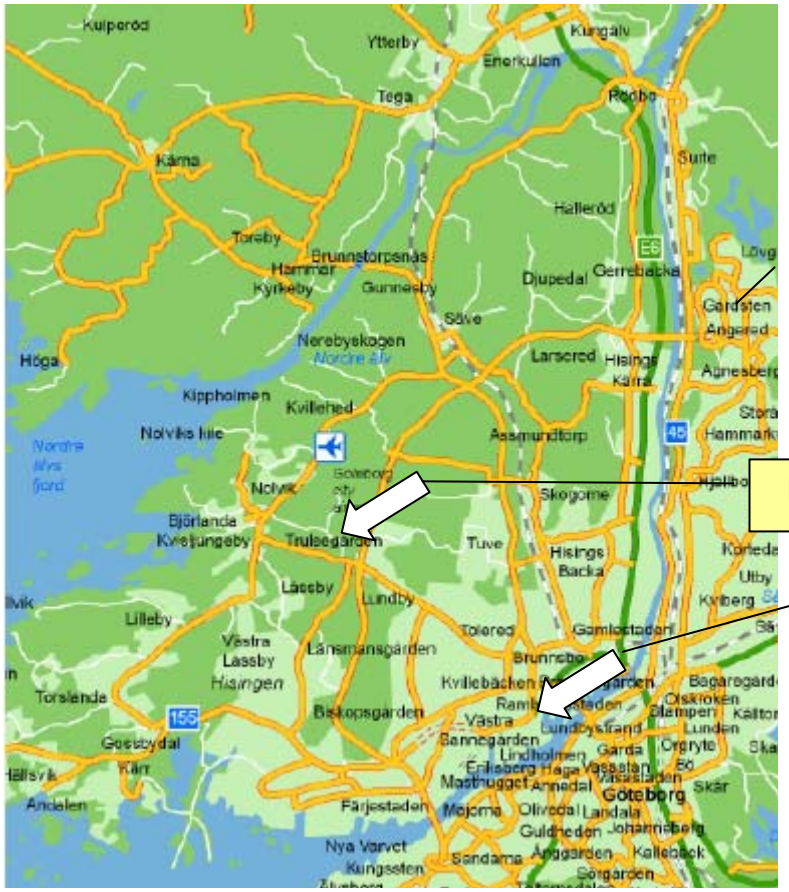
Evaluation of the VOLVO Truck Demonstrator

VTI/VTEC

Experimental design - route

- Urban (50km/h) and interurban (70/90 km/h) road – approx 40 minutes drive
- Same route all drives, location of UC triggering predetermined – same for all cases
- Rush hours avoided
- Training of in-vehicle systems and tasks preceded the drive
- Start and end at VTEC



