Automotive Safety Council

Prevent Protect Notify

Number of employees per state

Alabama	90	Indiana	1659	Ohio	1419	Virginia	515
Arizona	473	Massachusetts	365	Rhode Island	224	Washington	575
California	202	Michigan	8,222	South Carolina	578	Washington DC	3
Florida	503	Missuori	1000	Tennessee	1000	Wisconsin	614
Georgia	460	New York	517	Texas	998		
Illinois	789	North Carolina	1915	Utah	4012		

Autoliv

BOSCH

Continental
The Future in Motion

DELPHI

GRACO

KSS
KEYSAFETYSYSTEMS

TAKATA

tass

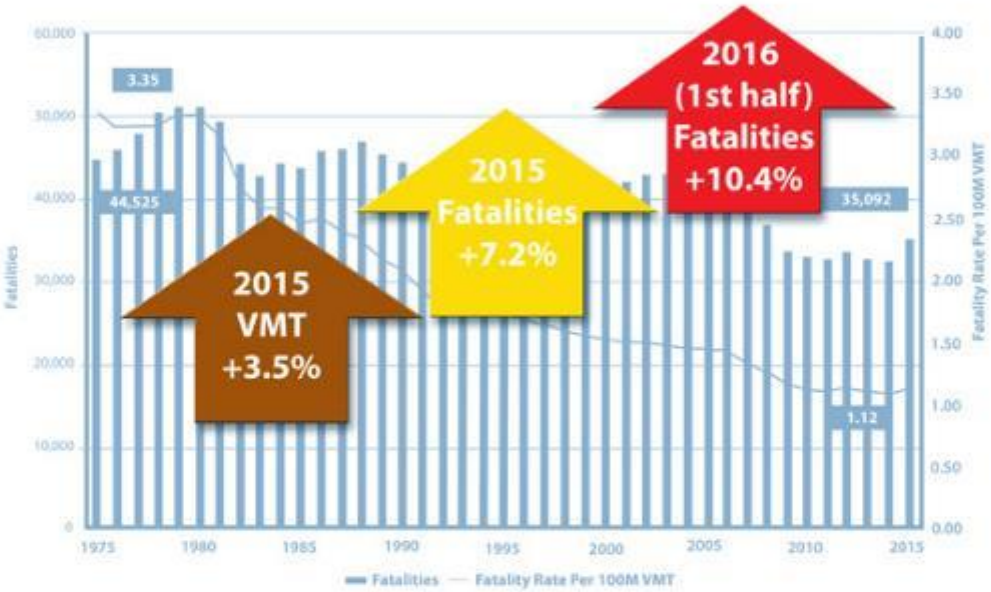
TOYODA GOSEI

TRQSS

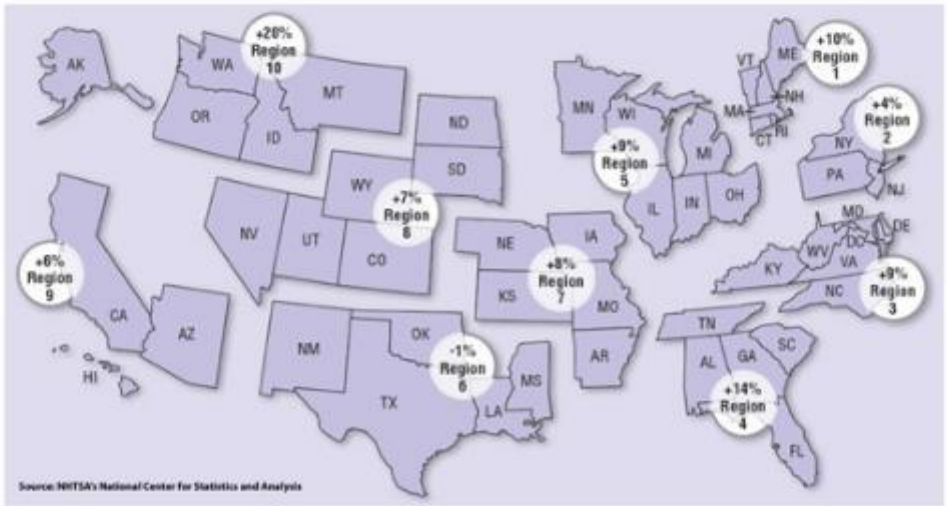
ZF

Automotive Safety Council

Vehicle Crash Statistics

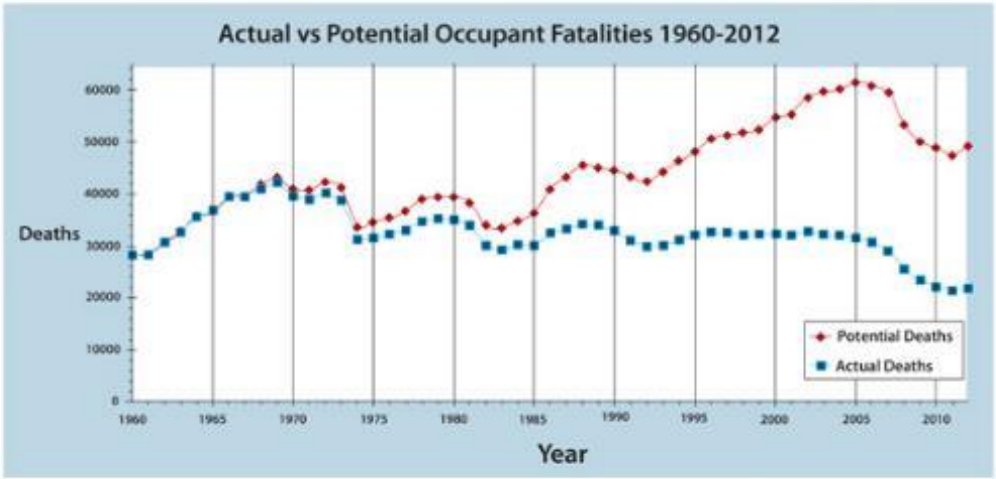


Percentage Change in Estimated Fatalities in 2015 From Reported 2014 Fatality Counts (by NHTSA Region)



