Traffic flow and driver behaviour

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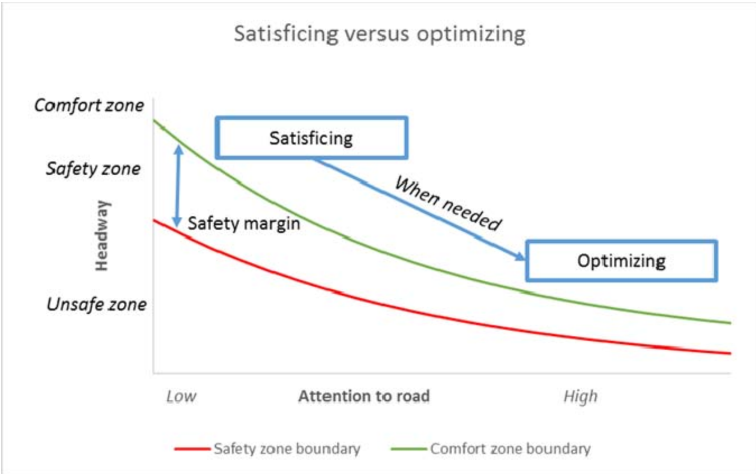
Outline of the presentation

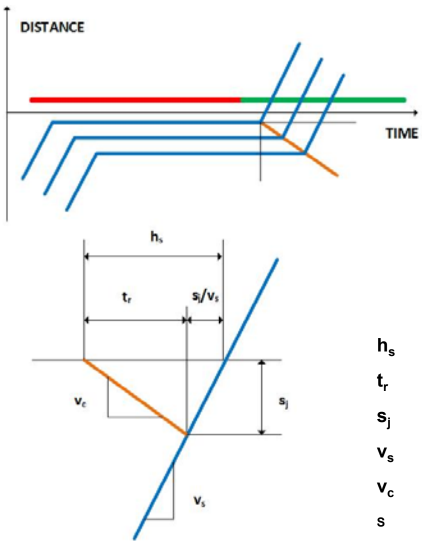
- Introduction
- Driver behavior and efficiency
- Saturation flow rate at traffic signals
- Driver behavior – competition or cooperation ?
- Cooperation at roundabouts
- Merging, diverging and weaving
- Discussion

Driver behaviour and efficiency

- Driver behaviour is an important factor to increase capacity when needed
- Driver assistance systems might increase attention, safety and efficiency



Saturation headway and saturation flow rate – model 1

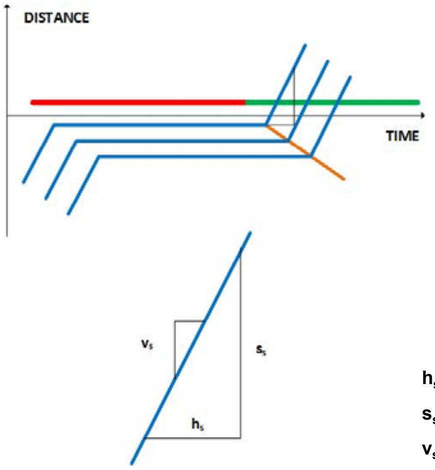


$$h_s = tr + \frac{s_j}{v_s}$$

$$S = \frac{1}{h_s}$$

	Parameter	Typical value
h_s	Saturation headway	1.8 - 2.0 sec
t_r	Queue dep. reaction time	1.0 - 1.5 sec
s_j	Jam spacing	7 - 10 m
v_s	Saturation speed	40 - 60 km/h
v_c	Queue clearance wave speed	20 - 30 km/h
s	Saturation flow rate	1800 - 2000 veh/h

Saturation headway and saturation flow rate – model 2



$$h_s = \frac{s_s}{v_s}$$

$$S = \frac{1}{h_s}$$

	Parameter	Typical value
h_s	Saturation headway	1.8 - 2.0 sec
s_s	Saturation spacing	20 - 30 m
v_s	Saturation speed	40 - 60 km/h
s	Saturation flow rate	1800 - 2000 veh/h

