



# Driver Attention and Vehicle technology

Anders Eugensson

Volvo Cars

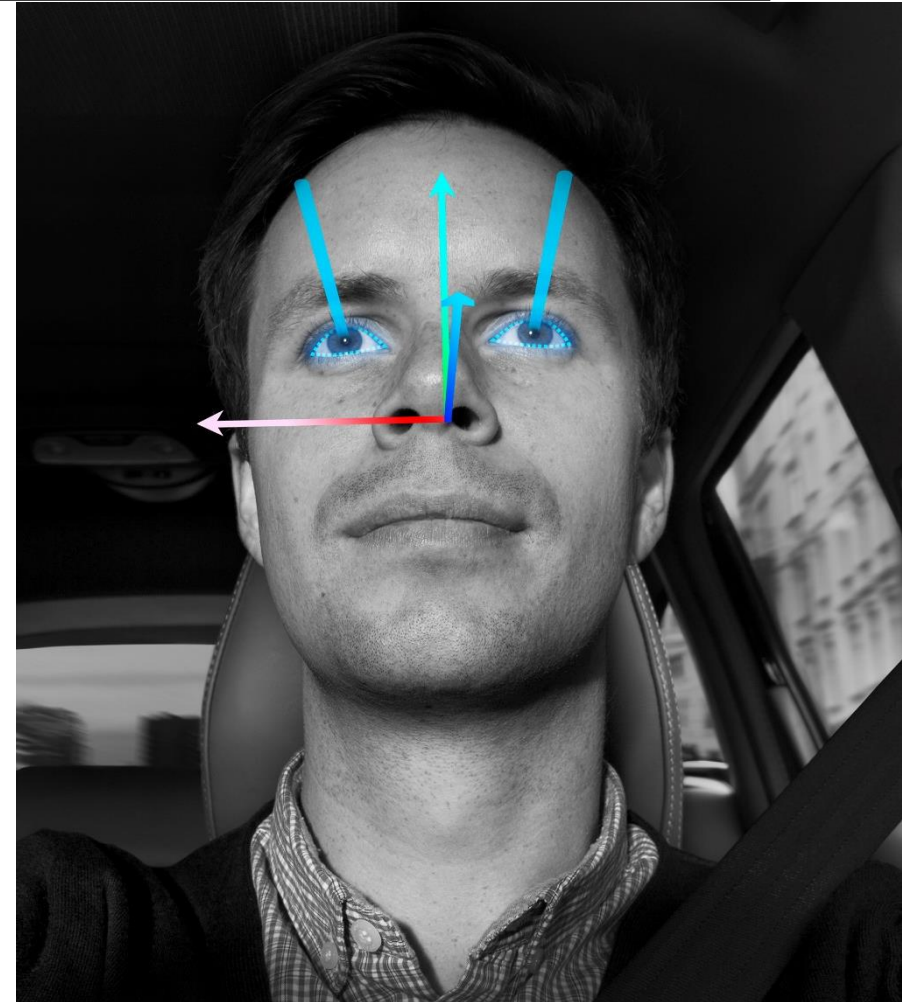
Volvo Vision 2020 “Nobody should be killed or seriously injured in a new Volvo car”



# Attentive driving vision



- No crashes caused by inattention.
- Eyes- and mind-on-threat!
- Safely deliver infotainment ("pocket the smartphone")
- Sleep-free driving



# Safety Designed for the error prone driver



The ideal driver does not exist, full attention is not possible, this is the core problem.

DOT HS 812 115

A Brief Statistical Summary

February 2015

## Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey

94% of crashes attributed to driver-related critical reasons:


- **Recognition error:** driver's inattention, internal and external distractions, and inadequate surveillance
- **Decision error:** driving too fast for conditions, too fast for the curve, false assumption of others' actions, illegal maneuver and misjudgment of gap or others' speed
- **Performance error:** overcompensation, poor directional control, etc.
- **Non-performance error:** Sleep most common

 Vägverket

Vision Zero forms a basis

Vision Zero not only Zero fatalities  
Vision Zero, 5 dimensions

- vision for many stakeholders
- ethical platform (right to survive)
- ~~shared responsibility~~
- **safety philosophy (failing human)**
- ~~driving forces for change~~