- **NHTSA reported that the significant increase in fatalities in 2015 was primarily driven by increases in pedestrian, motorcyclist, and pedalcyclist fatalities.**

Vehicle Age & Fatality Statistics



"Since 1960 motor vehicle safety technologies have saved *613,501 lives.*" (Global NCAP, 1/26/15)

- **The Probability of Fatal Injury in newer vehicles is substantially less, even as they age.**

"The likelihood of crashing (per 100,000 miles driven) has decreased from 30% in an MY 2000 car to 25% in an MY 2008 one, when both vehicles are driven as new." - (Glassbrenner, 2012)

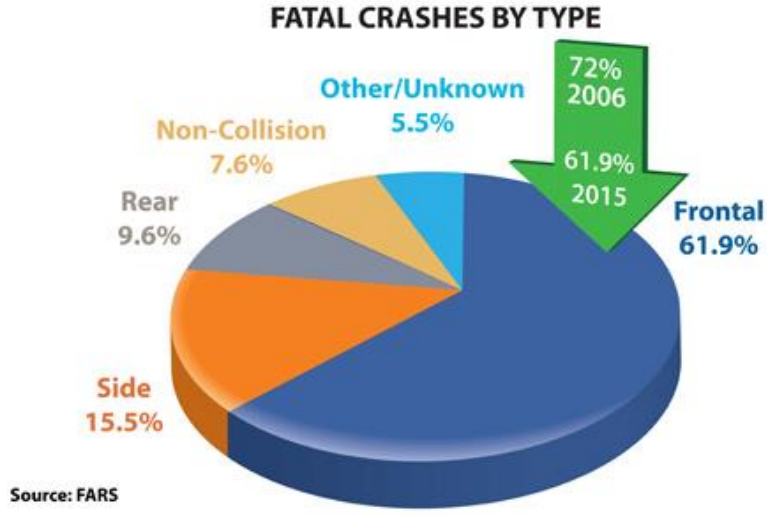
"The chances of dying in a crash in a late-model vehicle have fallen by more than a third." (IIHS, 2015 Status Report)

Sources for Graphs, Top: LIVES SAVED BY VEHICLE SAFETY TECHNOLOGIES 1960 TO 2012
Middle: both are from FARS 2005-2011

Vehicle Crash Fatality Statistics - Frontal

VIDEO

IIHS CRASH



Lives Saved	
Year	Frontal Airbags
2011	2,341
2012	2,422
2013	2,398
2014	2,400
2015	2,573

Reduction in Frontal Crash Fatalities by 10%

Proposed New US-NCAP Rating

Current NCAP

Overall rating
1 to 5 stars

Crashworthiness

Proposed New NCAP

Weighted Sum
(Weight TBD)

Overall Rating Score

- TBD → Crash-worthiness
- TBD → Pedestrian Protection
- TBD → Crash Avoidance 5 star rating

Proposed New NCAP – Pedestrian Protection

NHTSA intends to use the same (or similar) scoring system and apportioning that Euro NCAP uses in accordance with the Assessment Protocol

Pedestrian Protection

- TBD → Crashworthiness Pedestrian Safety
  - 2/3 → Head form tests
  - 1/6 → Upper leg form
  - 1/6 → Lower leg form
- TBD → Pedestrian Crash Avoidance Score
  - TBD → Pedestrian Automatic Emergency Braking
  - TBD → Rear Automatic Braking

Standard -> Full Score
Optional -> Half Score
Not Available/Fail ->Zero

Proposed New NCAP – Crash Avoidance

Crash Avoidance

- 35 → Forward Collision
  - 12 → FCW
  - 12 → CIB
  - 11 → DBS
- 30 → Visibility
  - 15 → Lower Beam Head Lighting
  - 9 → Semi-automatic Headlamp Beam Switching
  - 6 → Amber Rear Turn Signal Lamps
- 35 → Driver Awareness/ Other
  - 7 → LDW
  - 8 → Blind Spot Detection
  - 20 → Rollover Resistance

