# A "SIDRA" FOR ROAD SAFETY

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## ABSTRACT

SIDRA is a junction/intersection model that is used throughout New Zealand and Australia to quantify the efficiency (e.g. traffic delays) of an isolated intersection. It is just one of a series of computer packages available for assessing the efficiency benefits/disbenefits of roading changes.

However, none of the available packages allow simultaneous evaluation of safety and efficiency in NZ conditions, for road network improvements/changes. Such software will be required in the future to enable roading authorities to assess the safety impact of new or changed roads and intersections. Similar software is in various stages of development internationally, including SafetyAnalyst & IHSDM in the USA, SafeNET in the UK, and Road Safety Risk Manager & NetRisk in Australasia.

This technical note identifies the important attributes that are required in a road safety evaluation tool, or series of tools, for New Zealand conditions. It includes a review of the overseas software, whether they can be applied in New Zealand and what local software may be required.

# INTRODUCTION

Detailed analysis is often undertaken to estimate travel time and vehicle operating costs (VOC) associated with transport network changes. For example, SIDRA is a model that is used throughout New Zealand (NZ) and Australia to quantify the efficiency of an isolated intersection. Analysis of the crash effects of transport network changes is less common, particularly in urban networks. When such analysis is undertaken it is often in a very simplistic manner. Why is this so? It is because we do not have analysis tools readily available to predict the safety impacts of road network changes. What we need are road safety prediction tools that are as easy to use as SIDRA.

Unlike Australia, NZ has much of the base research required to develop a crash prediction tool. For most intersection and link types, crash prediction 'base' models are readily available or are being developed. There is also a good understanding of the impact of common road features/ improvements within the crash monitoring database. Using transferability modelling techniques specified in the companion technical note (Turner et.al. 2007), it is possible to supplement the NZ crash prediction models with models from other countries. Techniques are also being developed to transfer the results of 'before and after' studies between countries, using similar methods as for crash models.

Over the last decade a number of road safety analysis packages have emerged internationally. These include Road Safety Risk Manager (RSRM) and NetRisk in Australia (developed by ARRB), SafeNET in the UK (developed by TRL), and Interactive Highway Safety Design Model (IHSDM) and SafetyAnalyst in the USA (developed by FHWA). The questions we need to ask are:

1) Do these packages provide the right type of tools that we require in NZ? (each of these packages has different applications and outputs) and
2) Can we customise these packages so that the outputs produced are of adequate quality to be of use to the local transport profession and will be accepted by decision makers?

This technical note briefly reviews the overseas packages that are available, what they can do and our opinion on whether they can be customised to NZ conditions. It then discusses what types of road safety tools we believe need to be available in NZ going forward so that we

1) Can improve the safety analysis of transport network changes, so that at the least the safety impact of schemes is maintained at current levels (Sustainable Road Safety) and
2) Focus on road safety problem areas and invest funding wisely so that safety improves over time.

## Overseas Safety-Analysis Software

Developed since the 1990's, IHSDM is a suite of evaluation tools for assessing the safety impacts of geometric design decisions (FHWA 2007a). The software (released for general distribution in 2003) has five modules. The policy review and traffic analysis modules do not have a direct safety function. The crash prediction module predicts the expected frequency of crashes on a road-way segment, based on geometric design and traffic characteristics. The alignment of the road can be inputted from design drawings in various formats. For existing road segments the software enables the crash history to be used in the crash prediction evaluation, by using the Empirical Bayes method.

The design consistency module helps diagnosis of safety concerns at horizontal curves. It provides estimates of the magnitude of potential speed inconsistencies between design speeds and likely operating speeds. The intersection review module has an expert system that diagnoses both existing and proposed intersection design deficiencies and recommends possible improvements. There is considerable potential for this package to be used by roading designers and transport professionals in

NZ. The software has a tool that allows it to be calibrated for each State in the USA. Research is currently underway to assess whether IHSDM can be calibrated to NZ conditions (Koorey 2006).

The SafetyAnalyst software has been designed to assist transport professionals in developing a targeted and cost-effective road safety improvements program for a transport network (FHWA 2007b). There are six main modules to the package, as shown in Figure 1. The software utilises the latest methods and research, including crash prediction models, results of 'before and after' studies of numerous improvement projects and the empirical Bayes method. The developers have made extensive use of expert panels to ensure the research used is of a high quality. To fill the gaps in knowledge there has been a number of studies on various countermeasures (see NCHRP 500 series). The remaining gaps in knowledge are being addressed in a new round of research studies.