Experimental design – the vehicle

Speech microphone

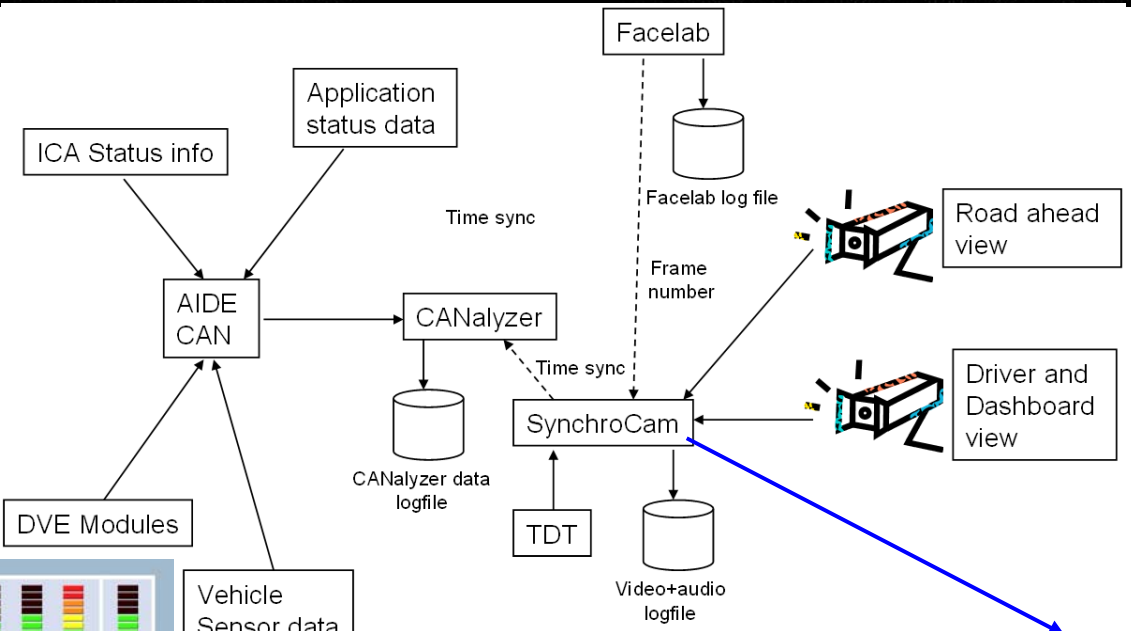
Nomad phone

Experimental design – 8 Use Cases

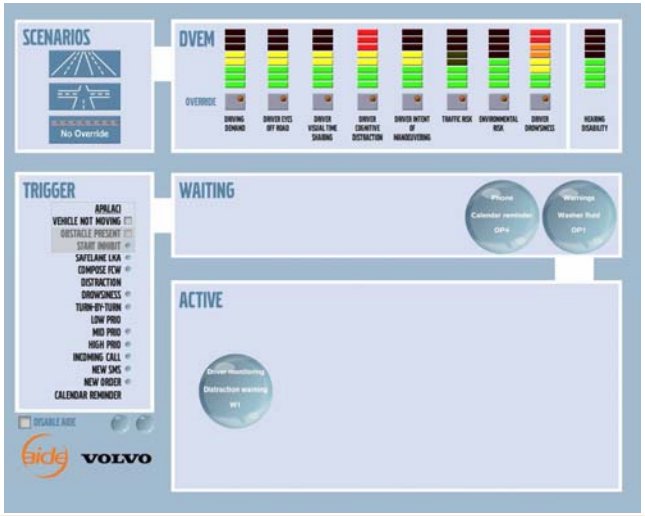
Demonstrator use case group	Use Case	AIDE	Non-AIDE
Rescheduling to resolve channel conflict	Driver looking for vehicle state information – incoming message (UC5)	Message delayed	Message not delayed
Rescheduling to resolve workload conflict	Intersection with traffic light – incoming phone call (UC7)	Phone call delayed	Phone call not delayed
Output form modification to resolve between channel conflict	Reading SMS – warning message (UC9)	Visual + voice	Visual + sound
Output form modification to resolve workload conflict	Intersection driving demand – warning message (UC8)	Visual + voice	Visual + sound
Output form modification to resolve inattention conflict	High cognitive workload – warning message (UC10)	Visual + voice	Visual + sound
Nomadic device integration	Incoming phone call, out going phone call, MP3 song (UC2,3,4)	Integrated HBK + SID	Handheld phone

All UC were repeated 2 times – in total 16 tasks/drive

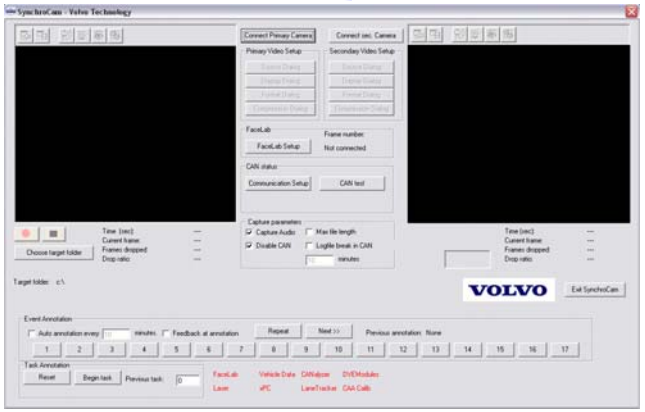
Experimental design – triggering and data logging



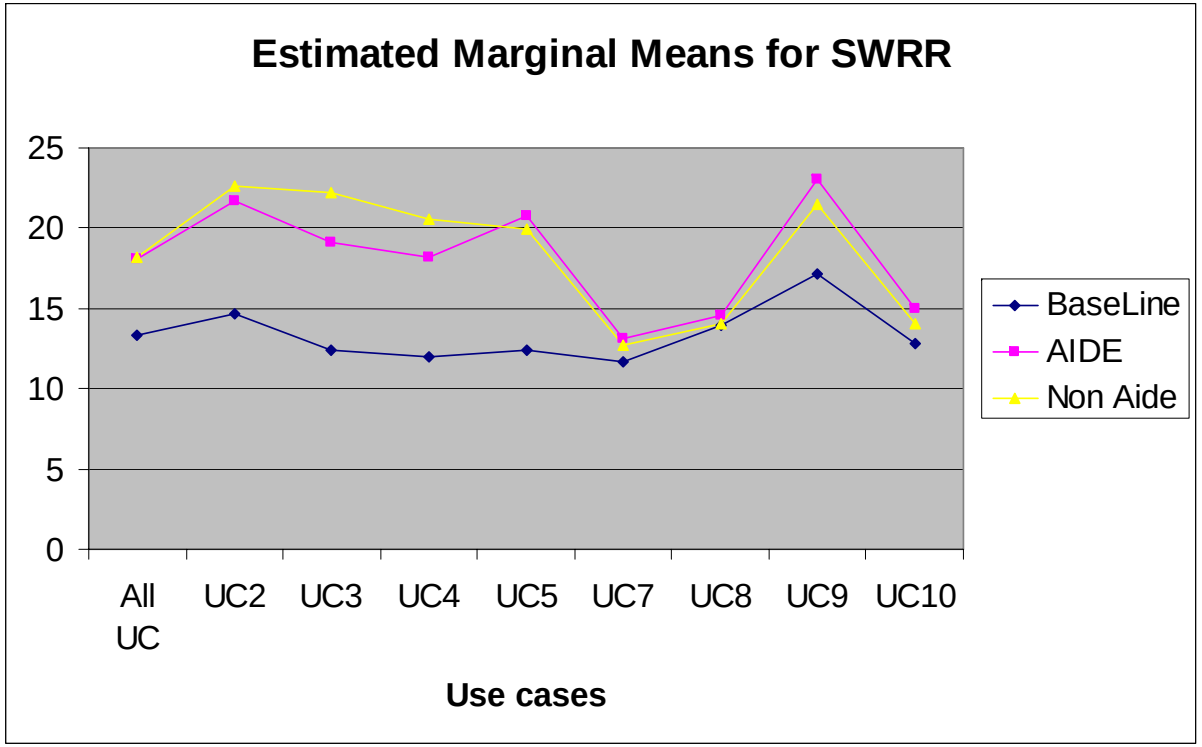
Supervision of DVE state and UC triggering



