Human Factors: The Driving Future

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Overview

- Review latest technologies entering car cockpit
- Discuss their impact on driving
- Discuss human factors implications of these developments

PART 1 – THE TECHNOLOGIES

Driving is a Complex Thing

- Complex, multi-task, activity
- Not surprisingly, error prone
- About 1800 killed, and 24,000 seriously injured each year in Australia during last decade
- About 1.2 million killed, and 39 million injured each year, world wide
- Human factors has made a major contribution to reducing the toll
- But there is a lot to be done.

The evolving vehicle cockpit

- Engines more efficient and reliable
- Structures more crashworthy
- Fewer mechanical links
- The vehicle cockpit largely the same
- ….but it's changing
- 3 broad classes of technology are starting to dominate the cockpit – entertainment systems, communication systems and intelligent transport systems

Entertainment Systems

- Wireless radio
- Audio casette players
- CD players
- Video
- Television
- DVD
- Entertainment services in-car or through smart phone, PDA, iPods … – eg nearest restaurant, latest move

Communication Systems

- Voice communication
- Text messaging
- Video messaging and conferencing
- Internet
- Email
- Facsimile
- In-car or on portable devices (eg mobile phones)

Intelligent Transport Systems

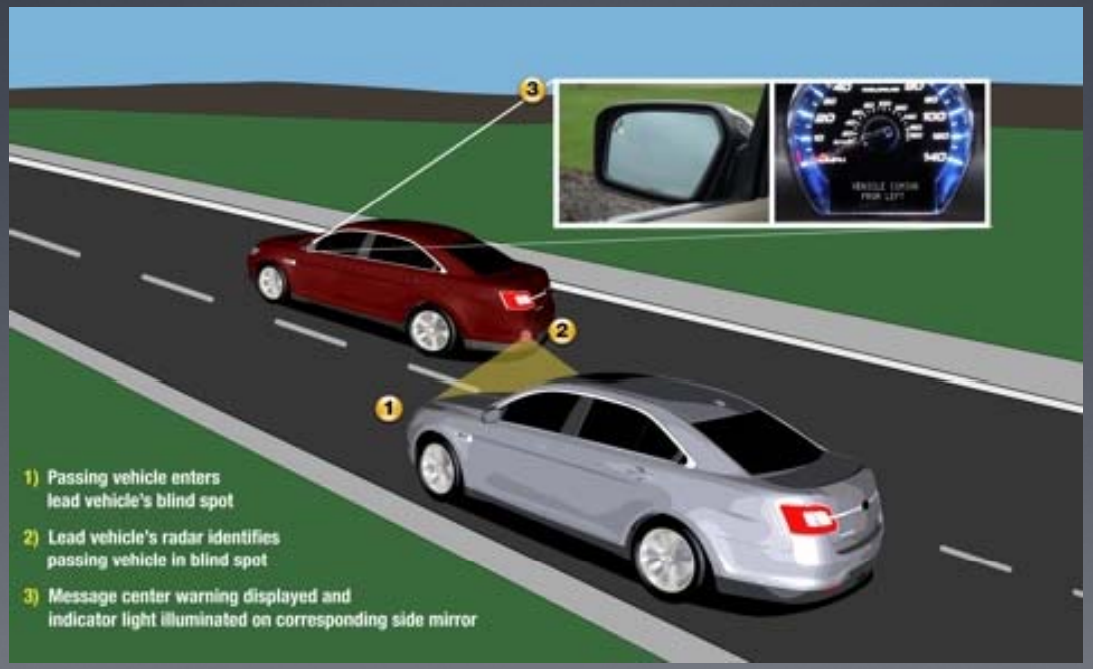
- Collection of electronic, telecommunications and computing technologies that can be combined in different ways to increase driver safety, mobility and comfort
- At various stages of development
- Safety systems can prevent crashes, reduce crash trauma and reduce post-crash trauma
- Some keep drivers in the loop; some automate drivers out of it