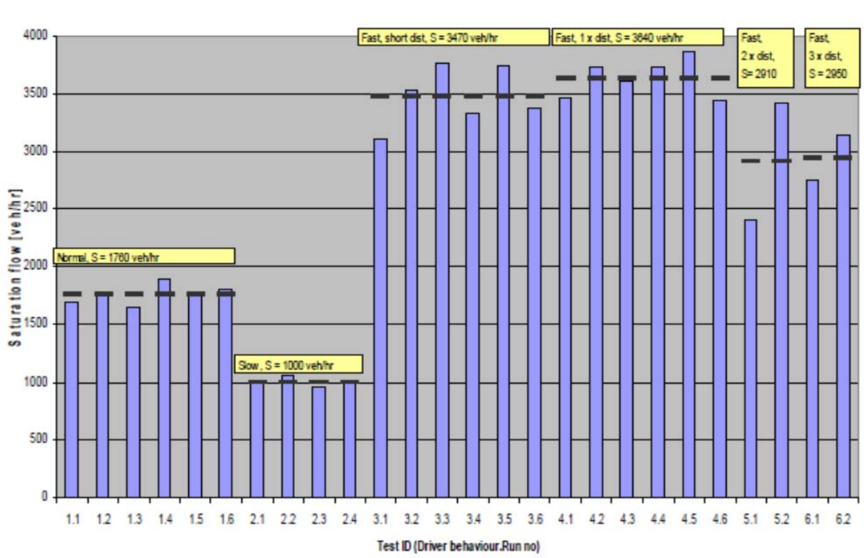
Example from Trondheim

Experiments – field trials at a closed track

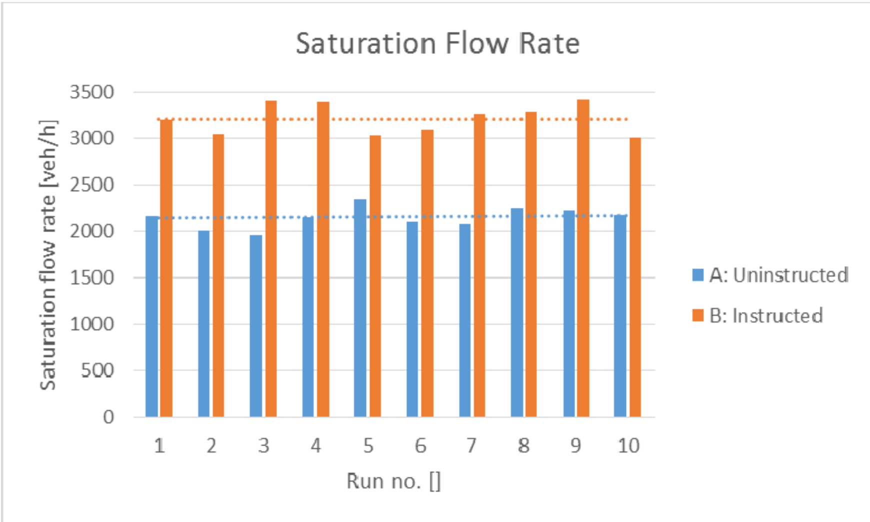
2016 Hell Motor Arena
- 22 cars
- 20 runs
- 2 different scenarios

1999 Tiller
- 10 cars
- 26 runs
- 6 scenarios

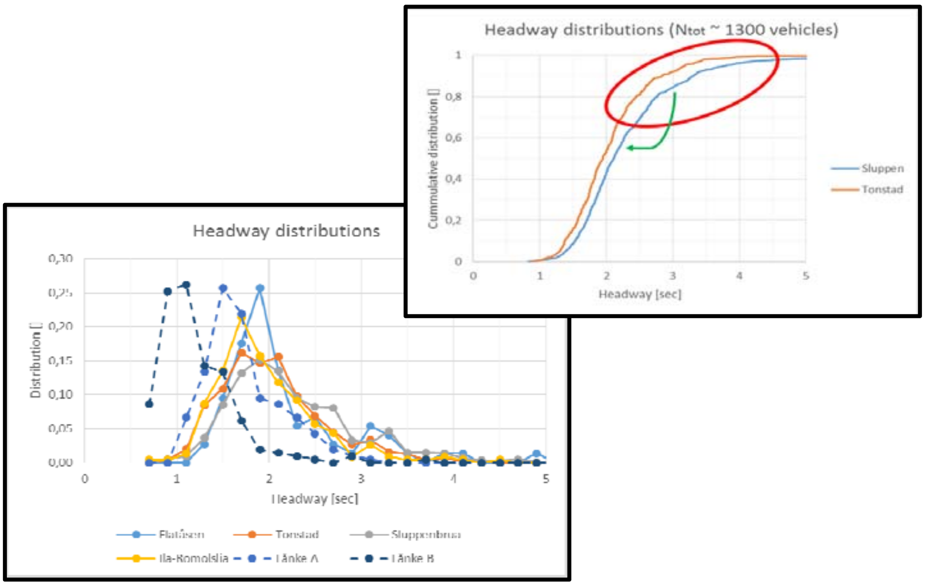
Results 1999 – Finding the limit for efficency



