Road Safety Trends, Targets and Safety Programs in New Zealand

by Dr Shane Turner
New Zealand
Kiwi’s vs Aussies

[Images of New Zealand and Australia landscapes and symbols]
Outline

- Land transport organisations
- NZ & US crash/accident trends
- NZ safety targets & priorities
- Road Safety Auditing
- Road infrastructure safety assessment (RISA)
- Safety management systems
- NZ and Australia road safety toolkits
- Crash (Accident) prediction models
- Some recent projects
  - Rural intersection models
  - Roundabout Models
- Applications of models in Economic Evaluation
Land Transport Organisations

- Central Government
  - Land Transport NZ – funding, guidelines & research
  - Ministry of Transport – big picture (2010 RS targets)
- Regional Councils
  - Regional Transport Strategies
  - Regional Transport Committees
- Road Controlling Authorities
  - Transit NZ – State Highways
  - Local Authorities – District & City Councils
- Consultants – Opus, Beca & MWH
- Universities – Auckland & Canterbury
Trend in NZ Fatalities

FIGURE 1
ROAD DEATHS

Year

Deaths

Number of fatal crashes in last 20 years from 1986 to 2005

Number of crashes

Years

48% reduction
Fatal Indices

**Figure 2**
DEATHS PER VEHICLE AND PER CAPITA

- **Deaths/100,000 population**
- **Deaths/10,000 vehicles**

- **Per capita**
- **Per vehicle**

Year:
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000

Deaths: 0 to 30
Deaths per vehicle: 2 to 8
Trends in deaths per 100,000 population in NZ, USA and Canada

Years

Rate per 100,000 population
7 8 9 10 11 12 13 14 15 16 17

New Zealand
USA
Canada
Deaths per 100,000 population in NZ and Australia

![Graph showing the rate of deaths per 100,000 population in NZ and Australia from 1988 to 2004. The graph indicates a decrease in the rate over time, with a steeper decline for NZ compared to Australia.](image-url)
Worldwide Comparison

Fatalities (per 100,000 pop)

Source: OECD & IRTAD
Road Safety Strategy 2010

Aims
- To reduce road casualties to no more than 300 deaths and 4,500 hospitalisation a year by 2010.

Key priority area for action
- Engineering safer roads
- Reducing speed
- Combating drink driving
- Dealing with serious offenders
- Encouraging the use of safety belt
- Improving safety for pedestrians and cyclists
- Improving the vehicle fleet
- New and better targeted education initiatives.
Road deaths per 10,000 vehicles and 2010 target in New Zealand

![Graph showing the trend of road deaths per 10,000 vehicles from 1996 to 2011, with a steady decrease approaching the 2010 target.]
Road Safety Auditing

- Teams of 2 or more
  - Road safety engineers & designers
  - Lead auditor, auditors & observers
- Four stages
  - Feasibility
  - Concept Design
  - Detailed Design
  - Post-Construction/Pre-opening
- Introduced nationwide in early 1990’s
- Mandatory for government funding
Road Safety Auditing

- Existing road audits – Stage 5 audits
- Use detailed checklists
- Current developments:
  - Themed audits – delineation
  - Road-works site audits
  - Pedestrian and cycle focused
  - Development audits
Road Infrastructure Safety Assessments (RISA)

- Safety Assessment of sample of local council roads
- Removes subjective assessment of previous methods – where some key issues missed
- Current focus is on rural routes (to be extended to urban routes in 2 to 3 years)
Road Infrastructure Safety Assessments (RISA)

- Produces list of key issues that need to be addressed by local councils, such as:
  - Poor delineation
  - High number of roadside hazards
- Analysis uses crash rates and AMFs (in future CPMs will replace rates)
- Involves three day survey, overnight analysis and reporting to council
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<th>0 km</th>
<th>1 km</th>
<th>2 km</th>
<th>3 km</th>
<th>4 km</th>
<th>5 km</th>
<th>Length (km)</th>
<th>Exposure Risk</th>
<th>Relative Risk</th>
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**Figure 6 Cross Section Field Sheet**
Guidelines for developing a safety management system for road controlling authorities
Holistic Approach to Road Safety

Diagram showing three intersecting circles labeled Vehicle, Road, and Driver, alongside a triangle labeled Engineering, Education, and Enforcement.
Figure 1: Safety management system (SMS) structure
Safety Management Systems