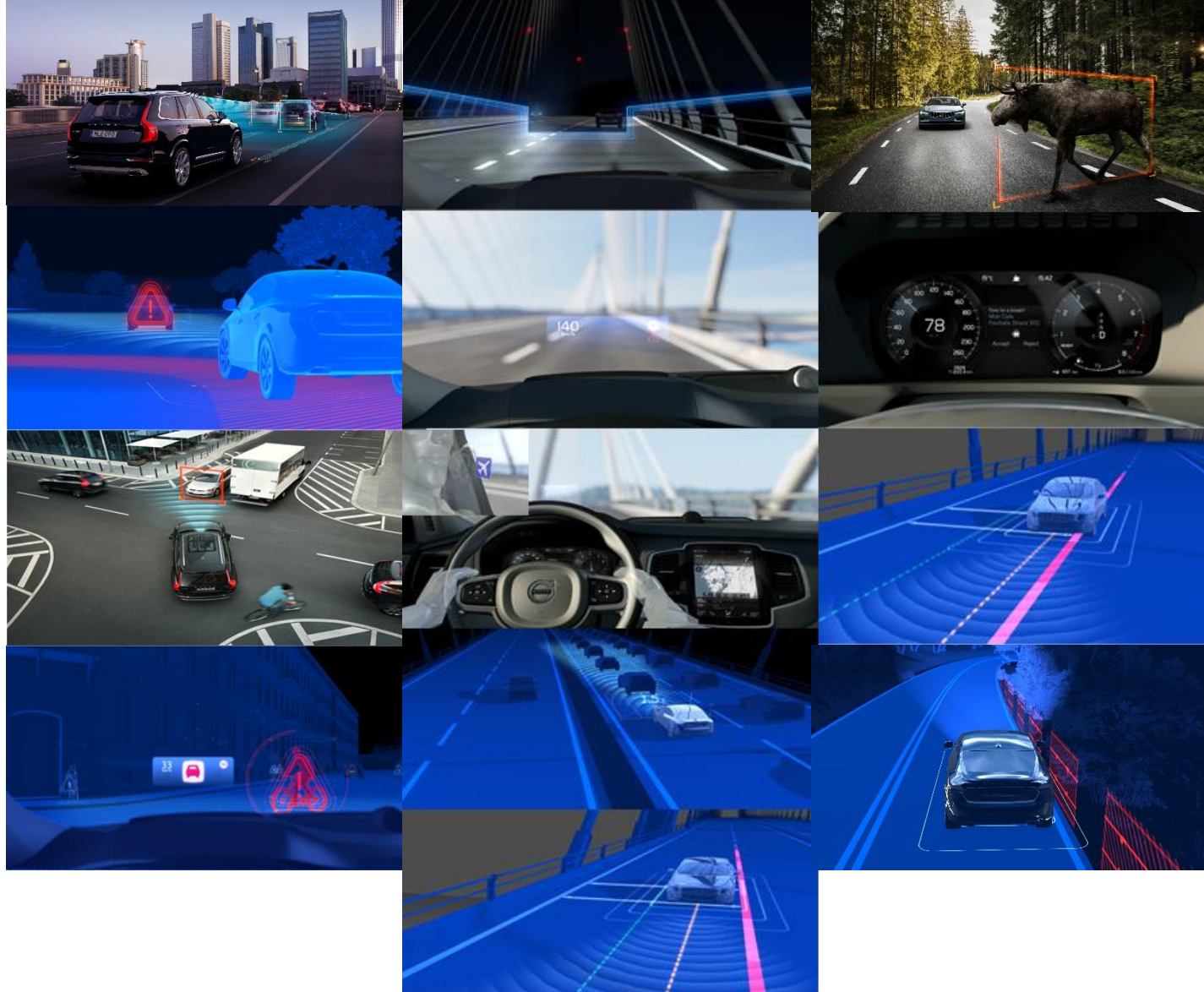
 Vägverket

**Unsafe driver behaviour can be tackled through the whole integrated safety chain**

- Through limited access to the vehicle
- Through support for normal driving
- Through warnings in risky driving
- Through correction in hazardous situations
- Through taking control in situations when driver is out of control