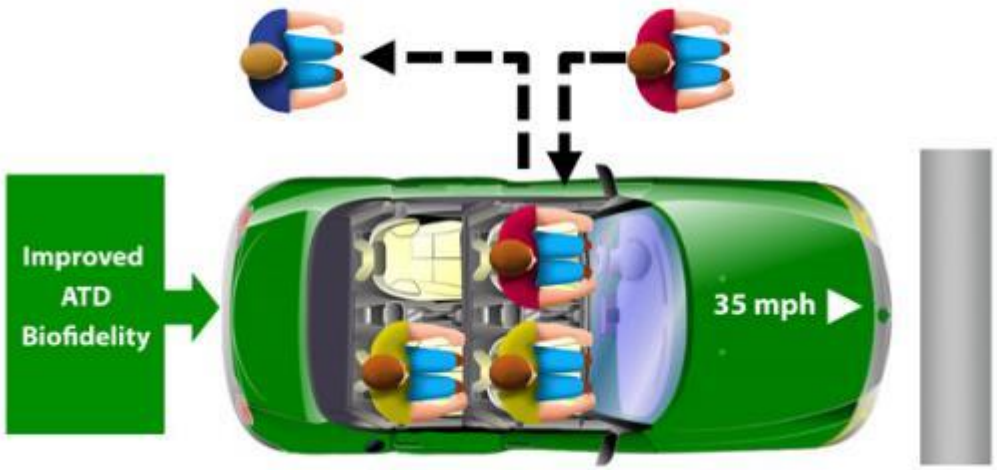
Table 11. Crash Avoidance Rating Scale

CA Point Total	CA Rating
1-19	1 star
20-39	2 star
40-59	3 star
60-79	4 star
80-100	5 star

Frontal Crash Modes Proposed for US-NCAP

Proposed NCAP Frontal Crash Test Changes

HIII 50% replaced with THOR 50%



HIII 5% (Front & Rear Passenger)

Countermeasures for 35 mph Frontal Crash – 0 Degree

Driver Occupant

New ATD (THOR)
- Seat Cushion Airbag
- Knee Airbags
- Pretensioners
- Active Pre-pretensioners

Passenger Occupant

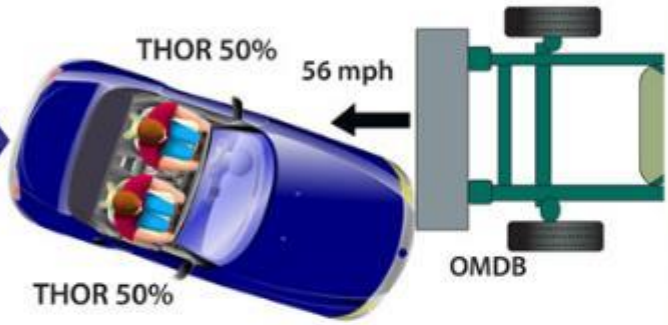
Seat Position Changed
- Seat Cushion Airbag
- Knee Airbags

Rear Seat Occupant

New Load Case
- Seat belt Load Limiter with stop
- Inflatable Belts
- Rear Seat Airbags
- Anchor Location

Frontal Crash Modes Proposed for US-NCAP

New oblique angle crash condition



Countermeasures for 56 mph Frontal Crash – Oblique

Driver and passenger may glance off traditional frontal airbags

New concept passenger airbag captures passenger head and torso

Automotive Safety Council

Brain Injury Criteria (BrIC) Proposal For US-NCAP

What is BrIC?

- Brain injury can be caused by head contact with interior structures of the automobile or sudden translational and rotational head motion
- The brain injury severity depends on duration and conditions of impact event
- Currently BrIC is not part of FMVSS208 or US-NCAP specified injury criteria
- Proposed US-NCAP update requires BrIC as a injury criteria in frontal, oblique and lateral impacts for driver and passenger occupants
- Restraint industry has proposed changes in seat belt characteristics, new airbag shapes and sizes to mitigate Brain Injury Criteria (BrIC)

VIDEO

Brain Injury Criteria

Why BrIC is Important?

Average annual number of deaths in Automotive Fatal Crashes in US (2002-2006)

- Fatalities attributable to brain are second only to thoracic attributable fatalities
- Brain injury is frequently referred to as the "silent epidemic" because the complications from TBI, such as changes affecting thinking, sensation, language, or emotions, may not be readily apparent
- The societal cost associated with TBI is much higher than any other body regions.

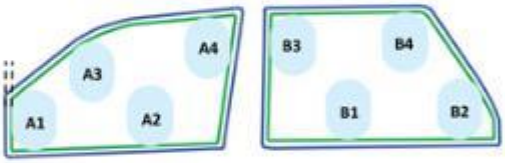
New Tests Enhance Occupant Safety in Rollover Events

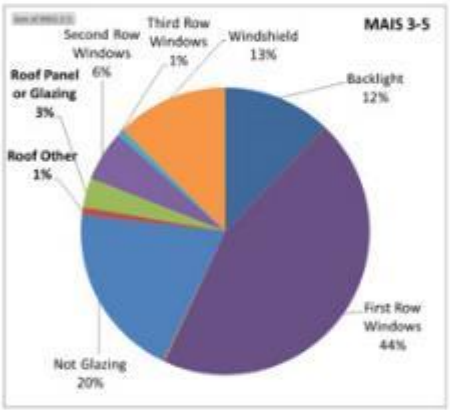
Ejection Mitigation Using Airbags



FMVSS 226 EJECTION MITIGATION

- **Maximum 4 test points per window in the front 3 rows**
- **Tests at 2 Impact speeds: 16 km/h &20 km/h**
- **Phase-In: September 1st 2013 – September 1st 2017**
- **Excursion target <100mm**



