



# Evaluating ADA technologies in the Netherlands by means of demonstration projects and micro-simulation modelling

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# OVERVIEW and goals of FOT

- Research project aimed at assessing LDWA, LKS and CA
- Increase knowledge of risk and success for deployment of lateral control
  - Effect on safety and traffic flow
  - Acceptance and consensus
  - Infrastructure consequences
  - Relation with other developments
- Phase 1, field trial with LDWA and simulator study
- Assess primary and secondary impacts of CA on traffic flow and throughput in NL

# What are CA systems

- Development within European Chauffeur-2
- Combines LKS and SDK (ACC)
- LKS tracks lateral position and provides active feedback
- SDK based on ACC that monitors relative speed and distance to leading vehicle
- Takes into account dynamic capabilities of other vehicles and
  - Recognises target object
  - Keeps the shortest gap
  - Warns for stationary objects
  - monitors

# Components of DECA evaluation

- Literature Review
- Driving simulator study
  - To build a test environment with a truck simulator
  - To use experienced drivers to test CA under various conditions
  - To adapt and calibrate the driver model used in micro-simulation
- Traffic simulation model
  - To modify the driver and vehicle models in the programme
  - To simulate various traffic conditions under different rates of CA penetration

# Findings Literature review

- Large scale ADA implementation unlikely before 2020
- Development of technology is autonomous and governments need to ensure watchdog role
- High levels of ACC penetration negatively impacts traffic flow and safety
  - Interaction between ACC and non-ACC is problem
- Acceptance of ADA technology varied but growing (AICC)

# Driving simulator study

- Driving simulator based on a DAF95 XF on a moving base
- ACC installed with settings of 1; 1.3 and 1.5 s and max. deceleration of  $3,0\text{m/s}^2$
- LKS based on info. From D-C
- 18 drivers with 5 years experience
- Within subjects design, each driver test trip and 4 trips (4 conditions with 2 ind. Variables)
- Drivers select own headway setting; leading traffic brakes unexpectedly on normal freeway
- Data incl speed, lateral pos.; steering wheel angle, time, speed of other traffic, CA state etc



# Driving simulator study (2)

- Rating scale mental effort to test acceptance
- ANOVA tests on dependant variable using volume and CA state as independent variable
- Intended lane changes not included in analysis
- Drivers instructed when to activate CA although possible to temporarily deactivate – these data also excluded



# Driving simulator results

- Majority of drivers selected headways of 1,3 and 1,6 seconds
- CA active for > 84% of trip time
- Interaction between traffic volume and CA state had no effect on avg. Speeds
- Std dev of speed smaller with CA on
- More time in right lane when CA on and more so at lower volumes
- No. Of lanes changes fewer when CA is on
- No significant difference in mean lateral position (more to centre with CA on)

# Driving simulator results (2)

- SDLP indicates effort to keep a straight line over time
- SDLP significantly reduced with CA on (drivers swerve less)
- The avg. SDLP with CA off higher than normal
  - Simulator environment (size, effort)
  - Dynamic behaviour of model
- Minimum TLC (risk measure) significantly higher with CA on
- One third of min. TLC less than 1s and not affected by CA state

# Driving simulator results (3)

- Upward of 60% of trip at headway  $< 5s$
- Prop. Of time spent at headways  $< 1s$  significantly higher with CA off
  - CA on has setting of more than 1s therefore prop time below due to cut in
- Average headways between 2,6 and 2,9s
- 216 Incidents with unexpected braking analysed
  - 35% change lane when lead vehicle brakes hard
  - 20% change lane when lead vehicle brakes
  - Seems than CA gives driver confidence – not necessary to change lanes as emergency manoeuvre

# Driving simulator results (4)

- No significant diff. In maximum deceleration with CA on or off (higher with CA off)
- Traffic volume has no significant effect on the perceived mental effort (RSME) but CA state does
- RSME significantly lower with CA on
- Drivers rate driving task as reasonably strenuous with CA off and slight with CA on

# Traffic simulation study using MIXIC

- Driver model in Mixic adapted to reveal interaction between CA and driver (lane changes braking etc)
- Two penetration scenario (0 and 100%) at two traffic volume regimes modelled (4 cases)
  - Total of 40hours of data per case
- MIXIC is stochastic model using distributions and random numbers of driver and vehicle characteristics and produces various output
  - Traffic safety (shockwaves, conflicts, headways, TTC etc)
  - Traffic flow (speed, capacity, traffic volumes etc.)

# Simulation results

- If HGV represent 10-20% of all traffic and are all equipped with CA there will be NO significant affect on traffic flow and capacity.
- Indirectly this implies no affect on traffic safety
- No of shockwaves decrease if all HGV have CA (possibly due to fewer overtaking manoeuvres)
- The spread of headways in the slow lane increases if all HGV have CA (broader range in following times)

# Conclusions

- No negative traffic effects of use of CA in HGV sector on primary roads
  - No significant changes in terms of traffic flow, safety
  - Effectiveness of CA possible if the system application were extended (e.g., to passenger vehicles, extension of functionality to include stop&go)
- Drivers indicated perceived workload decreased with CA use
  - Possible compensating behaviour not investigated