Swedish Road 2009-11-25 36 Administration

# Holistic = car + human together



# #1 tactic: Risk reduction with active safety/attention sensor/AD

Critical Situation



# #2 tactic: Reduce Eyes-off-road time by design

Non-Driving Related Activities



**Mismatch/Timing**



**CRASH RISK**

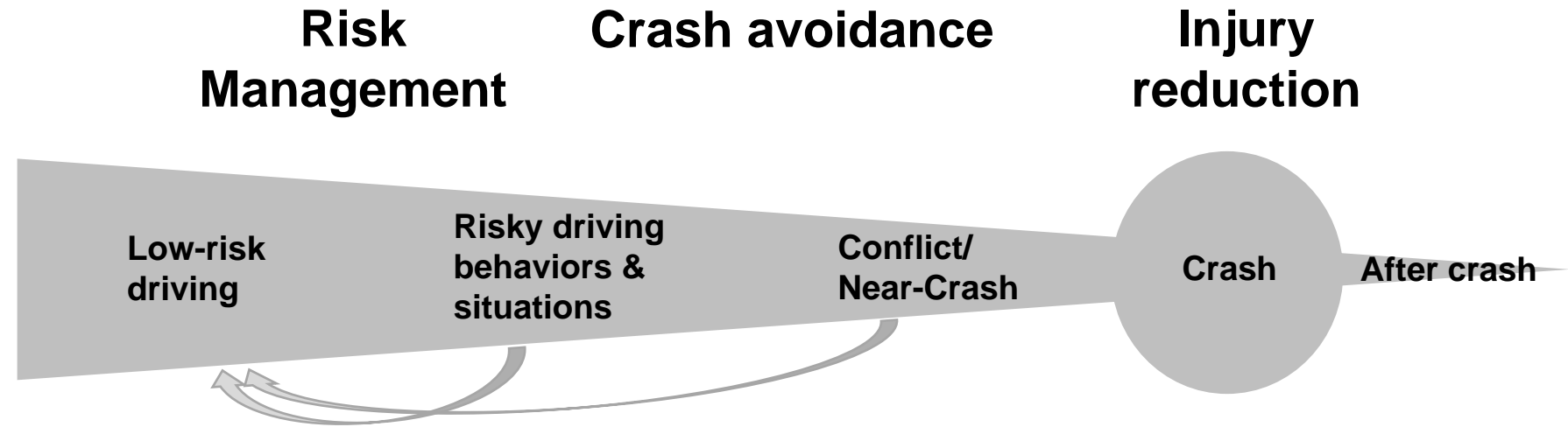
**Risk Reduction by removing critical situations**



**Risk Reduction by safe interaction design**



# Prevention in the whole sequence



## No perceivable threat

- Change risky behaviors early in the sequence
- Decision influence: convince the driver, appeal to "the rational brain"