Data source: NHTSA NASS database

New curtain airbags help reduce / prevent excursion of head past window plane

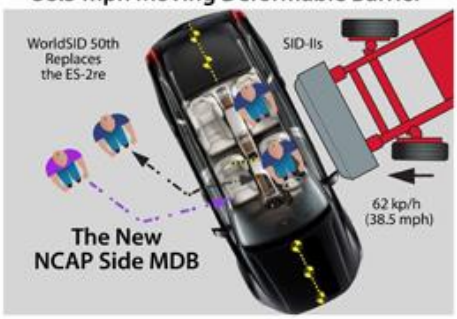
Sunroofs are getting larger than ever

- **Nearly 40% of new vehicles sold in the market last year featured a sunroof – a fourfold jump since 1990, according to analyst firm WardsAuto**
- **40% of potential new car buyers said their next vehicle purchase would likely include a panoramic sunroof**
- **Existing airbag technologies can be redeployed to address excursions through larger panoramic sunroof**

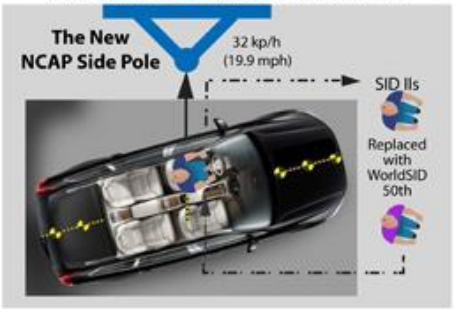

Side Impact Modes Proposed for US-NCAP

NHTSA Request for Comment "New US-NCAP"

38.5 mph Moving Deformable Barrier



19.9 mph 75 Degree Oblique Pole



WorldSID

WorldSID 50th Percentile Male Side Impact Dummy Biofidelity– ISO Ratings

Head	Neck	Shoulder	Thorax	Abdomen	Pelvis	Overall
10	5.3	10	8.2	9.3	5.1	8.0

Source: Scherer, R., Bortenschlager, K., Akiyama, A., Tylko, S., Hartleib, M., and Harigae, T., "WorldSID Production Dummy Biomechanical Responses," The 21st International Technical Conference for the Enhanced Safety of Vehicles, Paper No. 09-0505, 2009

Potential countermeasures for New Side Impact Crash – Tests

Side Airbag Countermeasures
- **Distributed load on the ribs and abdomen**
- **Arm support and rotation**
- **High pressure with larger vents size**

Roof Mounted Curtain Airbag Countermeasures
- **Manage head acceleration**
- **Reduce Brain Injury Criteria "BrIC"**
- **Reduce head rebound force**

A Recent History of Seat Belts

FMVSS & US-NCAP

2010

- US manufacturers are phasing in features like adaptive load limiters, crash locking tongues and other technologies as needed to address updated requirements in FMVSS 208, US-NCAP and IIHS test protocols
- National seat belt usage rate is 85%

2016

- National belt usage rate reaches 90%

2019 NHTSA Proposed New NCAP

- New frontal oblique crash test added
- Ratings updated to add credits for advanced driver assistance technologies
- New ATD technologies will be used to assess performance in new frontal, side and impact pole tests

EuroNCAP

- Europe's traffic fatality rate has been reduced by nearly 60% since EuroNCAP started publishing their ratings in 1997
- EuroNCAP frequently updates its criteria to encourage quick adoption of new safety technologies
- The European Commission has adopted a goal to further reduce traffic fatalities by 50% in the ten-year period from 2010 to 2020

2014

- EuroNCAP added credits for advanced driver assistance technologies to already-existing credits for seat belt reminders and other safety features
- Western EU seat belt usage rate is 92%

2016

- New child-protection tests and ratings

2018

- New far-side impact protection test and rating criteria

2019

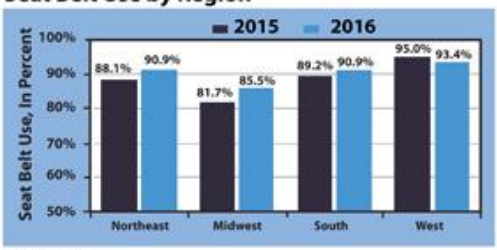
- Europe starts phase-in of mandatory seat belt reminders for all seats

2020

- New frontal crash test mode, and new dummy added to existing tests
- Western EU belt usage rate projected to exceed 95%

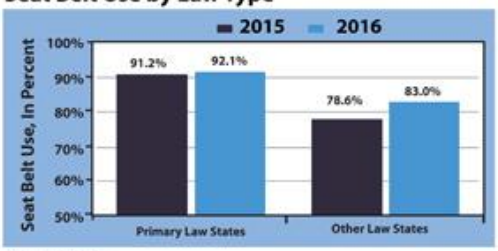
Seat Belts Save Lives

Seat Belt Use by Region



Source: NOPUS

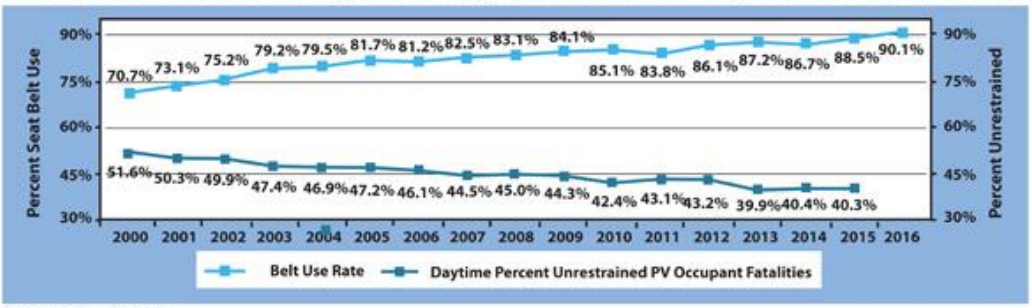
Seat Belt Use by Law Type



Source: NOPUS

1 The FARS 2016 data on the percentage of unrestrained passenger vehicle occupant fatalities during daytime will be available in 2017