Supervision of data logging and task annotations



Objective data - SWRR



SWRR
- Gap size = 3
- LPF = 0.6 Hz

- Higher Visual WL for A and NA in total and for all UC except 7,8 and 10
- Higher for NA v. A for UC3 (phone out)

Objective data – Speed Control

- Mean speed lower for NA and A vs. BL – total of all UC
- Mean speed was lower for NA vs. BL for all UC (individually) except UC2, 9
- Mean speed was lower for A vs. BL for UC4

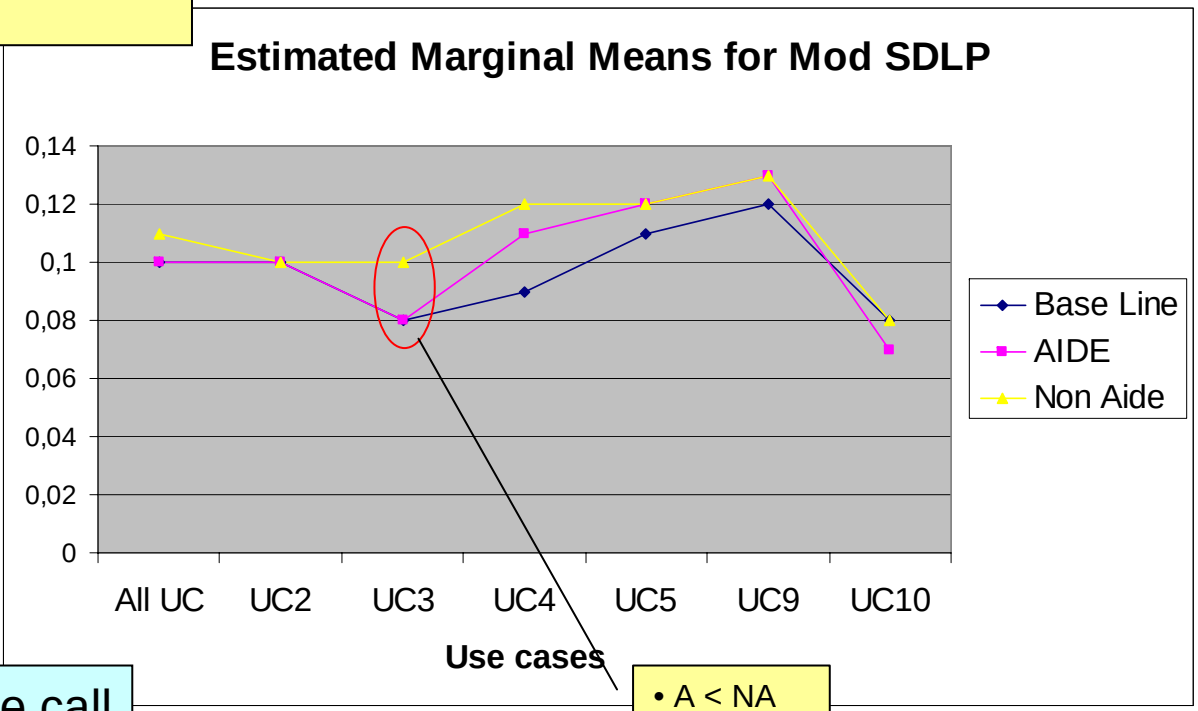
- Max speed few significant differences (NA lower vs. BL in UC3,4,5)

- Sd speed higher for NA and A vs. BL – total of all UC
- Sd speed higher for NA and A vs. BL in UC4 and 9
- Sd speed higher for NA vs. A in UC2

- Conclusion: Lower speed and higher Sd speed in A and NA vs. BL

Objective data - Lateral Control

- Poor lateral data in many cases
- MSDLP, LC
- Very few differences only MSDLP
- TLC not feasible