## Perceivable threat present

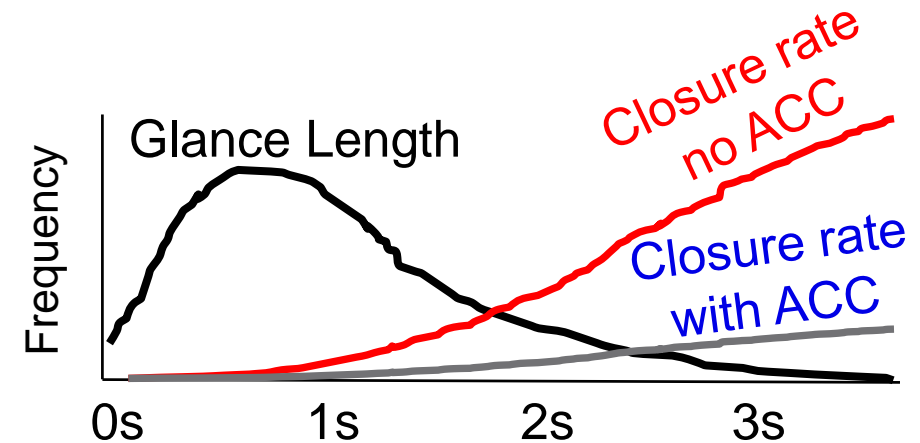
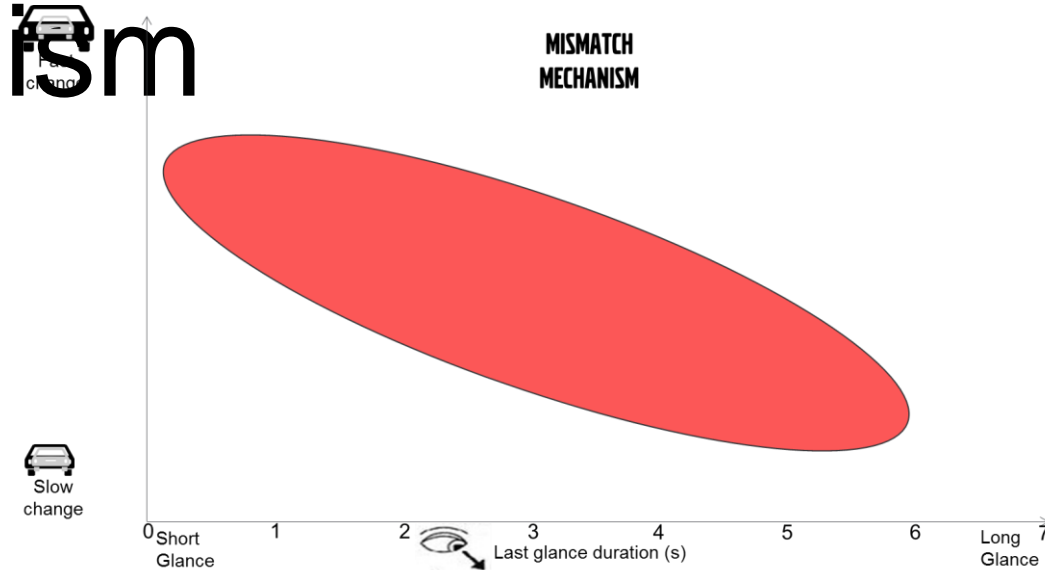
- The threat (real-world) contains the information we react on
- We need to attend to that threat

# inattention crash mechanism

- Crashes are associated with:
  - Short glances and high closure rates, and
  - Long glances and slow closure rates.

## countermeasures

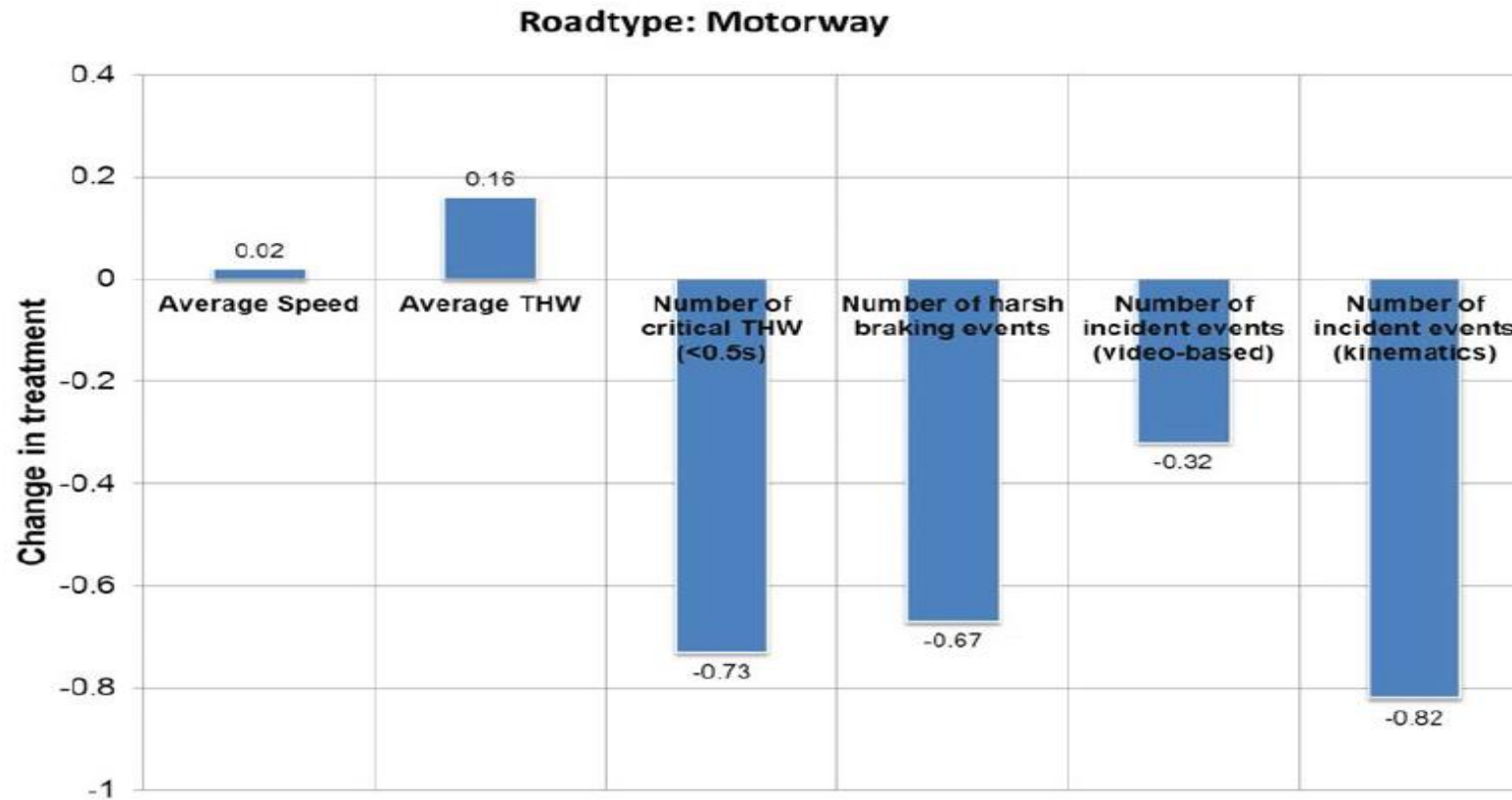
1. Reduce eyes-off-road time
2. Active Safety systems replace the eyes when drivers look away and protect the driver if the situation changes rapidly during an off-road glance.
  - Create more time headway, active braking, and warnings
  - Emergency braking (AEB), Forward Collision Warning (FCW),
  - Rear Collision warning (RCW),
  - Adaptive Cruise Control (ACC),
  - Connected Safety
3. Safety coaching