National Seat Belt Use Rate and Daytime Percentage of Unrestrained Passenger Vehicle Occupant Fatalities

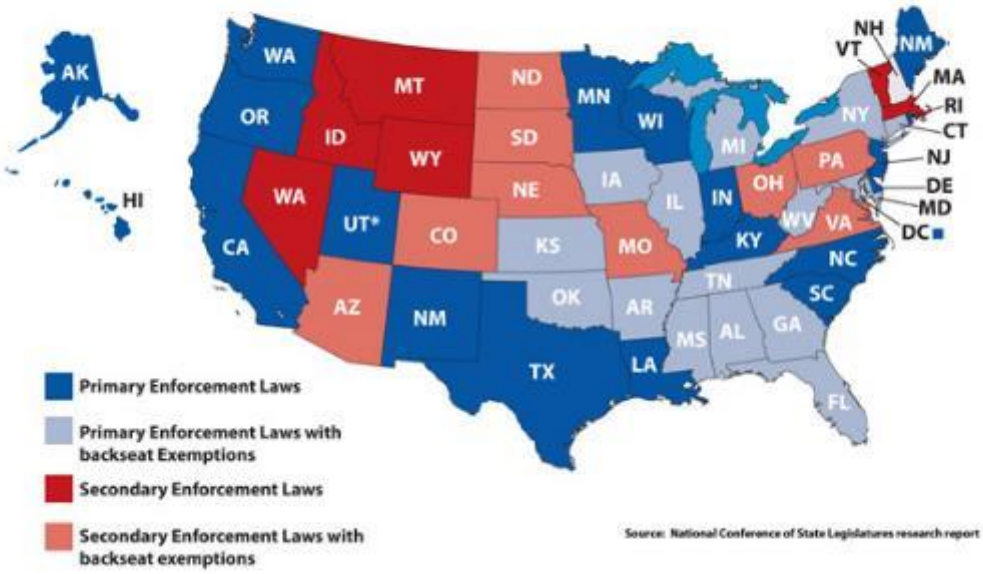


Source: NOPUS and FARS

- **A total of 22,441 passenger vehicle occupants died in crashes in 2015 (on average, a death about every 23 minutes)**
- **At least 9,874 (44%) of those victims were unrestrained**
- **In 2015 alone, seat belts saved 13,941 lives**
  - **Young adults (age 18-24) are less likely to wear seat belts than those in older age groups**
  - **Men are less likely to wear seat belts than women**
  - **Adults who live in rural areas are less likely to wear seat belts than adults who live in urban areas**
- **Airbags provide added protection but are not a substitute for seat belts**
- **Airbags plus seat belts provide the greatest protection for adults**
- **It is estimated that 100% seat belt use could reduce crash related fatalities by 2,800. This represents a reduced cost to society of $27 Billion.**

***NHTSA VSL published data and ASC estimate**

State Seat Belt Laws



Source: National Conference of State Legislatures research report

- Primary belt laws allow police to stop and ticket a motorist if the driver and passengers are not buckled up. (Nonconforming primary laws allow exceptions for some vehicles, such as pick-up trucks.)
- Secondary belt laws allow police to issue a citation only if the driver is first stopped for another infraction.
- Backseat exemption: passengers older than age 7 to 18 (depending on each state's law) can ride in the back seat without wearing a seat belt.

- **Seat belts can reduce the risk of:**
  - **Receiving moderate to critical injuries by 50%**
  - **Fatal injury to front seat passengers car occupants by 45%**

- **Only one state (NH) does not mandate front seat belt usage, while about 45% of the US population resides in states that do not mandate rear seat belt use for adult occupants**

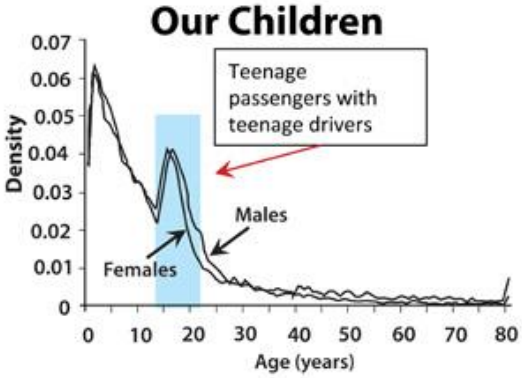
- **In 2015, rear seat belt use averages 83.3% in those states which mandate it, compared to only 61.4% in those states that do not (front seat belt usage averages 88.5% nationally)**

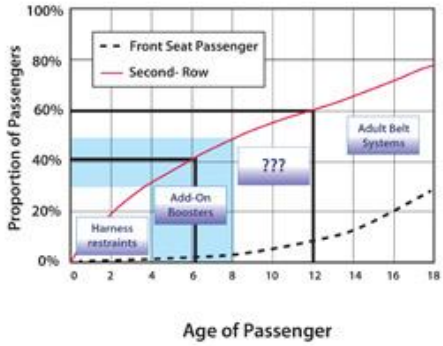
- **Rear seat occupants can reduce their risk of dying in a crash by better than 50% simply by buckling up**