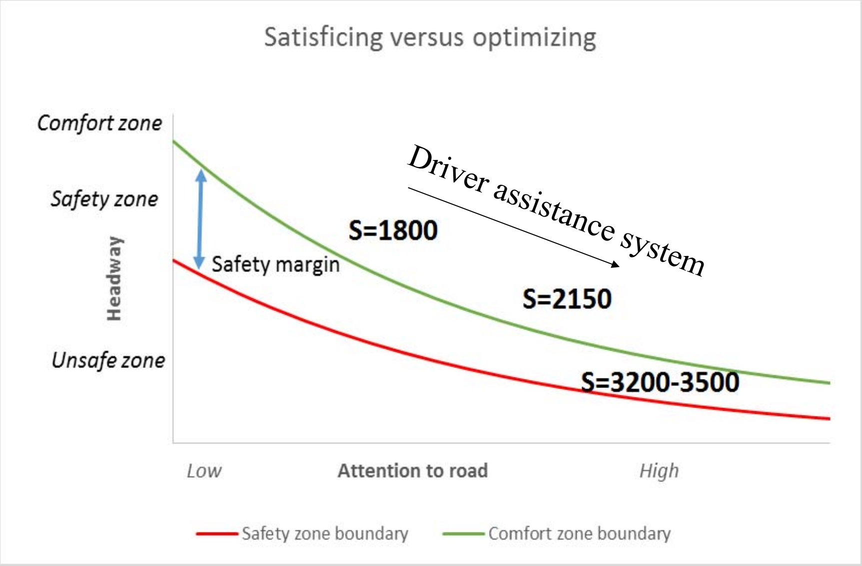
Results 2016 – Saturation flow rate



Observed headway distributions



Satisficing or optimizing?



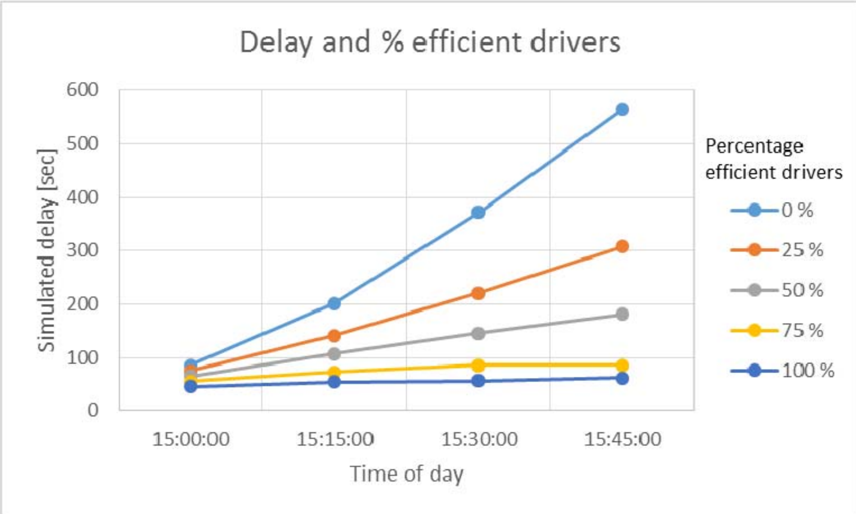
How does driver behavior affect delay?

Example from Trondheim

Aimsun micro simulation

100 replications

How does driver behavior affect delay?



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Traffic flow at bottlenecks

In the active bottleneck:

- Driver attention
- Increase capacity
- Minimize lost time

- 20-30 % capacity increase is feasible, just from driver behavior

- Use driver assistance system?

Upstream intersections with Downstream Flow Restrictions:

- Distribute priority
- Minimize delays for those not heading for the bottleneck
- Minimize stress and aggression

- Green time is not optimal for distributing priority in DFR conditions!

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Conclusions – driver behavior and efficiency

- Driver support systems can provide assistance based on position and traffic conditions
- Experiments have shown that there is a great potential for enhanced driver behavior
- Doubling throughput is possible (with maximum effort)
- Efficiency gains of 20 % may be obtained without drivers leaving the comfort zone, and without sacrificing safety margins
- Simulations have shown that such efficiency gains lead to significant delay reductions
- The challenge is that your willingness to be efficient leads to reduced delays for those following you. There's no immediate reward …

Road traffic - Competition or cooperation?

Competition has been shown to be useful up to a certain point and no further,

but cooperation, which is the thing we must strive for today,

begins where competition leaves off.

Franklin D. Roosevelt

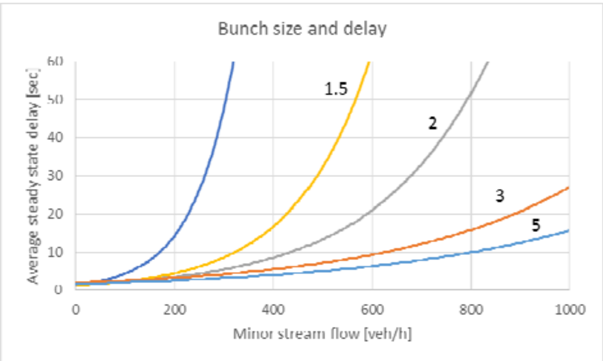
If you want to make peace with your enemy, you have to work with your enemy.