# ACC, FCW & Visual attention

- ACC + FCW decrease the number of incidents, harsh braking events, and THW below 0.5 s, *despite* increasing secondary task engagement (Malta et al., 2012).



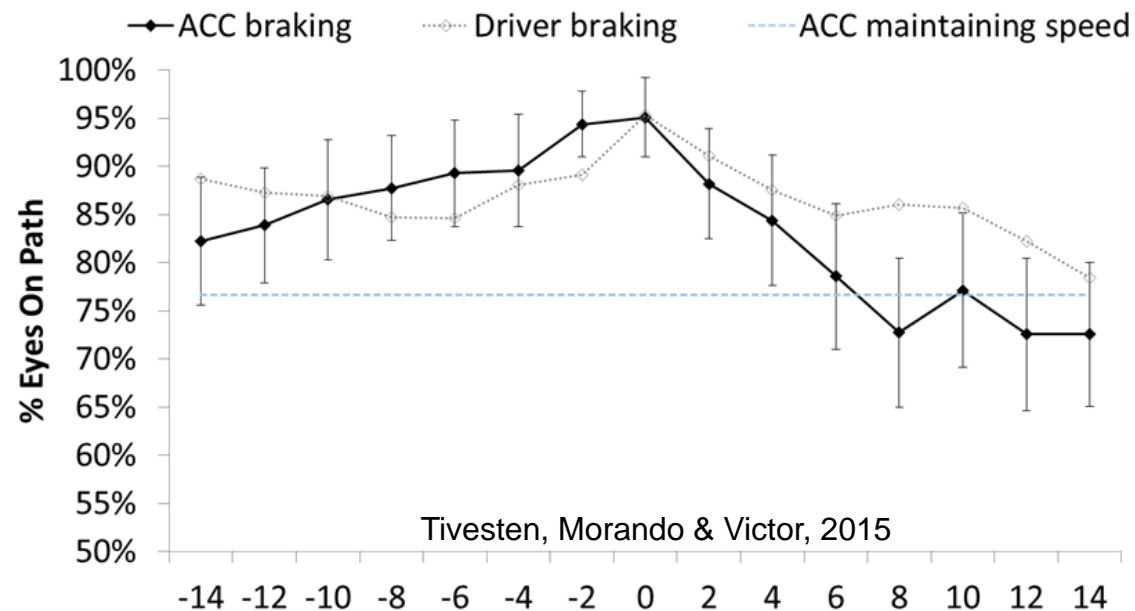
**Figure 5: Overall benefit of ACC+FCW on motorways (passenger cars). Numbers above bars indicate the relative change (positive or negative) between baseline and treatment for each indicator. These numbers can be read as percentages as well (i.e. 0.16 = 16 %)**