- **Very few vehicles have rear seat belt visual or audible reminders (these are mandated for the driver, and very common for the right front passenger)**

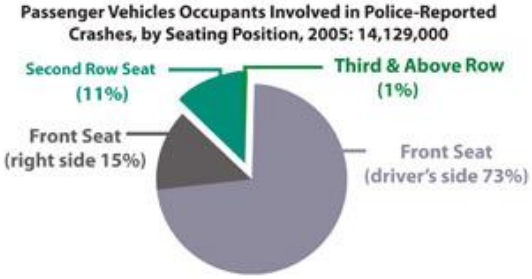
Rear Occupant Safety

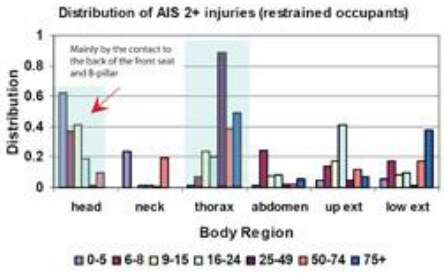
Who travels in the rear seat?





Percentage Injured and Types of Injuries





Wearing seat belts is safer

We can improve upon it

Rear Occupant Safety Study

Hybrid Restraint Systems

Seat Belt Configurations	 3-Pt Belt	 4-Pt Belt 'X'	 Suspender	
Pre-Tensioning	 Retractor PT	 Buckle PT	 Anchor PT	
Load Limiting	 Progressive LL	 Constant LL	 Digressive LL	 Switchable LL
Inflatables	 Inflatable Belt	 Bag In Roof	 Self Conforming Rear Seat Airbag	

Advanced Hybrid Restraint Systems

Restraints	Pre-tensioning	Load Limiting	Hybrid (belt + bag)
Baseline (Current)	None	None	None
Advanced Seat Belts	Retractor + Anchor	Yes	None
Advanced Hybrid	Retractor + Anchor	Yes	Yes

Rear Occupant Safety Study

Advanced Hybrid Restraint Systems May Help Improve Rear Seat Safety

6 Year Old

- Head Injury reduced by 43%
- Neck Injury reduced by 70%

Small Adult Female

- Head Injury reduced by 75%
- Neck Injury reduced by 70%
- Chest Injury reduced by 62%

IARV's - Based on the Supplement: Development of Improved Injury Criteria for the Assessment of Advanced Automotive Restraint Systems – II (2000)

Rear Occupant Safety

Ease of Use Plays a Big Role in Car Seat Safety

- Road injuries are the leading cause of unintentional deaths to children in the United States.
- Correctly used child safety seats can reduce the risk of death by as much as 71% (source: SafeKids Worldwide)
- 73% of car seats are not used or installed correctly (source: SafeKids Worldwide)

- Technologies such as belt tensioner systems may help prevent misuse by making the process of installing a car seat easier

Rear-Facing Car Seat Usage

- The American Academy of Pediatrics recommends children ride rear-facing until at least 2 years of age
- Rear-facing helps keep children safer
- Rear facing seats help support the head, neck, and spine in the event of a motor vehicle collision

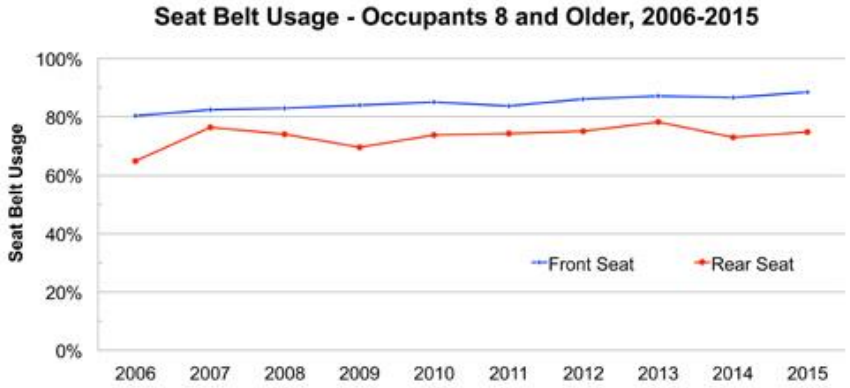
- Caregivers often graduate their children to forward-facing seats prematurely due to lack of legroom

- Seats with higher rear-facing weight limits and that provide extra legroom help promote the AAP and NHTSA recommendations

Reducing Rear Occupant Injuries

In 2016 - Seat Belts saved 1,672 rear occupants' lives

- Improving usage to 100% could have saved an additional 337 lives
- Increasing rear passenger belt use also reduces risks to front passengers
- Seat belt use reminders (MAP-21) and Primary Use laws will reduce fatalities
- Eliminating 337 fatalities would potentially have reduced societal cost by $3.2 Billion in 2015



Proposed US-NCAP changes will also increase Rear Seat Safety

- Incorporating rear occupant protection will accelerate system development
- Eliminating 293,000 rear seat injuries would potentially have reduced societal cost by as much as $113 Billion in 2015