ITS FOR CRASH PREVENTION

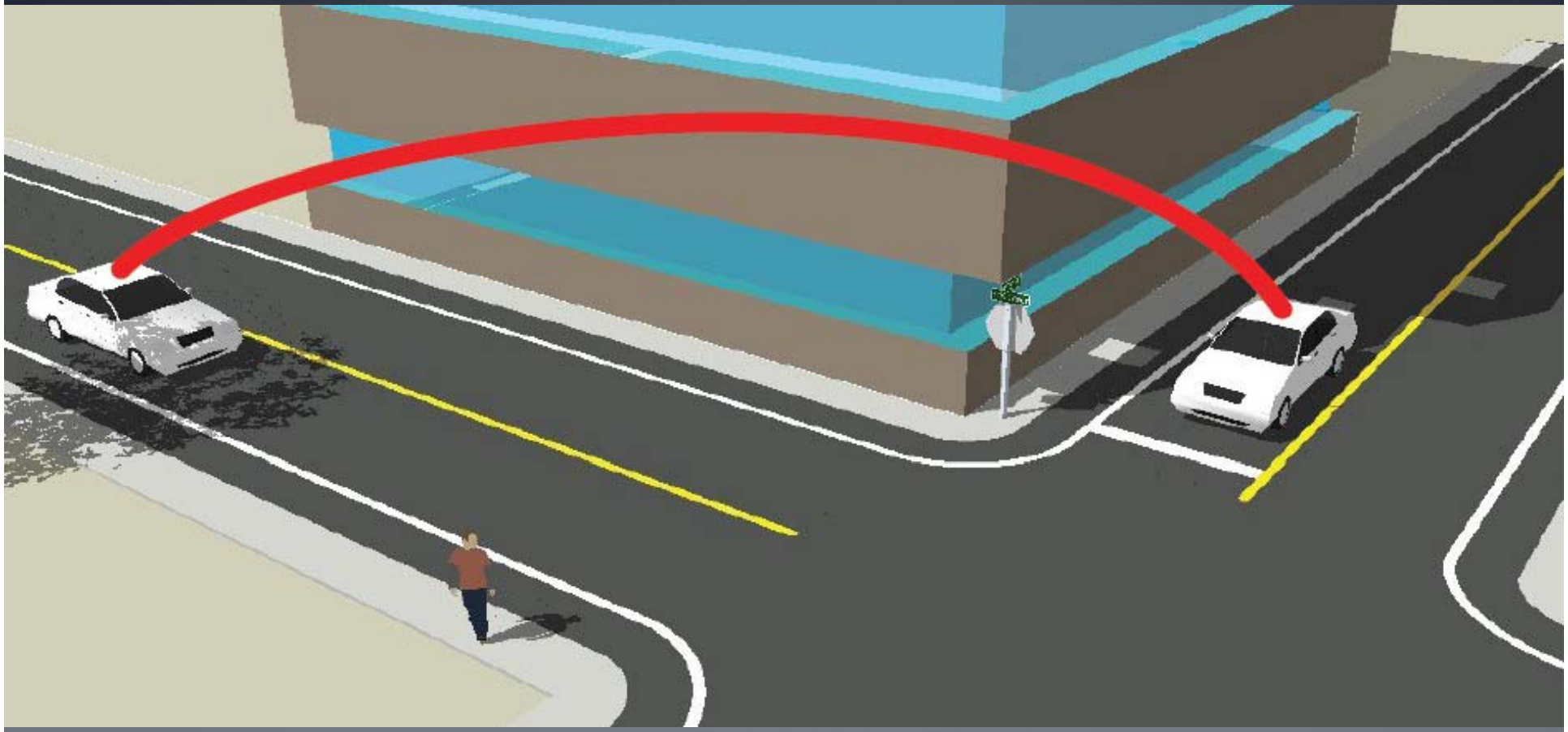
Intelligent Speed Adaptation

Forward Collision Warning

Blind Spot Information Systems



Intersection Collision Warning



Lane Departure Warning/Lanekeeping Assist

