TRB Roundabout Conference,
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# Relationship between CAPACITY and DRIVER BEHAVIOUR

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## First an international journey of roundabouts …

## Roundabouts: Spain

No give-way (yield) line !





Capacity and Driver Behaviour

## Roundabouts: Paris, France

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## Roundabouts: Bodrum, Turkey






## An intersection: India's solution to the problem of pedestrians and cyclists at intersections

## A roundabout in Australia




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## Roundabout after deluge: Melbourne, Australia …

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# Roundabouts: Montreal, Canada

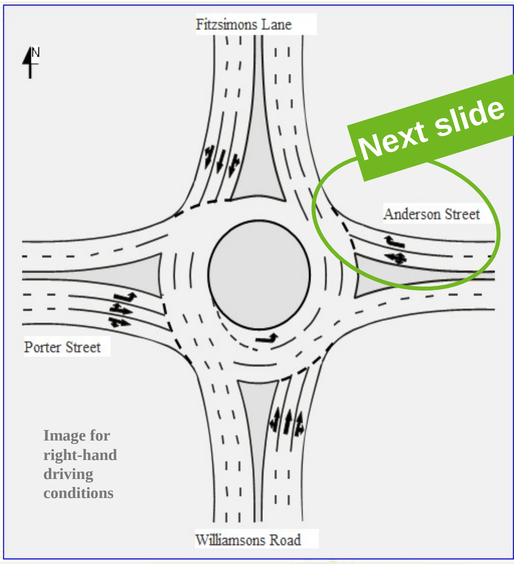

Lane utilisation !






## Fitzsimons Lane - Porter St Roundabout, Melbourne, Australia

Using SIDRA INTERSECTION, Vic Roads engineers redesigned a highly congested two-lane roundabout in Melbourne as **a three-lane roundabout eliminating persistent congestion.**



## Lane use at roundabouts: Australia

Not for approach-based models !







## UK Roundabouts: Flare and lane use !!

Effectively single lane !

Empty lane !

## UK Roundabouts: Continuous lane without kerb

Drivers avoid this circulating lane resulting in upstream approach lane underutilisation !






## UK Mini-roundabouts

1 in 20 drivers went around the island: effectively 4-way yield !

## This paper

- Analytical models use **capacity** as a basic parameter in traffic performance estimation. Traffic characteristics that affect capacity are not often clearly explained or understood. This causes **difficulties** in practice when professional judgement has to be used in **interpreting output** and **calibrating models** for specific applications.

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## This paper

- There is also a need to establish relationships between traffic parameters used in **analytical** models and **microsimulation** models. In this context, **gap-acceptance parameters** are very important in modeling roundabouts using these two types of models.

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## This paper

- A general analytical model is given to provide a common formulation relating **key variables** in intersection analysis to various **driver behaviour (driver-vehicle) characteristics**. These key variables are:
  - **follow-up headway** for gap-acceptance situations (roundabouts, sign control, and filter / permitted turns at signals), and
  - **saturation flow rate** for signalised intersections.






**CAPACITY:** a common formulation for **signalised** and **unsignalised** intersections (including **roundabouts**)

$$\text{Capacity} = u \times s = u \times 3600 / (t_r + L_{hj} / v_s)$$

$u$ = proportion of time when the vehicles can depart from the queue:

- signals are green ($u = g / c$), or
- gaps are available

$s$ = saturation (queue discharge) flow rate.

## Queue discharge headway, $h_s$ (follow-up headway in gap-acceptance, $t_f$)

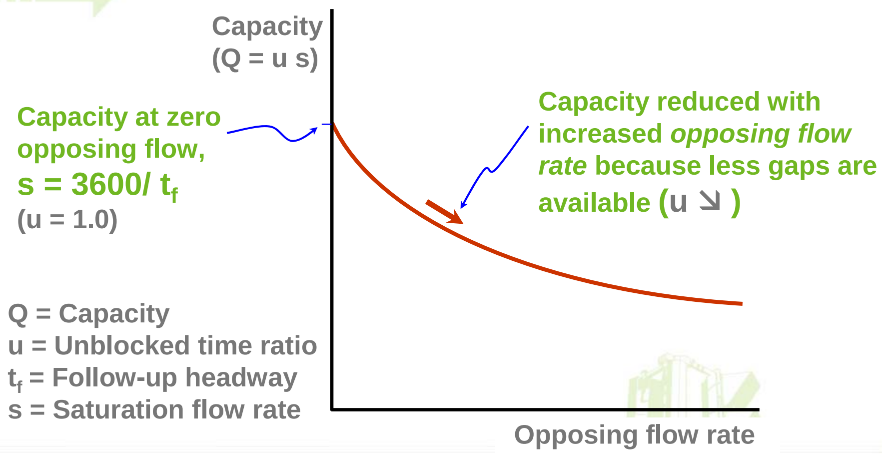
$$h_s = t_r + L_{hj} / v_s$$

- $t_r$ = **driver response time** during queue discharge (seconds)
- $L_{hj}$ = jam spacing (m or ft)
- $v_s$ = saturation speed (m/s or ft/s)
- $s$ = saturation flow rate (veh/h)