Changes to FMVSS 208/9 could allow Seat Belts to be more effective

- Removal of barriers to system integration could improve rear seat safety
  - 747 properly-restrained rear seat passengers were killed in 2015
  - Different vehicle environments drive the need for tailored solutions
  - Restrictions on seat belt design prevent effective use of load limiters in rear seats
- Seat belt reminders front/rear can improve usage and reduce overall injury risk
- Improving the comfort and convenience of seat belt systems can increase usage rates
  - Better integration in the vehicle's design for comfort and ease-of-use
  - Active technologies such as belt/buckle presenters
  - Illuminated seat belt buckles

Automotive Safety Council

Rear Seat Belt Reminder

Rear Seat – Seat Belt Reminder Technology Exists Today

EuroNCAP awards ratings points to vehicles with what it calls intelligent or enhanced belt reminders for rear seats

- **IIHS HLDI Status Report**
  - **"Back seats also should have belt reminders, parents say"**
  - **"Drivers back stronger belt reminders; European systems could be model"**

VIDEO

Rear Seat Safety

- **NHTSA / DOT HS 812 173, August 2015**
  - **"There were strong and consistent effects of the Enhanced Seat Belt Reminder System on…effectiveness in prompting seat belt use"**
  - **Enhanced Seat Belt Reminder systems for rear seats are estimated to save 106 lives per year which represents a billion dollar savings in societal cost**

Electronic Stability Control (ESC)

- Rollover resistance systems use Electronic Stability Control braking systems to try and stabilize a vehicle in emergency situations - e.g. emergency lane change - to reduce the risk of rollover
- Sensors detect if the vehicle is at risk of rolling, for example during a sharp turn, and the stability control system can automatically apply braking to individual wheels to stabilize the vehicle

- Electronic Stability Control is currently mandated on 100% of the cars sold in the USA in 2017
- It is estimated* that standard fitment of Rollover Resistance systems will reduce annual fatalities by up to 5,000 and injuries by up to 30,000. This represents a potential $60 billion annual cost saving to society.

Based on NHTSA VSL and ASC estimates

Automotive Safety Council

Forward Collision Warning (FCW)

- FCW Systems use radar, laser or object detection cameras as sensors
- Measure relative speed and distance to objects ahead of the vehicle, and look for reducing time gaps and distances to vehicles / objects ahead
- When the system detects a potential collision, it can:
  - Warn the driver using audio, visual or haptic (e.g. vibration) alarms
  - Prepare the vehicle's brakes for a faster response when the driver presses the brake pedal

VIDEO

Forward Collision Warning

- These technologies are currently available as options or standard fit on 18% of the cars sold in the USA in 2017
- It is estimated that 100% inclusion of this technology could reduce annual fatalities by up to 35 and injuries by up to 55,000. This represents a potential $22 billion annual cost saving to society.

Based on NHTSA and NCAP data

Automatic Emergency Braking (AEB)

- AEB equipped vehicles with Crash Imminent Braking and Dynamic Brake Support will:
  - Alert drivers of a dangerous situation using audio, visual or haptic alarms (Forward Collision Warning)
  - Automatically apply the vehicle brakes when an imminent collision is detected (Crash Imminent Braking)
  - Automatically increase braking if driver does initiate braking but with insufficient amount to avoid a collision (Dynamic Brake Support)

VIDEO

Automatic Breaking

- Standard equipment on ~ 6% 2016 vehicle models
- Optional on ~ 51% of all 2016 vehicle models
- Installed on ~16% of all 2016 vehicles sold
- U.S. DOT and IIHS announced the commitment of 20 manufacturers to make this technology standard on all cars and trucks by 2022
- It is estimated that 100% inclusion of this technology could reduce fatalities by up to ~108 and injuries by up to ~150,000 annually. This represents a potential $58 Billion annual cost saving to society.

Based on NHTSA VSL and ASC estimates

Automotive Safety Council

Lane Departure Prevention

- Use forward-looking camera or other sensors to detect lane markings and identify when the driver is unintentionally leaving the lane
  - Lane Departure Warning provides audible, visual and/ or haptic (e.g. vibration) alerts to the driver
  - Lane Keeping Assist uses the steering system to help the driver keep safely within the lane
  - System does not activate if driver uses turn signals to confirm planned lane change or exit – increases use of turn signals in highway driving

VIDEO

Lane Departure Warning

- This technology is currently available as option or standard fit on ~12% of the cars sold in the USA in 2017
- It is estimated* that 100% inclusion of Lane Departure Prevention systems could reduce annual fatalities by up to ~7,500 and annual injuries by up to 37,000. This represents a potential $86 billion annual cost saving to society.

Based on NHTSA VSL and ASC estimates

Automotive Safety Council

Blind Spot Detection (BSD)

- BSD equipped vehicles can:
  - Detection of one or more vehicles in either adjacent lane that may not be seen by the driver
  - Alert the driver to help facilitate safe lane changes with either audio, visual or haptic alarms
  - Be enhanced to include Active Lane Keeping Support

VIDEO

Blind Spot Detection

- BSD was installed on ~33% of all new vehicles sold in the US in 2016
- It is estimated that 100% inclusion of this technology could reduce annual fatalities by up to ~ 393 and injuries by up to ~ 20,000. This represents a potential $11.5 Billion annual cost saving to society.

Based on NHTSA VSL and ASC estimates

Automotive Safety Council

Rear Object Camera + Automatic Emergency Braking

- FMVSS111 Rear Visibility requires rearview image directly behind the vehicle Sept 2018
  - Installed on ~87% of all new vehicles sold in the US in 2016
  - Estimated to reduce annual fatalities by ~ 69 and injuries by ~ 5,000. This represents an estimated $2.6 Billion cost to society.