Driver Drowsiness Warning

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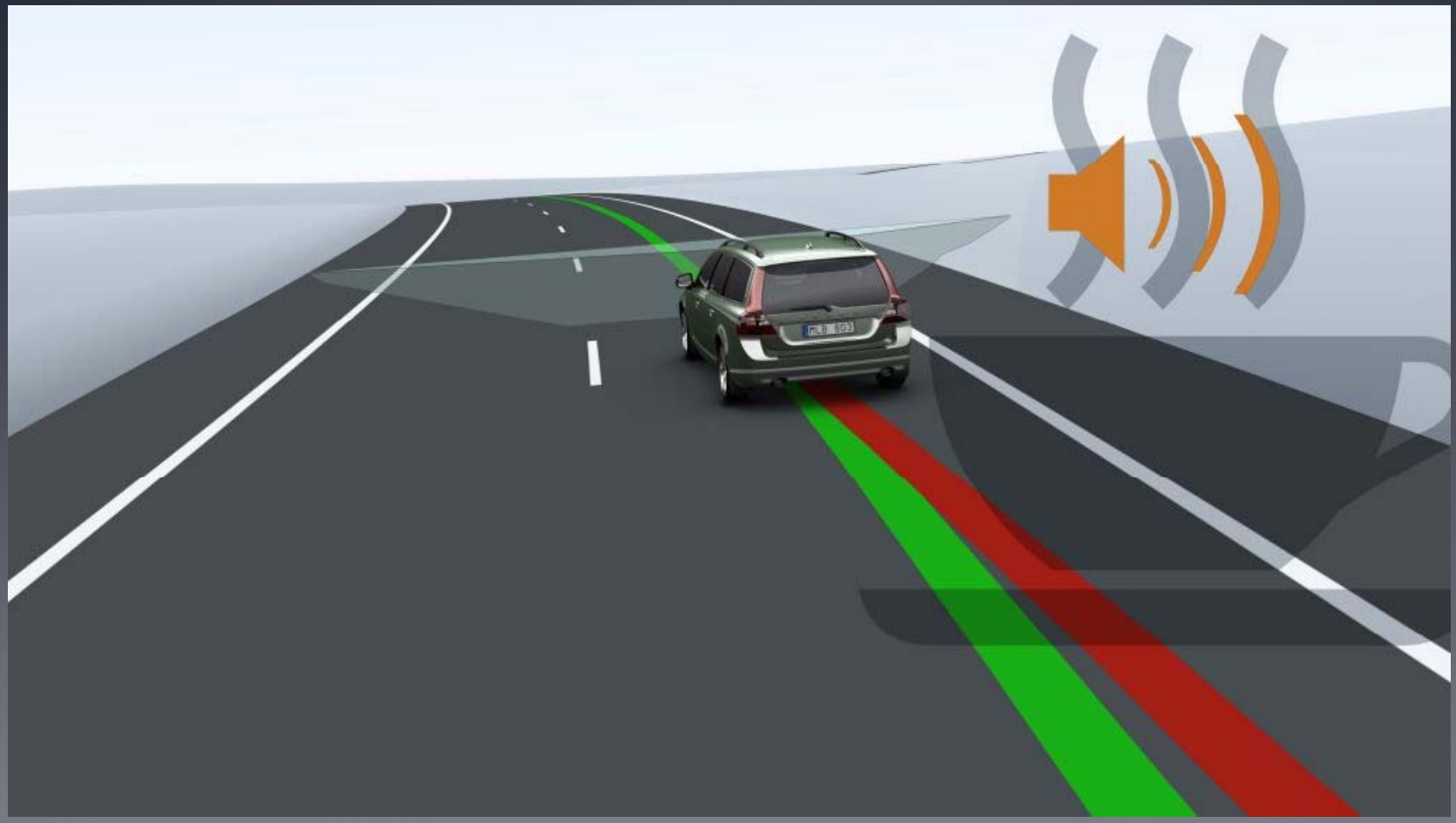
Driver Distraction Prevention and Warning



Vision Enhancement Systems

Curve Speed Warning

Imagine This?