## Drivers anticipate lead-vehicle conflicts during automated longitudinal control: sensory cues capture driver attention and promote appropriate and timely responses

Morando A., Victor T., Dozza M.

Submitted at Accident Analysis and Prevention

- **Threat-anticipation** mechanism
  - Sensory cues alert drivers of an impending threat



# Driver Alert Control (DAC)

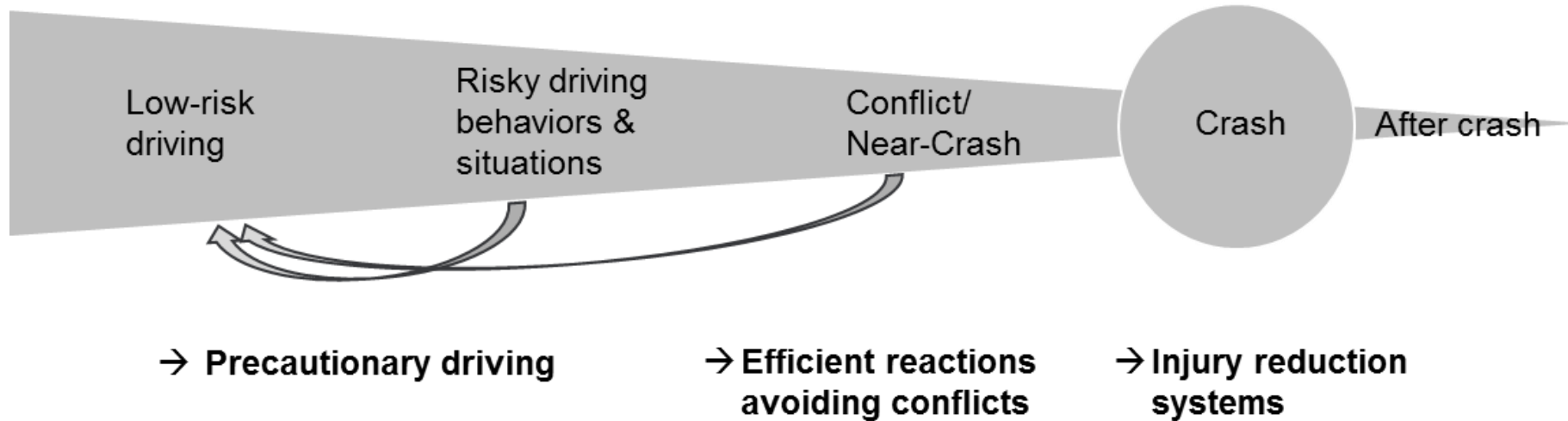


- When the first signs of inconsistent driving are detected, driver display shows: "Driver Alert Time for a break soon?"\*
- Purpose: Start considering taking action before possibly becoming a risk to oneself or others.
- When clear signs of inconsistent driving are detected, driver is warned with an acoustic signal and the driver display shows the "Driver Alert Time to take a



\* New in XC90  
"break" message

# Predictive vs in-conflict Attention reminders



**Predictive Inattention Warning:** Your current driver state is associated with an increase in risk  
- e.g. Time for a break soon?