Then he becomes your partner.

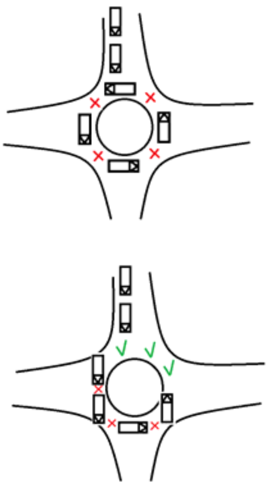
Nelson Mandela

Cooperation in roundabouts

Affecting gaps offered to yielding drivers



Adapted from figure 8.14
Revised Monograph on traffic flow theory
Chapter 8: Troutbeck and Brilon (2001)

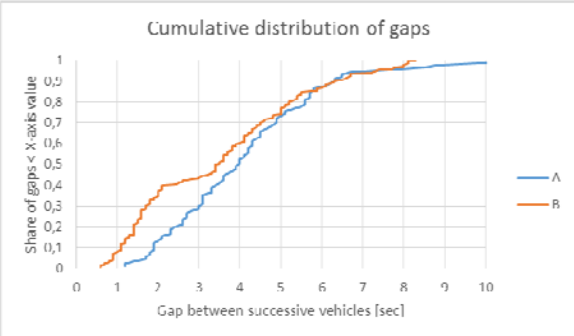


Results - Roundabout

	A	B
Critical headway [sec]	3,75	3,67
Critical gap [sec]	2,95	2,87
Follow-up headway [sec]	2,19	2,02

Delay per lap	Experiment 1 A	Experiment 2 A	B < A?
Average [sec]	72	49	Yes
Confidence interval	67-77	45-53	

Experiment	Circulating flow [veh/h]	Capacity for entering flow [veh/h]	Total
A	726	597	1323
B	840	668	1508
A/B	1,16	1,12	1,14



Zipper merging

- All merging of traffic movements in Norway is done as zipper merging
  - Lone drop from 2 to 1 lane
  - Entry to a main road with acceleration lane
  - Other merging situations
- The lanes have equal rights; 50/50 priority
- The merging should be made within a certain area

Cooperative zipper merging

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Uninstructed vs Instructed Zipper Merge

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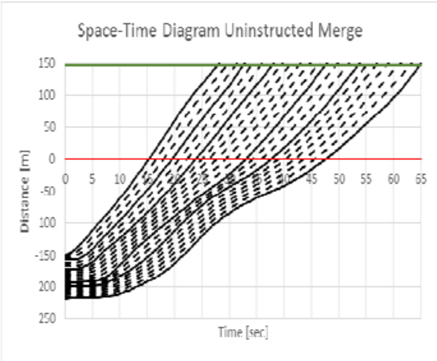
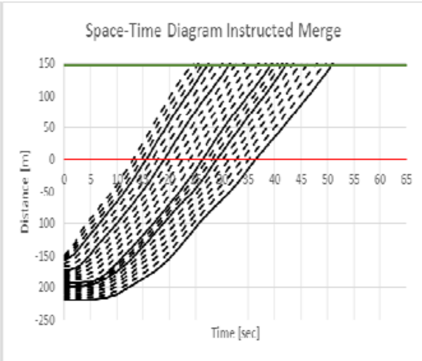
Results zipper merging





	Experiment 2 A		Experiment 2 B		
Distance from merge point [m]	Mean flow rate [veh/h]	Confidence interval (95 %)	Mean flow rate [veh/h]	Confidence interval (95 %)	B > A α = 5 %
-150 (2 lanes)	3357	2845-3870	3372	3240-3503	No
0 (1 lane)	2380	2027-2732	3490	3172-3807	Yes
150 (2 lanes)	2047	1906-2188	3272	3010-3535	Yes

Conclusions

Cooperation in traffic seems to

- Lead to more favorable gap distributions
- Slightly reduce critical gap and follow-up headway
- Increase capacity
- Reduce delays

Observed effects:

- Capacity increases of 20-30 % were obtained without sacrificing safety
- Drivers tend to understand the instructions given to them, and they are also capable of turning advice into behavior change
- By cooperating, instead of competing, “everybody” wins
- The challenge is that your willingness to cooperate leads to reduced delays for those following you. There’s no immediate reward…

Thank you for your attention

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