- Based on systems developed by Railways and Aviation
- SMS are required to make sure that the safety systems are right and consistent. Examples:
  - Temporary traffic control systems (e.g. events)
  - Safety auditing of all schemes
  - Identifying and removing roadside hazards
  - Raising community awareness of Road Safety
  - Enforcement of traffic rules (e.g. speeding)
  - Communication between road safety partners
Desire to develop a ‘safety culture’ within local councils and within wider community

Need to make safety a focus at the ‘grass routes’ (Councils) if national safety targets (2010) are to be met:
- Adequate funding
- Adequate staffing
- Upskilling of current staff
Crash Reduction Studies in Auckland

- Focus on blackspots on State Highway and motorway (freeway) networks
- Annual study (monitoring) of sites
- Desktop analysis of crash trends
- Add and remove sites based on crash clustering
- Day and night-time inspections of sites
- Tracking and reviewing low cost road safety improvements
- Development of improvement programmes
Rural Black Route Studies (SHs)

- Identification of 10 worst performing rural road sections – by crash rate
- Target high crash rate roads using 3’E’; Engineering, Enforcement, Education
  - Improved safety engineering of the road
  - Comprehensive road safety education
  - Effective enforcement
- Formation of road safety task force
  - Transit NZ, Police, LTNZ local council, Road safety coordinators & Specialised road safety consultants
Accident Investigation Monitoring Analysis
Accident Monitoring Database

- Developed in late 1980’s
- Local councils and their consultants submit data forms on low cost safety projects
- Most projects developed in crash reduction studies and safety audits
- Analysis of sites by LTNZ/ LTSA after 5 years of after data
- Well over 1000 sites in database
Change in Accidents by Accident Type

- Turning "L" movements: -43%
- Turning "J" movements: -15%
- Rear-end / obstruction: -64%
- Pedestrian: ~
- Overtaking: -71%
- Merging: ~
- Lost Control (straight): ~
- Lost control (bend): ~
- Head-on (straight): ~
- Head-on (bend): ~
- Crossing: ~

Number of Accidents

After
Before

0 5 10 15 20 25
ARRB’s Safety Analysis Tools

- **Road Safety Risk Manager**
  - Windows based tool for selecting and ranking road safety improvements at a site
  - Uses relative risk before and after improvement compare with base-line road segment
  - Based on before and after studies including NZ data – accident monitoring database

- **NetRisk**
  - Network Screening Tool
  - Ranking of sites for treatment
Crash Prediction Models - Model Form

- Typical Multiplicative Form
  \[ A_T = b_0 Q_1^{b_1} Q_2^{b_2} \]

- Assume Crashes have a Poisson or Negative Binomial Distribution
Model Types - Disaggregation

- Disaggregate Crash Data
  - Intersection/link type
  - Crash type (e.g., LB - right-turn-against)
  - By time of day (e.g., AM Peak)
  - By city (e.g., Christchurch)

- Covariates
  - Location and features e.g.:
    - $A_{chch} = b_{01} Q_1^b Q_2^b$
    - $A_{wgtn} = b_{02} Q_1^b Q_2^b$

- Issues with Scarcity of Data
Accident Prediction Models (2000)

Example of Model Developed: Right-turn-against at Signalised Crossroads
Example of Model Developed: ‘Crossing’ at Signalised Crossroads
Example of Model Developed: ‘Entering vs Circulating’ at Roundabout Crossroads
Two Current Studies

- Rural & High Speed Intersections (Stop, Yield, Signals and Roundabouts)
- Urban Roundabouts
- Some results.....
## Rural Intersections - Sample Size

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<thead>
<tr>
<th>Region</th>
<th>Number of Sites</th>
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<tbody>
<tr>
<td></td>
<td>Crossroads</td>
<td>T-junctions</td>
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<tr>
<td>Auckland</td>
<td>16</td>
<td>15</td>
<td></td>
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<tr>
<td>Waikato</td>
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<tr>
<td>Bay of Plenty</td>
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<tr>
<td>Taranaki</td>
<td>23</td>
<td>9</td>
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<tr>
<td>Manawatu-Wanaganui</td>
<td>2</td>
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<tr>
<td>Wellington</td>
<td>7</td>
<td>2</td>
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<tr>
<td>Canterbury</td>
<td>33</td>
<td>34</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>101</strong></td>
<td><strong>100</strong></td>
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</tbody>
</table>
Variables