**In-conflict Inattention Warning:** You are in a pre-crash situation, likely caused by your current state  
- e.g. leaving lane, approaching object, eyes closed → emergency brake/steer, wake up, eyes on threat

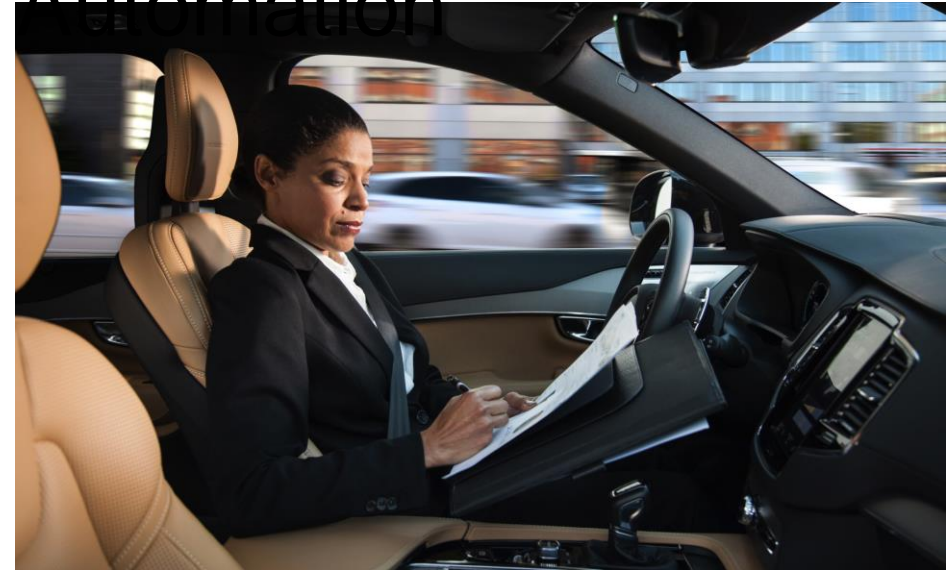
# Supervised VS Unsupervised automation

## Pilot assist / Supervised Automation



- Driver is responsible, should monitor and supervise
- Driver responsible to intervene whenever needed
- Limitations: Lane markings, road design, oncoming objects, pedestrians, animals, restrictions in steering/braking/acceleration force that can be applied

## Autopilot / UnSupervised Automation



- Manufacturer responsible
- Tested on and expects extreme situations
- Takes precautions, takes decisions
- Driver free to do something else

# NHTSA Guidelines response



**”Yes, we aim to be compliant.”**

→ Specified ISO 16673 Occlusion Method - 12s Total Shutter Open Time (TSOT)

Challenges:

1. NHTSA Eye-glance method (EGDS) has serious test-retest reliability issues
2. Task selection
3. Real-life distraction vs NHTSA method



# Low Test-retest reliability of eye-glance



	AC1 For each driver, max 15% glances >2.0 s										AC2 For each driver, mean glance duration <2.0 s (Mean Glance Duration)										AC3 For each driver, total glance time <12.0 s									
	RG1	RG2	VG1	VG2	VG3	VG4	VG5	VG6	VG7	VG8	RG1	RG2	VG1	VG2	VG3	VG4	VG5	VG6	VG7	VG8	RG1	RG2	VG1	VG2	VG3	VG4	VG5	VG6	VG7	VG8
Activate vehicle function	2	3	2	2	2	2	4	2	1	4	2	3	2	2	2	2	3	2	1	4	0	0	0	0	0	0	0	0	0	0
Activate USB	3	1	0	2	3	1	2	2	3	2	3	1	0	2	2	1	3	2	3	3	0	0	0	0	0	0	0	0	0	0
Set a new dest.	8	10	8	7	7	7	7	8	7	7	6	4	4	4	4	2	6	2	5	5	9	13	11	7	13	13	8	11	12	9
Set a favorite dest.	2	4	3	3	0	4	4	2	3	4	6	2	1	3	3	1	5	2	5	3	0	0	0	0	0	0	0	0	0	0
Select and play music from USB	8	6	7	7	5	4	10	5	9	8	6	3	4	5	2	2	6	4	5	6	3	1	1	2	1	3	3	4	3	3
Call contact from recents list	3	4	2	5	4	2	5	2	3	3	4	3	1	6	3	3	4	2	4	4	0	0	0	0	0	0	0	0	0	0
Dial phone number manually	11	10	6	10	9	7	10	9	9	9	9	3	2	7	5	4	7	5	6	7	3	3	5	3	1	4	3	3	4	1
Change temp.	6	2	3	4	4	3	5	3	4	5	6	2	1	4	4	3	5	3	4	5	0	0	0	0	0	0	0	0	0	0
Set seat heat	1	0	0	1	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Manual radio tuning	5	3	3	4	3	4	5	2	4	7	2	1	0	0	2	2	2	0	1	2	12	16	10	11	17	15	13	13	14	14