- UC 3 Making a phone call

- A < NA
- BL< NA

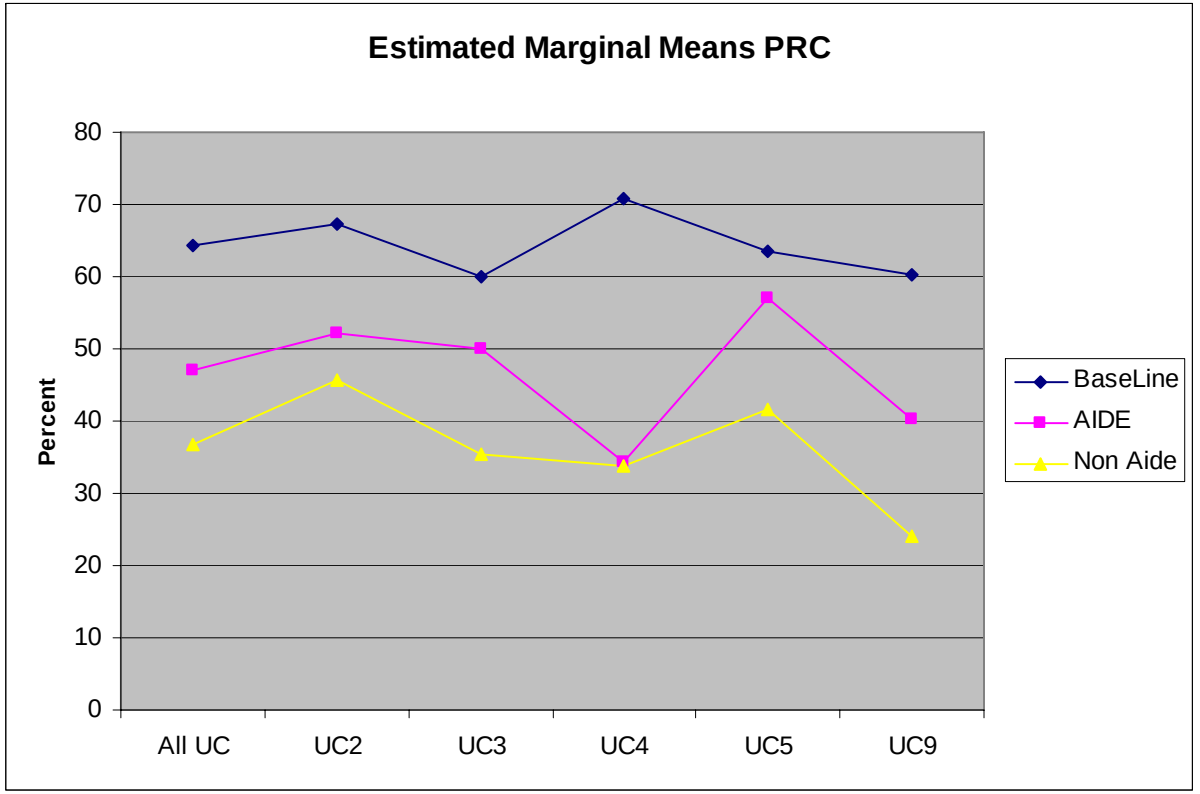
Objective data – Eye Gaze data

- FaceLab – 2 camera system
- VDM tool for analysis
- Metrics – PRC, GF, TGT
- Only UC 2, 3, 4, 5 and 9

- NA < BL for All UC (total), all UC (individually)
- A< BL for All UC (total), all UC (individually) except UC5
- NA < A for All UC (Total), all UC (individually) except UC4

Aide helped the drivers to keep their eyes on the road

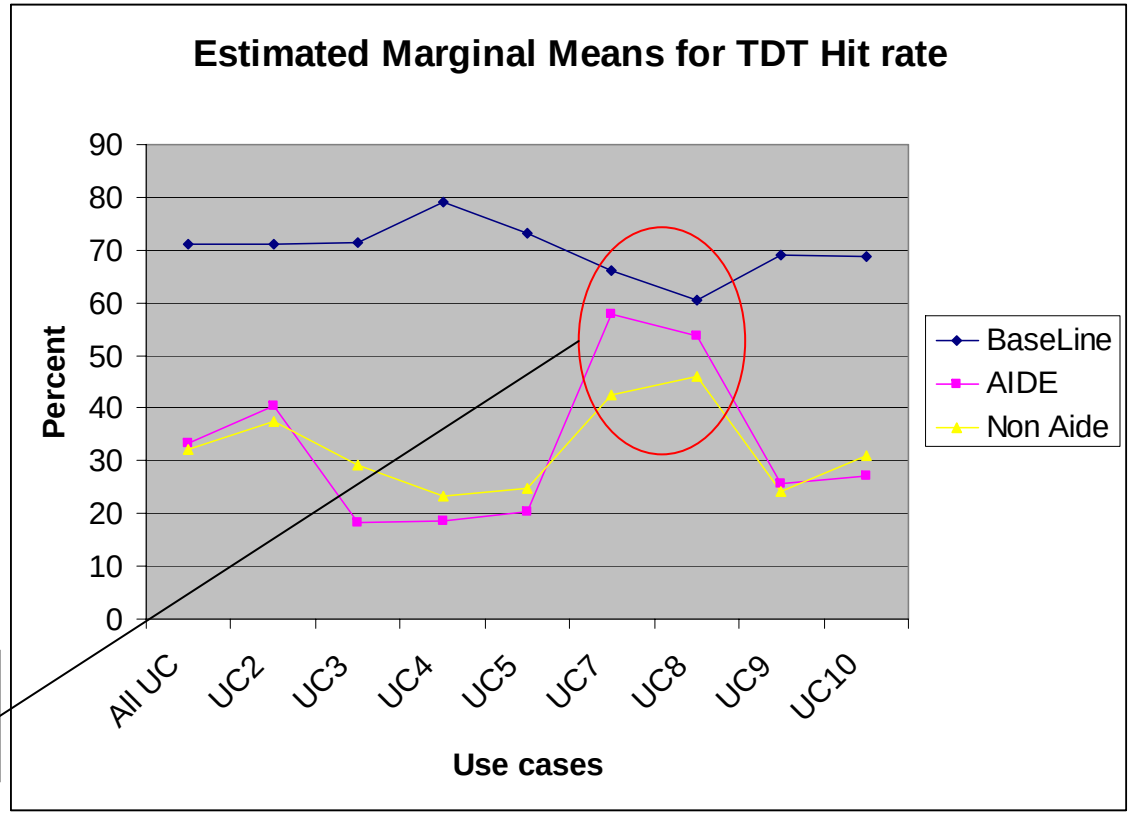
Percent Road Centre



Objective data – TDT Hit Rate

- Hit rate lower for NA vs. BL
- Hit rate lower for A vs. BL except UC 7, 8
- Hit rate higher for A vs. NA UC7