ITS FOR TRAUMA REDUCTION

Seat Belt Reminder

Intelligent Speed Adaptation

ITS FOR COMFORT

Adaptive Cruise Control

Satellite Navigation

ITS FOR POST-CRASH TRAUMA REDUCTION

Automatic Crash Notification

Estimated Safety Impact

E-IMPACT Project (EC - FP6) – estimated the potential reduction in fatalities assuming a 100 percent penetration rate of the technologies:

- Electronic Stability Control – 16%
- Lane Keeping Support (including BLIS) – 15%
- SpeedAlert (ISA with haptic warning system) – 8%
- Emergency Braking (ie Forward Collision Avoidance) – 7%
- Automatic Crash Notification – 6%
- Driver Drowsiness Monitoring and Warning – 5%
- Wireless Local Danger Warning (ie obstacles on road and low friction – warnings sent to following cars– 4%

Estimated Safety Impact

- Intersection Safety – 4%
- NightVision Systems – 3%
- Pre-Crash Protection of Vulnerable Road Users – 2%
- Lane Change Assistant (Warning) – 2%
- Full Speed Range ACC – 1%

(http://www.eimpact.info/results.html)

Reality

- Estimates are based on crude assumptions about how these ITS technologies will impact on the driving task
- For most systems, we know little or nothing about how they will change driving behaviour in the long term, and how they will interact with other systems to modify behaviour.
- The EC-funded euroFOT project will shed light on this issue.

PART 2 – IMPACT OF TECHNOLOGY ON DRIVING

Implications for driving

- At beginning of a cockpit interface revolution
- Average person is unaware of these technologies they exist now in Europe and will be more common in Australia in ordinary vehicles within next 5 to 10 years
- They will impact on driving in different ways and raise a variety of human factors and ergonomic issues, many of them unexplored.

The Driving Task

Complex, multi-task, activity which involves:

- finding your way
- following the road
- monitoring speed
- avoiding collisions
- following traffic rules
- controlling the vehicle (eg gears, accelerator)

(Brown, 1986)

Provides simple heuristic for thinking about how Intelligent Transport Systems will impact on driving

Finding Your Way

- Will be easier – via satellite navigation and traffic signs beamed into the car (e.g., "70 Smith Road"; "Melbourne 100km").

Advantages of beamed information:

- Display information when you want it, and earlier in time
- As long as you like, and can repeat it
- Just how you like it (visual/auditory, as small/large and soft/loud as you want)
- Can comprehend it under all weather conditions
- In your own language when driving in other countries
- Especially good for some driver sub-groups – can customise information design for special groups

Following the Road

- Will be easier
- Will have lane departure warning, drowsy driver warning and driver distraction and mitigation systems
- And steering assistance to get back onto road

Monitoring Speed

- Will be easier
- Beam speed signs into car
- Intelligent speed adaptation, optimised for different road and weather conditions

Avoiding Collisions

- Will be easier
- Warnings from traffic signs beamed into car (eg "reduce speed"; "workmen ahead")
- Warnings systems for obtacles in front, behind, at side and in blind spots
- Braking support to avoid collision if warnings ignored or to brake harder than driver is willing to brake
- Traffic information systems – incidents, weather, traffic changes
- Night vision systems

Follow Traffic Rules

- Will be easier….
- Regulatory signs beamed into the car (eg “STOP”; “GIVE WAY”)
- Linked to control systems that automatically enforce regulations (eg prevent you from parking in no parking zone; prevent you from going through STOP sign without yielding)

Controlling the Vehicle

- Ultimately, vehicles will be able to take over contol of most driving sub-tasks
- For the moment, however, neither passenger car drivers nor vehicle manufacturers are ready for that

Summary

- Technology will have a huge impact on driving – it will fundamentally change the driving task
- Technology will automate many different psychological processes involved in driving the vehicle
- ITS will, potentially, have huge safety benefits
- But we need to be aware of the effects of automation, and address them
- Human Factors and Ergonomics professionals will be important

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PART 3 – HUMAN FACTORS ISSUES