α Outcomes were 60% consistent between the 10 groups

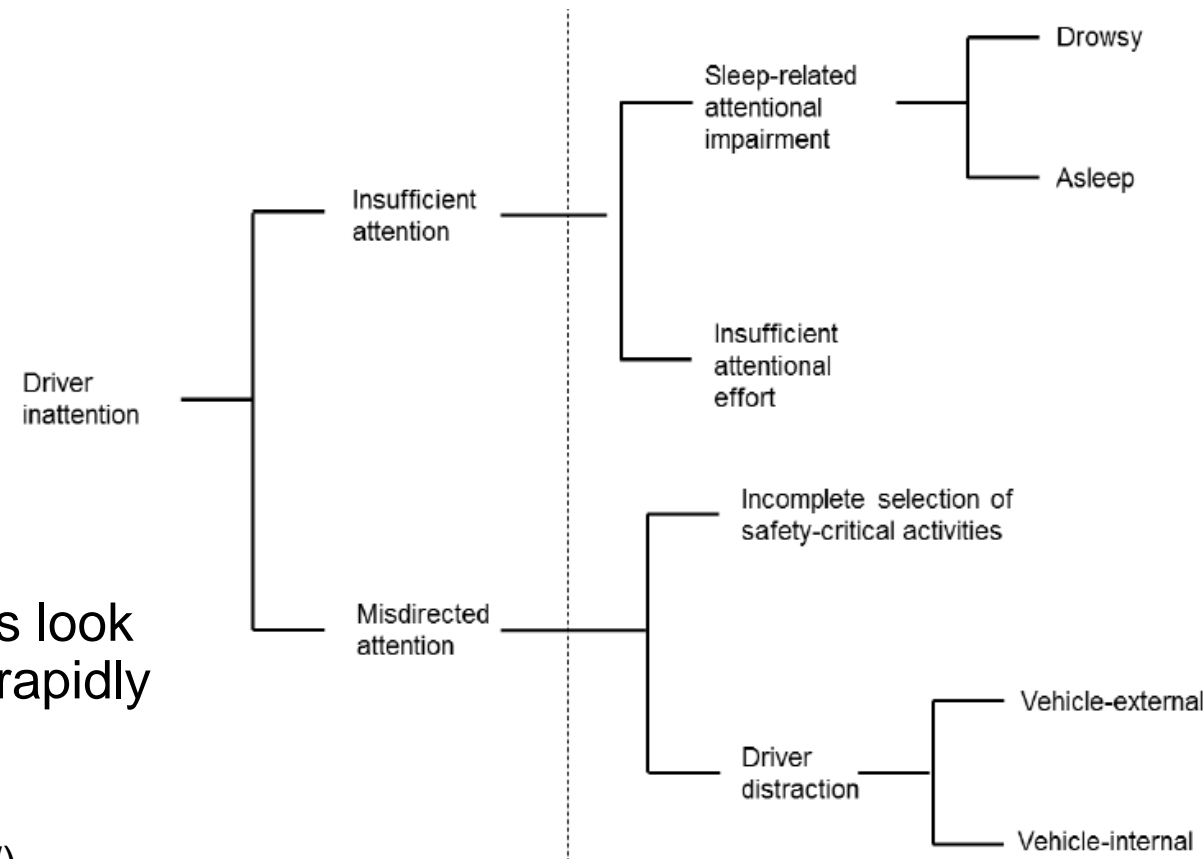
# Conclusion

## Proactive Crash Avoidance – reduce exposure

- Reduce eyes-off-road time
- Safety coaching

## Reactive Crash Avoidance – prevent crashes

- Active Safety systems replace the eyes when drivers look away and protect the driver if the situation changes rapidly during an off-road glance.
  - Create more time headway, active braking, and warnings
  - Emergency braking (AEB), Forward Collision Warning (FCW),
  - Rear Collision warning (RCW),
  - Adaptive Cruise Control (ACC),
  - Connected Safety
  - etc



“*Driver inattention* is conceived of in terms of **mismatches** between the current resource allocation and that demanded by *activities critical for safe driving*”

**Thank You!**