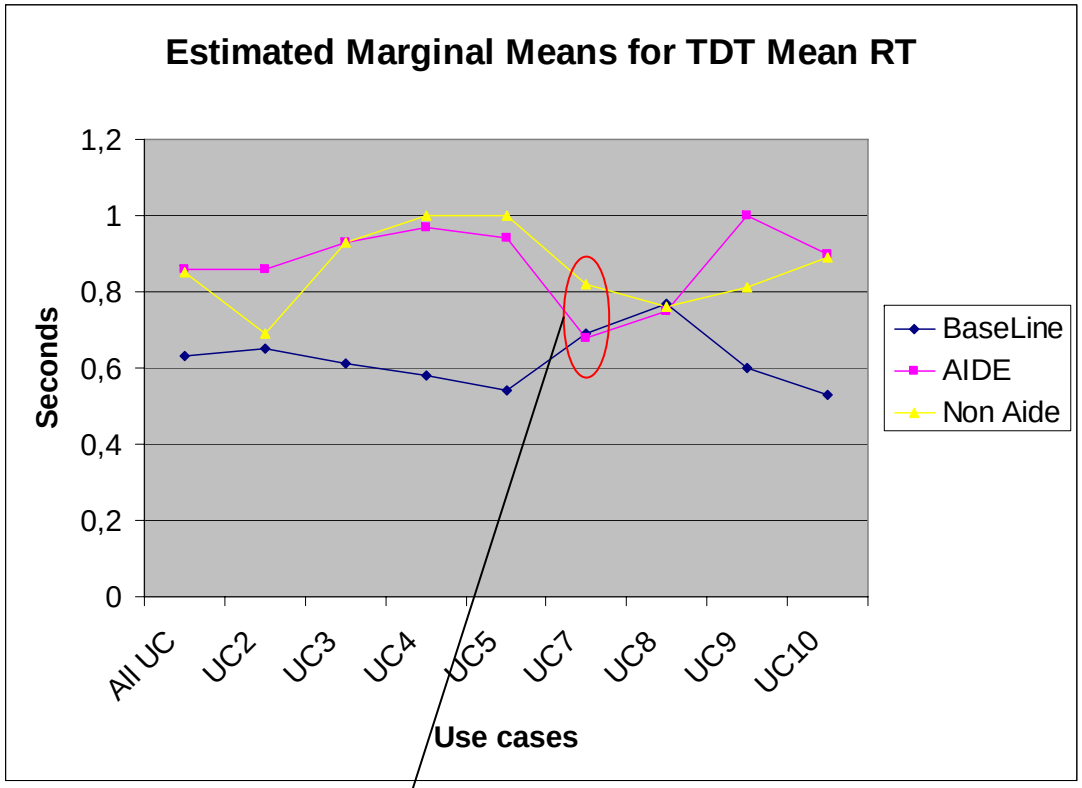
- UC7 Delayed phone call
- UC8 Message at intersection



Objective data – TDT Reaction Time

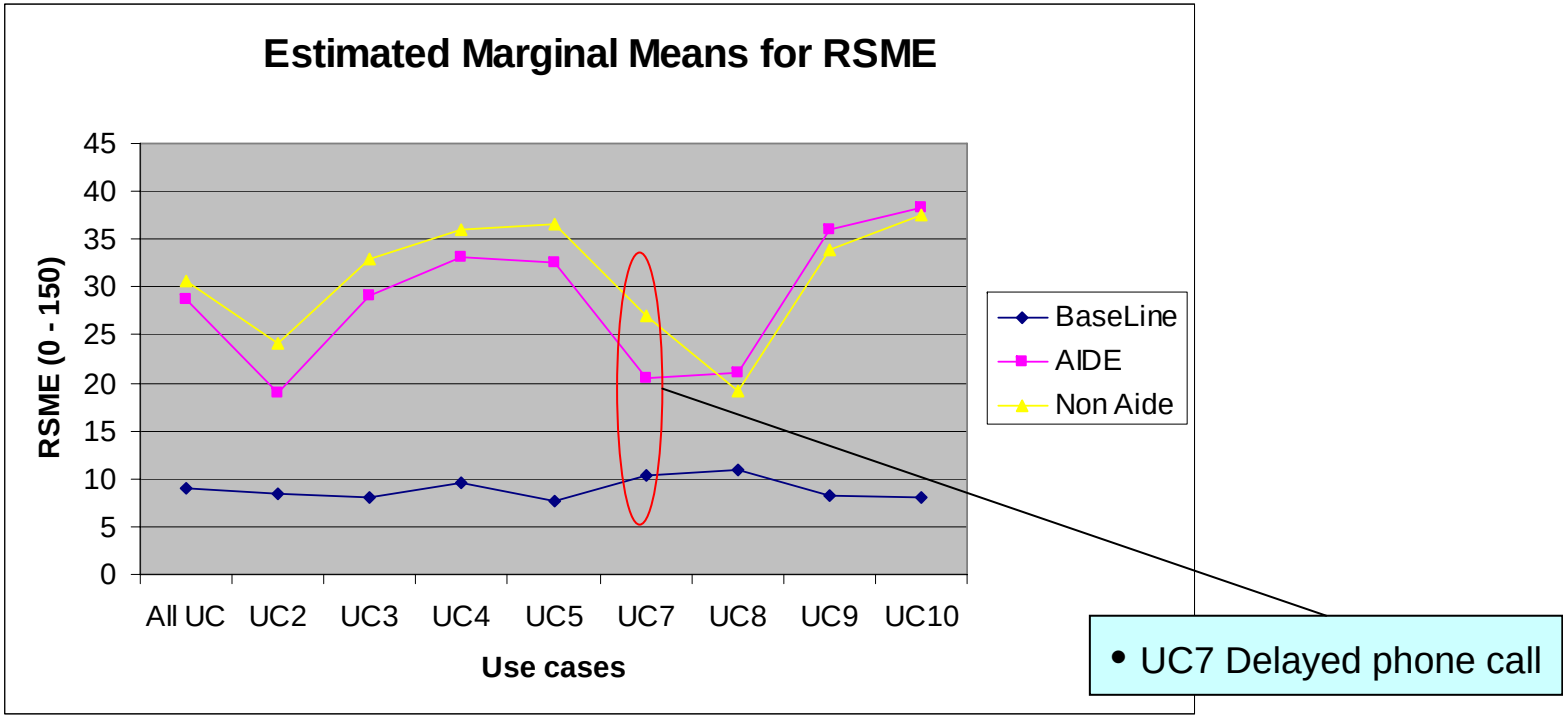
- RT longer for NA and A vs BL All UC (total)
- RT longer for NA and A in most UC (individually)
- RT longer for NA vs. A in UC2, 7 and 9