- Traffic Volume (movement & approach)

- Speed (mean and standard deviation)
Variables

- Visibility (to left and right & combined)

- Comparison with Austroad SD standard
- Right Turn Bay (discrete – large benefit)
- Others (lighting & control type)
Accident Prediction Models

- Rural Priority T-junctions
  \[ A = 5.29 \times 10^{-6} \times q_1^{1.33} \times q_5^{0.15} \times (V_{RD} + V_{LD})^{0.33} \]

- Rural Priority X-Roads
  \[ A = 1.20 \times 10^{-4} \times q_2^{0.60} \times q_5^{0.40} \]
  \[ A = 2.05 \times 10^{-4} \times q_2^{0.40} \times q_{11}^{0.44} \]
## Roundabouts - Data and Sample Size

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<td>Christchurch</td>
<td>Auckland</td>
<td>Palmerston North</td>
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<td>Single Lane Circulating</td>
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<td>3-arm</td>
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Variables

- Daily Traffic Volumes
Variables

- Speed and Visibility

- Multiple enter lanes ($f_{MEL}$) & circulating
## Accident Prediction Models

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Equation (crashes per approach)</th>
<th>Error Structure</th>
<th>GOF**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entering-vs-Circulating (Motor-vehicle only)</td>
<td>$A_{UMAR\ 1} = 6.12 \times 10^{-8} \times Q_e^{0.47} \times Q_c^{0.26} \times S_C^{2.13}$</td>
<td>NB (k=1.3)*</td>
<td>0.26</td>
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<tr>
<td>Rear-end (Motor-vehicle only)</td>
<td>$A_{UMAR\ 2} = 9.63 \times 10^{-2} \times Q_e^{-0.38} \times e^{0.00024Q_e}$</td>
<td>NB (k=0.7)*</td>
<td>0.25</td>
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<tr>
<td>Loss-of-control (Motor-vehicle only)</td>
<td>$A_{UMAR\ 3} = 6.36 \times 10^{-6} \times Q_a^{0.59} \times V_{10}^{0.68}$</td>
<td>NB (k=3.9)*</td>
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<tr>
<td>Other (Motor-vehicle only)</td>
<td>$A_{UMAR\ 4} = 1.34 \times 10^{-5} \times Q_a^{0.71} \times \phi_{MEL} = 2.66$</td>
<td>Poisson</td>
<td>0.17</td>
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<tr>
<td>Pedestrian</td>
<td>$A_{UPAR\ 1} = 3.45 \times 10^{-4} \times P^{0.60} \times e^{0.000067Q_a}$</td>
<td>NB (k=1.0)*</td>
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<tr>
<td>Entering-vs-Circulating (Cyclist circulating)</td>
<td>$A_{UCAR\ 1} = 3.88 \times 10^{-5} \times Q_e^{0.43} \times C_c^{0.38} \times S_e^{0.49}$</td>
<td>NB (k=1.2)*</td>
<td>0.61</td>
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<tr>
<td>Other (Cyclist)</td>
<td>$A_{UCAR\ 2} = 2.07 \times 10^{-7} \times Q_a^{1.04} \times C_a^{0.23}$</td>
<td>Poisson</td>
<td>0.50</td>
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Speed Relationship

- Impact of circulating speed on E vs C accidents – more benefits of reduction at higher speeds
Ongoing Research - Design Factors

- Alignment and Cross-section Data
Ongoing Research
Application - Economic Evaluation

- Economic Evaluation Manual – Appendix 6
  \[ A_W = w \times A_T + (1 - w) \times A_S \]
- Site Specific Accident Rate
  \[ A_S = \text{Accident History} \]
- Typical Accident Rate
  \[ A_T = b_0 \times Q_1^{b_1} \times Q_2^{b_2} \]
- Weighting for NB (0 < w < 1)
  \[ w = \frac{k}{(A_T + k)} \]
My Thoughts on Improving Road Safety in USA

- Place emphasis on safety auditing of new projects – learn from mistakes
- To raise profile of road safety need champions at all levels of Government.
- Road safety must be on politician’s agenda – use of advocacy groups – community not accepting current loss-of-life on roads
- Importance of safety management systems and development of safety culture – road safety committees at all levels
- Safety comparison of states and local councils