model could be shown without user intervention. For the councillor consultation, travel within the model was operated manually using flight, pan, zoom and scroll tools.

The model proved to be extremely useful to Councillors and public alike, and facilitated the decision making procedure leading to public notification of the designation.