TDT data shows positive effect of Aide in one UC



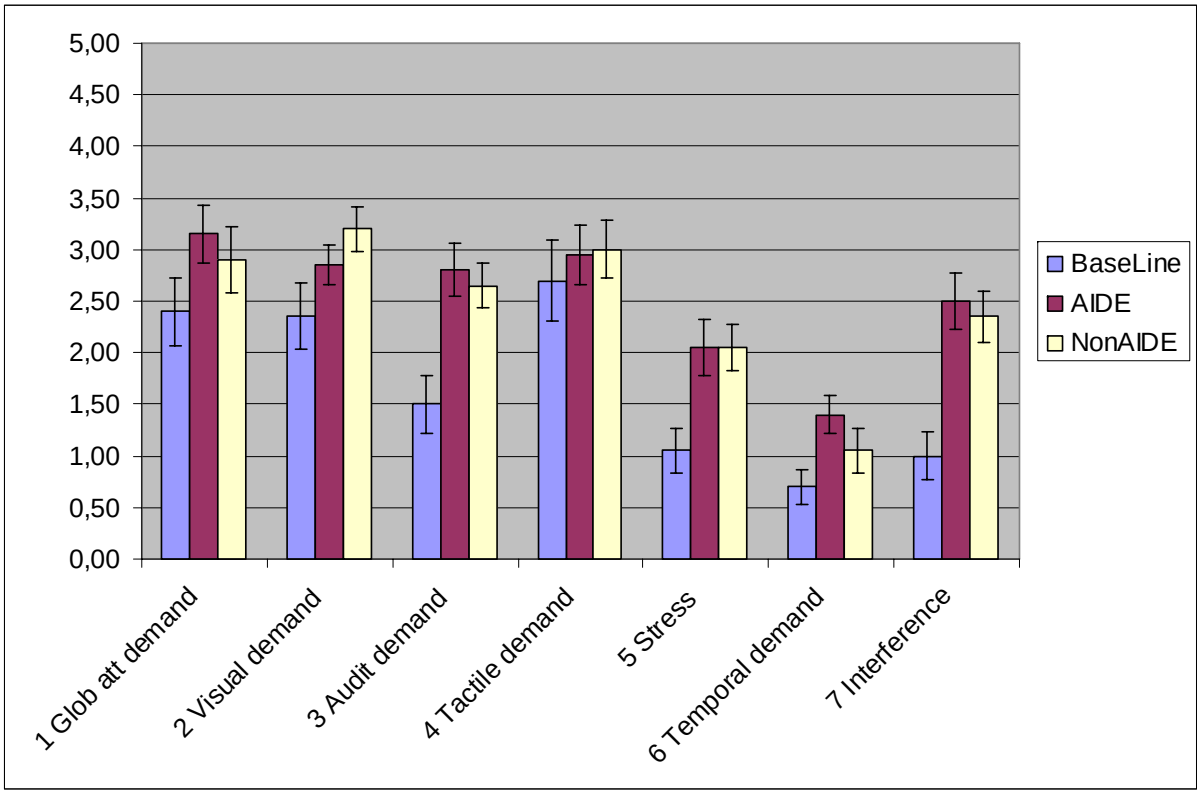
- UC7 Delayed phone call

Subjective data - RSME



- RSME was lower for BL compared to A and NA in total and for all UC
- RSME was lower for A compared to NA in total and for UC7 (delayed phone call)
- A trend that RSME is lower in 5 of 8 UC