Figure 1 – Safety Analyst Software Tools

The SafetyAnalyst software may be suitable for use in NZ. The limitation on its use is whether it can be adequately customised to NZ conditions. It is likely that some modules can be calibrated as with IHSDM, but others like the diagnosis tool (including crash collision diagrams) and economic appraisal tool may not be suitable, and analysis may need to be undertaken using NZ-specific tools. This can be determined once the software has been through beta tested and is released, hopefully later this year.

SafeNET is a software package to assist traffic engineers in the design of safer road networks in towns and cities. SafeNET provides a rapid assessment of the safety effects of potential network management changes, such as a change of intersection control or redistributed traffic volumes. Graphical and text outputs enable the user to see how such changes affect the crash frequency on the network. A network of road links and intersections can be graphically created within the program or data can be imported from certain traffic modelling packages, e.g. CONTRAM, SATURN. A range of road and intersection types can be chosen from, primarily in an urban context.

SafeNET implements a number of UK crash-risk models of various roading components (Burrow 1999). These allow crash frequency estimates to be made for individual elements of the road network (intersections and road sections) and the total network. An interesting aspect of SafeNET is the ability to model at a series of "levels" of complexity. The detail of inputs provided generally determines the detail and accuracy of outputs (i.e. crash types, vehicles involved), from flow data only to turning movements, geometric details, traffic composition, etc. By entering historical crash data, SafeNET can also modify crash predictions to take account of prevailing local conditions.

RSRM and NetRisk have been developed for use in Australia and NZ. Some of the research sitting behind both packages comes from NZ. The RSRM software is a relative risk tool that can be used to

1) Select and evaluate various safety countermeasures,
2) Undertake an economic appraisal of several improvements, and
3) Develop a prioritised program of improvements for several sites.

It therefore covers modules 3 through to 5 in the SafetyAnalyst toolkit. NetRisk has been developed as a network screening tool (i.e. module 1 of SafetyAnalyst); sections identified with high crash risk problems can then be investigated and prioritised using RSRM. However, our experience suggests that network wide analysis using RSRM would be extremely cumbersome.

In RSRM an evaluator enters data about one or more road sites and a number of improvement options are selected and evaluated. The limitation of RSRM is that it uses relative risk. It can indicate the decrease in risk (as a rating score) from a countermeasure, but not the expected number of crashes before and after treatment. Most NZ road safety engineers are more comfortable with crash predictions and crash rates, as they can check this with previous experience. This limitation is exacerbated by the subjective assessment elements of the analysis, some uncertainty about how to select options for some road types and the variable risk ratings produced when a group of trained road safety specialists evaluated the same sites (Durdin, 2007). RSRM is also limited by the quality of research that is available in NZ and Australia. For many road features and countermeasures, research from outside the region (USA and Europe) has had to be used and it is unclear whether this information is transferable. Just which information is used where is also unclear, as such information is not provided by the developers. Our experience with RSRM suggests it does some things such as road-side hazard evaluation, very well. However, there are better local procedures for other situations, and the relative risk outputs from RSRM preclude its use in conjunction with our approaches.

## New Zealand Road Safety Analysis Tool(s)

There are a number of potential applications of road safety analysis tools in NZ. These include:

1) Development of road safety improvement programmes
2) Risk mapping and performance assessments of existing urban and rural road networks
3) Evaluation of safety impacts of transport network improvements (e.g. capacity improvements)
4) Safety impacts of new developments

There are two specific areas that need to be covered. The first is a series of tools that can be used in the development of road safety programmes. The second is a series of tools that can be used to predict crash occurrence from an individual site through to an entire road network. In our opinion a suite of safety computer packages needs to be developed to do this. In a similar way that efficiency tools are available, ranging from SIDRA (for individual intersections) through to Transyt and TRARR (for road corridors) through to Paramics, Cube and EMME2 (for small to large road networks).

In both cases it is important that the tools are based on sound road safety research so that transport professionals can have confidence in the results. Where there are limitations in the road safety research, as is likely to be the case in this part of the world for the foreseeable future, this need to be highlighted to the user of the safety tools, in the output results (e.g. by presenting confidence intervals).