## Gap-acceptance capacity



## For example:

**Follow-up headway: $t_f$ = 3.0 seconds**

**Saturation flow rate = 3600 / 3.0 = 1200 veh/h**

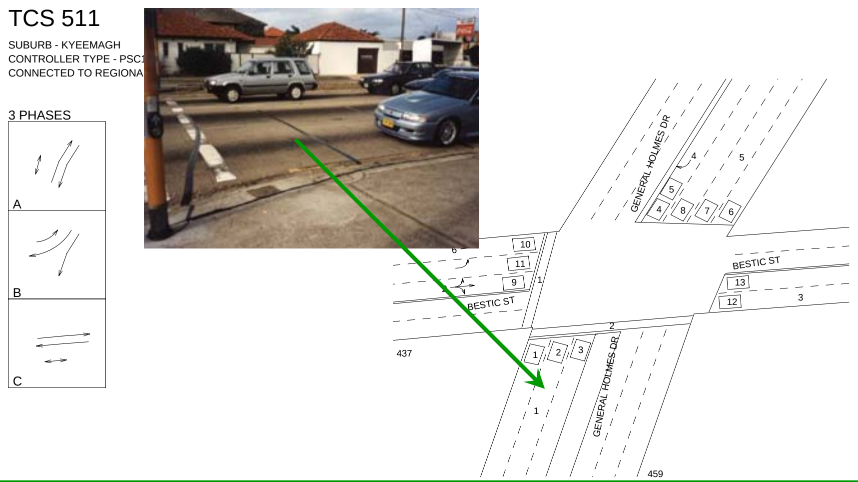
**Proportion of time available: u = 0.50**

**Capacity = 0.50 x 1200 veh/h= 600 veh/h**

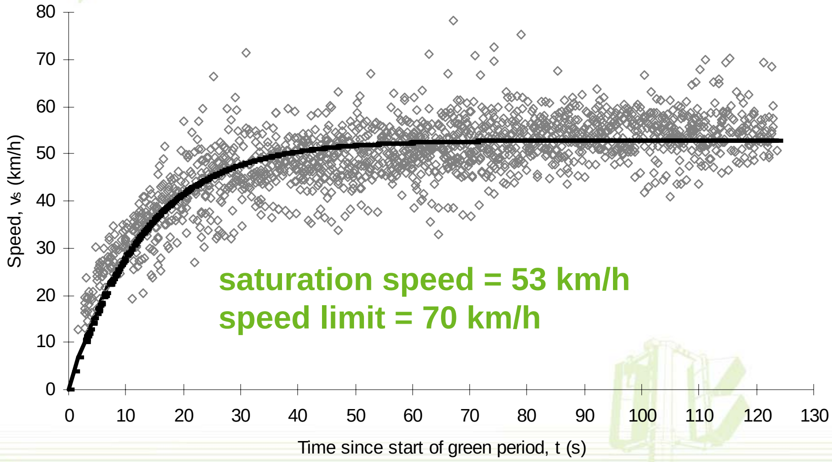





## At signalised intersections



## Queue discharge speeds:
### General Holmes Dve and Bestic St, Sydney (through traffic lane)







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## At signalised intersections

| Site | s (veh/h) | $h_s$ (s) | $v_s$ (km/h | $L_{hj}$ (m) | $t_r$ (s) |
|---|---|---|---|---|---|
| Sydney Site | 2278 | 1.58 | 52.8 | 6.6 | 1.13 |
| Average Through | 2083 | 1.73 | 45.1 | 6.9 | 1.17 |

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## Application to roundabouts: an example

- A **one-lane roundabout** with a central island diameter of **20 m** (66 ft), circulating road width of **8 m** (26 ft), and flow rates of 200 veh/h with no heavy vehicles for all movements (hence all circulating flow rates = 600 veh/h) was analysed using **SIDRA INTERSECTION**. The software estimated:
  - follow-up headway of $t_f = 2.34$ s
  - negotiation speed of 26.2 km/h (16.3 mph), hence $v_s = 7.3$ m/s (23.9 ft/s).






## Example continued: driver response time

- Using a jam spacing of $L_{hj} = 10$ m (33 ft), the **driver response time** was determined as $t_r = 0.97$ s.

  (not too different from those observed at signalised intersections)

## Example continued: HCM version

- When an Environment Factor value of 1.2 (default in the HCM version of SIDRA INTERSECTION) is used for the above example, the software estimated $t_f = 2.86$ s (instead of 2.34 s).

  Using a jam spacing of $L_{hj} = 10$ m (33 ft), a driver response time of $t_r = 1.49$ s is found (instead of 0.97 s).

  Thus, about 0.5 s increase in the follow-up headway value is attributed to the longer driver response time for US drivers. Hence lower capacities for US roundabouts.






## Example continued: longer vehicle

- If a longer vehicle length is assumed resulting in a longer jam spacing, e.g. $L_{hj} = 11$ m (36 ft), a driver response time of $t_r = 1.35$ s is found.

  In this case:

  - about 0.4 s of the 0.5 s increase in the follow-up headway is attributed to the driver response time and
  - about 0.1 s is attributed to the longer vehicle length.

## In conclusion

- The formula given provides a direct relationship between capacity and parameters representing driver behaviour, namely:
  - driver response time during queue discharge,
  - spacing between vehicles in the queue (jam spacing), and
  - saturation (queue discharge) speed.






- The relationships given in this paper provide a link between analytical and microsimulation models.

  This could help to improve compatibility between microsimulation methods and established analytical techniques used in traffic engineering practice, and to improve the practical usefulness of microsimulation tools through better model calibration and verification.

- Research is recommended on:
  - calibration of the relationship presented in this paper using field studies of many different traffic situations, and
  - investigation of driver and vehicle parameters used in various microsimulation software packages (how do they compare with the values given in this paper?).




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End of Presentation

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