Subjective data - DALI

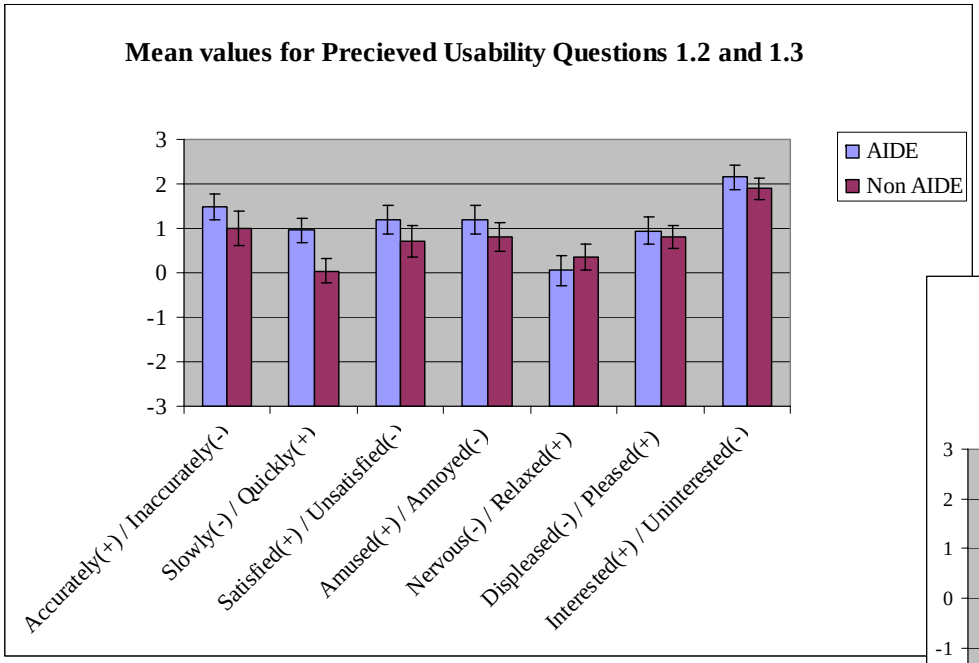


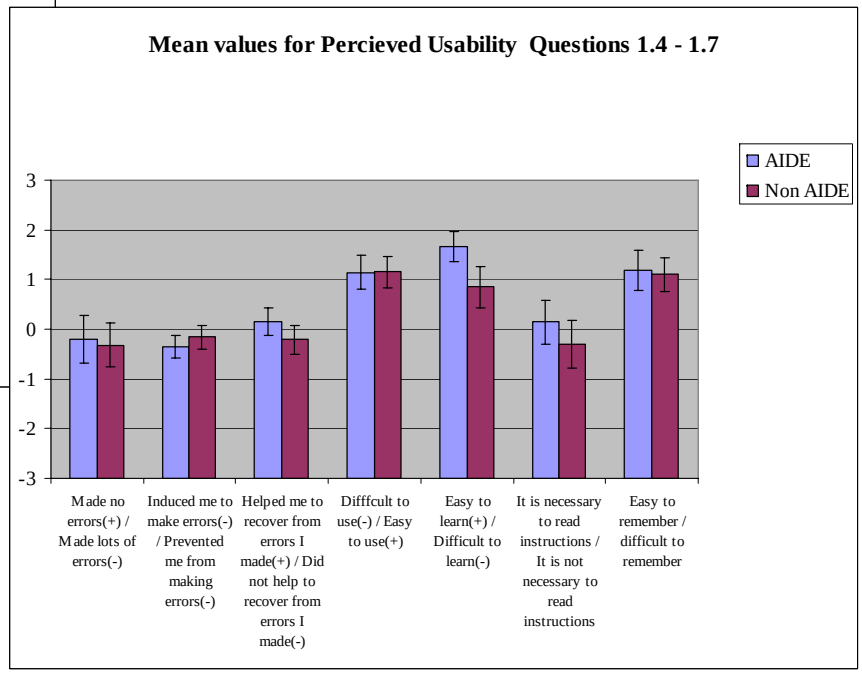
- There were no differences between A and NA
- A ratings were higher vs. BL for global, auditory, temporal and interference
- NA ratings higher vs. BL for visual, auditory, stress, and interference

Subjective data – CRF questionnaire driving performance

- Four questions were asked with relation to driving performance
  - General driving performance (Very well – Very bad) - no difference between the three conditions
  - Feeling of safety – (Very safe – Very unsafe) less safe for NA vs. BL
  - Number of errors made (e.g. missed to look in the rear view mirror, missed road signs etc.) most errors in NA and least in BL but no sign, differences.
  - Finally, they were asked about the most frequent errors – most frequent, missed to look in the rear view mirrors, missed road signs and misjudging lead vehicle speed.