While there are a few tools already used in NZ for developing road safety programmes, including the Crash Analysis System (CAS), deficiency databases, various proprietary priority ranking tools and (to a lesser extent) RSRM, the SafetyAnalyst software does show promise as a much better safety analysis tool going forward. This tool is based on high quality research, which has been reviewed by a panel of experts, and uses the very latest techniques. Given the investment that has been made into developing this tool (and associated research), it is very unlikely that a similar product could be developed in NZ or in Australia. While some elements, such as the collision diagrams and economic appraisal are unlikely to be compatible, it is expected that the remaining components of the programme can be calibrated to NZ conditions and used. We would recommend that any decision to develop a NZ-based tool be delayed until the final version of this software is available and transferability issues are examined, including a discussion with FHWA on changes that could be made to the software.

Road safety tools for urban intersections up to full road network level are required for applications 2, 3 and 4 above. The tools need to take into account new roads and intersections, changes in the characteristics of those sites (e.g. speed limit and road cross-section) and changes in exposure (e.g. traffic volume), as may occur when a new development occurs. There is considerable research available on crash frequencies and rates at urban intersections, and to a lesser extent, urban mid-blocks, in the form of crash predictions models (e.g. Turner 2000, Turner and Roozenburg 2006a). It is desirable that a corridor crash analysis tool be developed for urban roads in NZ. Of the overseas products, only SafeNET appears to provide a similar tool. Such a tool could be used to predict the change in crashes on existing roads, be they the result of route improvements or new development traffic, and the crash frequency likely on new routes, based on design plans. Figure 2 shows the various 'site' components that would make up this tool. The urban safety prediction toolkit would be a composite of intersections (I) and mid-blocks (M) models. A basic prototype of the intersection tool has already been developed. It enables a crash prediction to be made from the volumes of traffic, cyclists and pedestrians at an intersection. Other variables, such as visibility, road layout and signal phasing need to be added to the prototype.

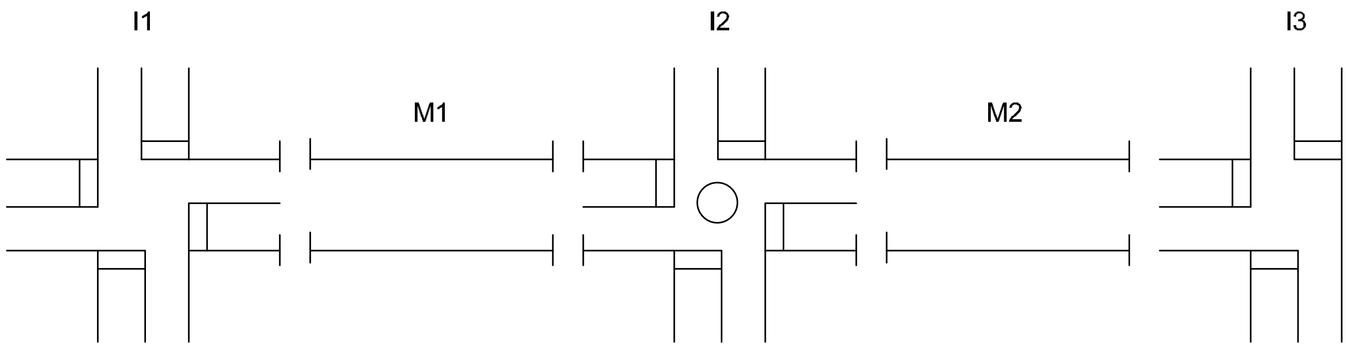


Figure 2 – Urban Safety Prediction Toolkit

The best option for urban networks may be to develop road safety modules for assignment models, such as Cube and EMME2. While such modules have been developed previously they are generally limited to a small number of variables, such as estimated traffic volume and 'link' types. To make these modules more useful it will be necessary to add in extra data, particularly cross-section, roadside environments and road alignment. This is particularly important for motorways.

The IHSDM software has the potential to provide a road safety tool for evaluating both rural road links and intersections in NZ. With crash models now available in NZ for rural intersections (Turner and Roozenburg, 2006b) there is the potential to develop a NZ tool for rural intersections, in a similar manner to the urban intersection models discussed above.

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