Workload

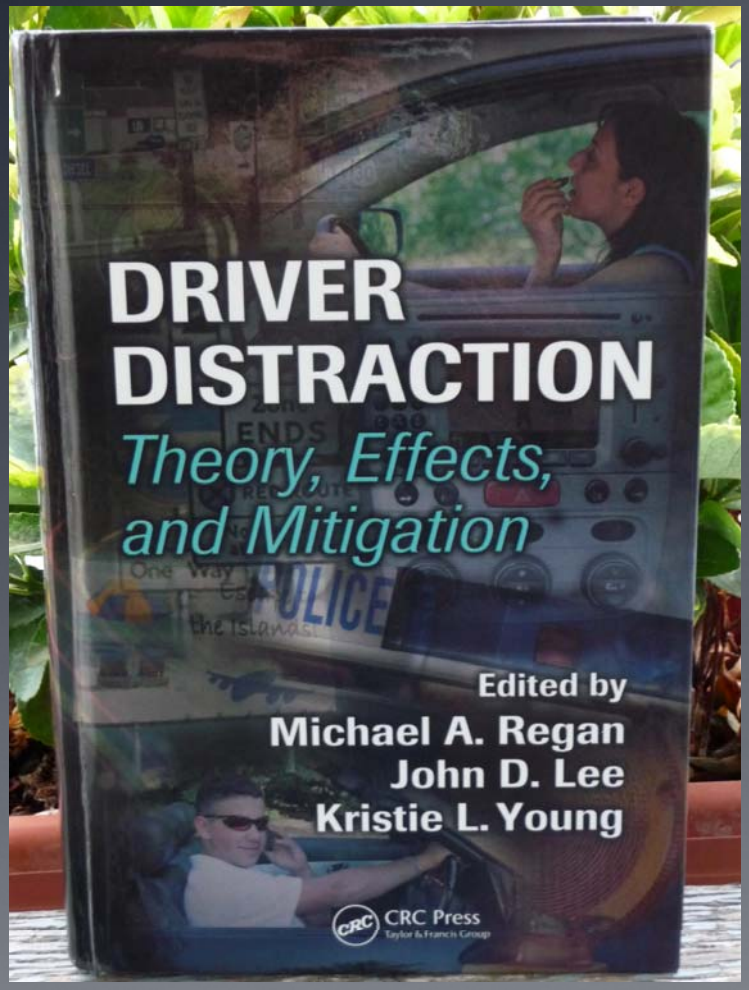
Car drivers will be exposed to many information sources, inside and outside vehicle:

- From traditional traffic signs outside vehicle
- From electronic signs outside vehicle
- From in-vehicle displays that duplicate inside the vehicle information displayed on signs outside
- From in-vehicle displays that present information from ITS technologies
- From entertainment and communication systems
- From other vehicles and road users; and
- From the physical characteristics of the road itself.

Workload

- Challenge is to rationalise, integrate and prioritise information
- If workload is too high, driver will be overloaded and driving performance will deteriorate
- If workload is too low, driver will fall asleep or will engage more in non-driving activities to stay awake.
- Vehicle designers are doing their best inside; traffic engineers are doing their best outside. But who is responsible for the integration and prioritisation of information flow to the driver from inside and outside?

Driver Distraction



- "Diversion of attention away from activities critical for safe driving toward a competing activity" (In Regan, Lee & Young, 2008)

- Can derive from driver use of entertainment and communications systems

- Can derive from poorly designed support systems that divert attention away from the road

Driver Distraction

- Reported deficits include (Bayly, Young, & Regan, 2008; Horberry & Edquist, 2008):

  - degraded lane keeping
  - degraded speed control
  - increased reaction time
  - missed traffic signals
  - shorter or longer inter-vehicle following distances
  - unsafe gap acceptanced
  - reduced situation awareness
  - poorer visual scanning
  - reduced horizontal field of view
  - missed checks (e.g., mirror checks)
  - etc

Driver Distraction

- Factor in up to 22% of car crashes and 71% of truck crashes, depending on how driver distraction is defined and the method used to measure it's impact on safety (Klauer et al, 2006; Olsen et al, 2009)
- Driver interaction with technology accounts for about 15 to 20 percent of all distraction-related crashes (Gordon, 2008)
- Distraction cannot be eliminated, because some some sources of distraction can never be eliminated eg erupting volcanoes
- The challenge for human factors is to minimise distraction through good HMI design and, if it can't be avoided, to develop effective real time distraction prevention and warning systems.