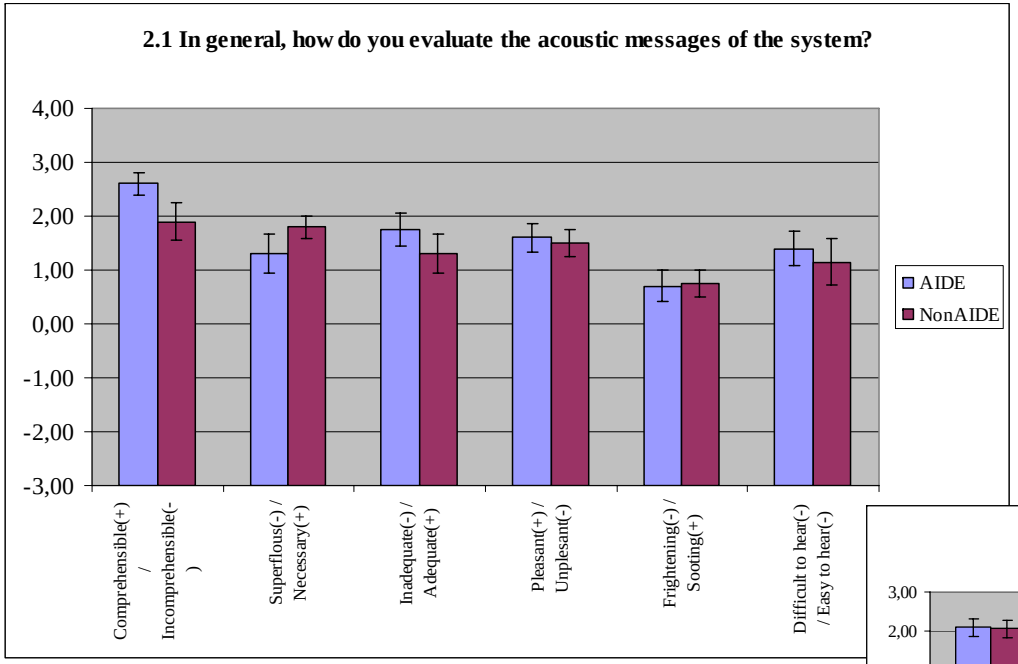
Subjective data – CRF Perceived utility

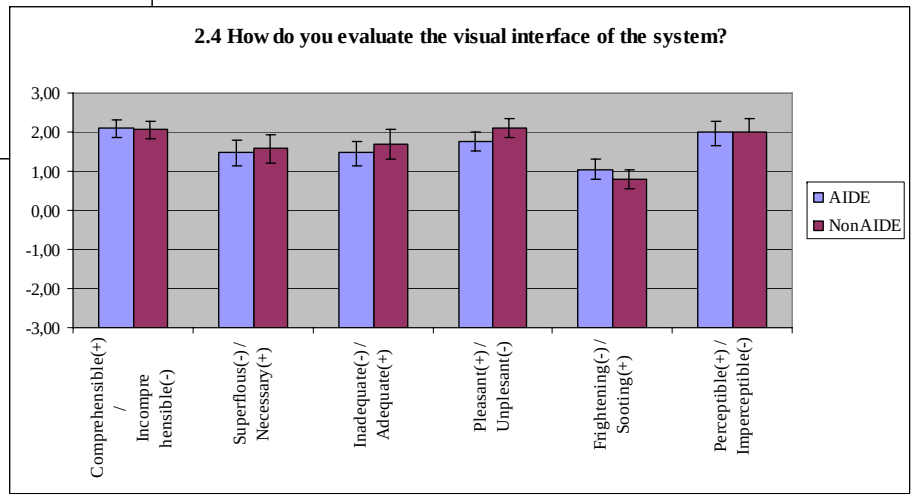




- Most averages on the positive side
- Small differences between Aide and Non Aide

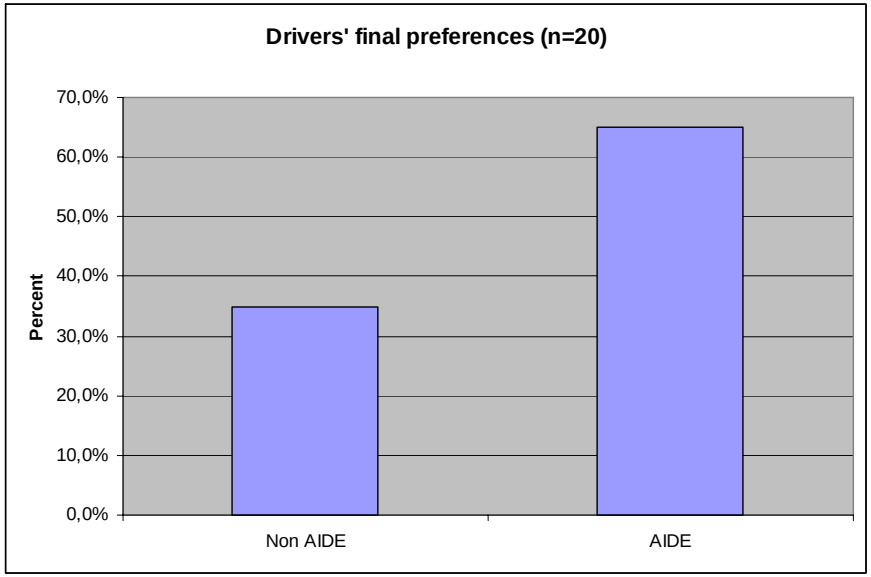
Subjective data – CRF Adequacy of interfaces





- All averages on the positive side
- Small differences between Aide and Non Aide

Subjective data – CRF Final questionniare



- The final questionnaire consisted of 11 comparative questions
- One question concerned possible differences (A/NA) with respect to LKA but most did not feel a difference
- However, over 60% preferred the A over the NA condition

Summary of results

- Objective data
  - SWRR – supports hypothesis partly specific UC3 (phone out)
  - Speed – no clear results (but less speed variation for A UC2 (in phone call))
  - Lateral pos – no clear results (but MSDLP lower for A in UC3 (out phone))
  - Eye Gaze – supports hypothesis (driver's eyes on the road)
  - TDT – supports hypothesis for UC7 (delayed phone call)
- Subjective data
  - RSME - supports hypothesis (total and UC7)
  - DALI - indifferent
  - CRF – Driving performance - indifferent
  - CRF – Perceived utility – indifferent
  - CRF – Adequacy of interfaces – indifferent
  - CRF – Final comparison – supports hypothesis

Transferring to risk

Risk factor	All Use Cases	Individual Use Cases
Average speed	A & NA ↓ vs. BL	UC2 NA ↑ vs A
Speed variability	A & NA ↑ vs. BL	UC2 NA ↑ vs A
Driver workload		
- SWRR	A & NA ↑ vs. BL	UC3 NA ↑ vs. A
- TDT	A & NA ↓ vs. BL	UC7 NA ↓ vs. A
- RSME	NA ↑ vs. A↑ vs. BL	UC7 NA ↑ vs. A
- DALI	A & NA ↑ vs. BL	----
Driver distraction		
- PRC	NA ↓ vs. A↓ vs. BL	UC2,3,5,9 NA ↓ vs. A

Conclusions

- Objective data provided useful information for the evaluation
- The UC affected workload, performance, and safety – A/NA
- Aide contributed to improve in some cases e.g. eyes on the road

- Subjective data did not contribute much to the evaluation
  - Except subjective workload and general preference
  - Difficult to relate questions to specific phenomena

- No difference detected in risk between A and NA

- However,
  - Difficult for the drivers to perceive the difference between A and NA
  - The difference between A and NA was not always very distinct e.g. UC8, 9 and 10 – presentation of messages (display/voice vs. display/sound)
  - Too many UC in one drive?
  - Lack of some critical data e.g. headway and improved lateral data

aide
TOWARDS FUTURE AUTOMOTIVE HMI
AIDE final workshop and exhibition April 15-16, 2008, Gothenburg

End