Behavioural Adaptation

- Drivers can adapt positively or negatively to new technologies.
- Positive adaptation occurs when people adapt to a system in the manner intended by the system designer.
- Negative behavioural adaptation, if it occurs, can take several forms:
  - Misuse eg don't disengage cruise control to reduce speed when going around a tight corner
  - Abuse – eg set cruise contol or top speed limiter to 10% above speed limit

Behavioural Adaptation

- "Task difficulty homeostasis" (Fuller, 2008) - eg drivers engage more in secondary activities if they feel that driving is too easy because of automation

Awareness of System Capabilities and Limitations

- Drivers must understand the capabilities and limitations of the systems with which they interact
- If not, they may overestimate system capabilities, fail to appreciate system limitations, program the system to do the wrong thing, or ignore the system when it issues correct advice.
- Eg reverse parking aids
- Eg speeding downhill with CC engaged, because driver doesn't realise CC does not brake when going down hills

Over-Reliance

- Drivers can become complacent if they perceive the system to be perfectly reliable and have total trust in it
- Drivers have been shown to adapt very quickly to some warning and avoidance technologies and rely on them completely after a brief period of time
- How many times have you obeyed your route navigation system when you were almost 100% sure the instruction was wrong?

Risk Exposure Change

- New technologies can change drivers' travel patterns and, hence, exposure to risk.
- Satellite navigation systems can, on the one hand, reduce unnecessary travel by preventing drivers from getting lost
- On the other, they can encourage people to take more trips to more unfamiliar locations, increasing exposure to the road network, and hence to risk
- This may be problematic for some user groups (eg the elderly), who may not be equipped to handle novel driving conditions in unfamiliar locations.
- It's a largely unexplored issue for most emerging systems

Skill loss

- Driver's driving skills (navigating, avoiding accidents, following the road etc), derived from control of current generation vehicles, may diminish as the vehicle becomes increasingly capable of scanning for, perceiving, assessing and responding to traffic hazards.
- This is problematic if a system fails or, in the current stage of evolution of vehicles, if drivers swap from vehicles with automated functions to vehicles with no automated functions.
- Training programs will, in future, need to develop a different repertoire of driving skills and knowledge brought about by the evolving vehicle. Whos' think about that?

Driver Acceptance

- If new technologies, designed to support drivers, are not acceptable to them, they won't buy them – and if they don't buy them, they won't use them – and if they don't use them, the systems won't deliver their intended benefits
- To be acceptable, they must be, among other things, useful, user-friendly, and satisfying to use – although there is much debate about what "acceptance" really means, and no reliable and valid tool exists for measuring it.
- ITS for vehicles are products – but unlike most products, relatively little research has been done to understand how acceptable they are to drivers, and what barriers to acceptance exist that might stifle system purchase and use .

Individual Differences and Preferences

- ITS technologies must cater for individual differences and preferences, as drivers are far more heterogeneous than operators in more regulated domains, like aviation.
- Some drivers will be happy to buy a car that does not let them turn off their forward collision warning system; other drivers will not.
- It is one thing to give a driver the option of finding their favourite radio station in 4 different ways, even if they choose the most distracting mode of operation
- But it's another to give them the option to turn off a forward collision warning system. What if they forget that its off and do little or nothing in the face of an emerging frontal hazard?

Individual Differences and Preferences

- Catering for individual differences and preferences without compromising driving performance and safety will be a great challenge for the HF community
- There's a lot we don't know about in this area

Conclusion

- ITS and other technologies will make it possible to significantly enhance the safety, enjoyment and amenity of driving
- Their potential benefits, however, could be undermined by their potential disbenefits if their short and long term effects on driving performance are not carefully researched and understood.
- Field Operational Tests allow us to understand these effects.
- Human Factors is playing a critical role in shaping the future of driving.


THE END
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