VIDEO

Rear Object AEB

- Rear AEB enhanced systems detect objects behind vehicles that are difficult for the driver to see while backing up
  - Display the rear view on a static screen located in drivers view
  - Alerting the driver and automatically braking if necessary
- No specific studies exist, but simulations indicate if rear automatic emergency braking had 100% inclusion, fatalities could be incrementally reduced by ~189 and injuries by ~13,500 representing a potential $4.4 Billion annual cost saving to society above the current FMVSS111 rule.

Based on NHTSA VSL and ASC estimates

Automotive Safety Council

Rear Cross Traffic Alert (RCTA)

- RTCA equipped vehicles can:
  - Improve the safety of backing up in cross traffic situations not seen by Rear Object Camera systems
  - Increases the field of view to assist the driver backing out of a parking space or alley by alerting the driver
  - Be enhanced to include Rear Automatic Emergency Braking

VIDEO

Rear Cross Traffic Alert RCTA

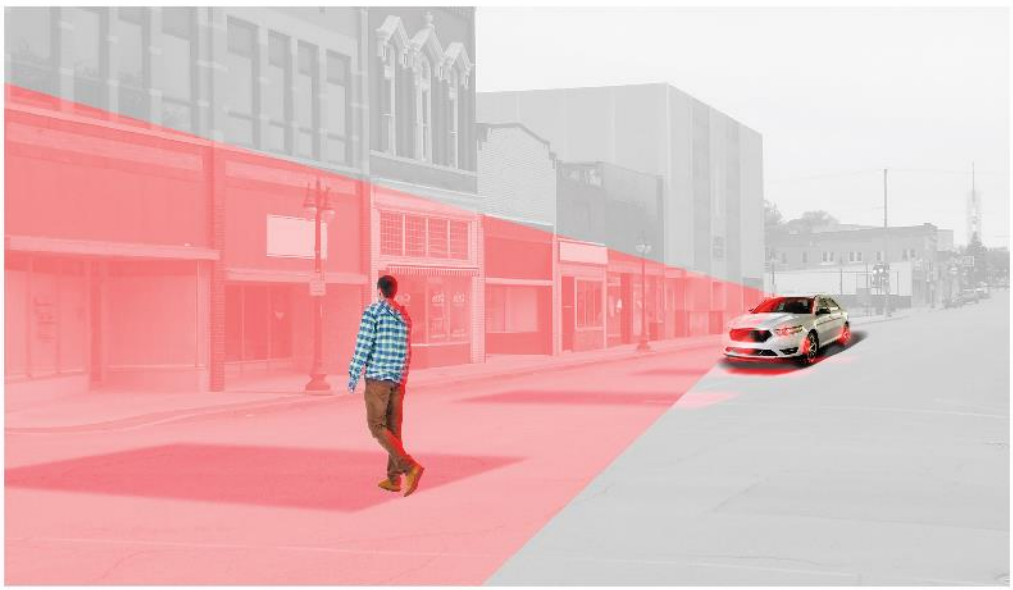
- RCTA was installed on ~23% of all new vehicles sold in the US in 2016
- It is estimated that once camera with display only are standard equipment this could reduce annual fatalities by up to ~ 69 and injuries by up to ~ 5,000. This represents a potential $2.6 Billion annual cost saving to society.
- Making Automatic Braking and Rear Cross Traffic Alert standard on 100% of vehicle produced can reduce fatalities and injuries even further

Based on NHTSA VSL and ASC estimates

Pedestrian Crash Avoidance / Automatic Emergency Braking

- System uses radar, camera, lidar sensors to "see" pedestrians
  - Wide variety of weather and lighting conditions
  - Urban and rural environments
- Sensors trigger Electronic Stability Control braking system to slow the vehicle, to reduce or potentially avoid a collision
- Fusion of multiple sensors – provides higher reliability decision
- Capability to provide other features desired by the driver

- Pedestrian fatalities increasing year-on-year – up 20% since 2011
  - 5,376 deaths in 2015, the highest number since 1976



- These technologies are currently available as options or standard fit on ~7% of the cars sold in the USA in 2016

- It is estimated that 100% inclusion of Pedestrian Crash Avoidance systems could reduce annual fatalities by over 810 and injuries by over 5,000. This represents a potential $7.9 billion annual cost saving to society

Based on NHTSA VSL and ASC estimates

Pedestrian Protection – Passive Safety

Hood Lifters

Avoid head/engine block contact --> Reduce head injuries

Pedestrian Protection Airbag

Lift hood to avoid head/engine block contact --> cushion head impact with windshield and roof pillars

Adaptive Headlights

- Vehicles equipped with Adaptive Headlight Beam Switching systems can:
  - Improve visibility using high beams
  - Reduce glare by switching to low beams
  - Benefits both vehicle occupants and vulnerable road users such as pedestrians or cyclists

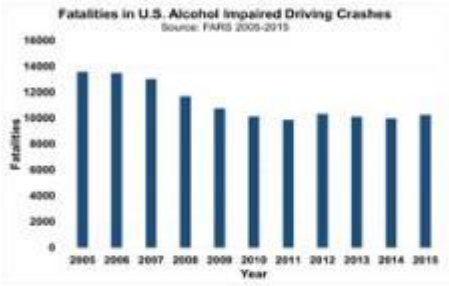
VIDEO

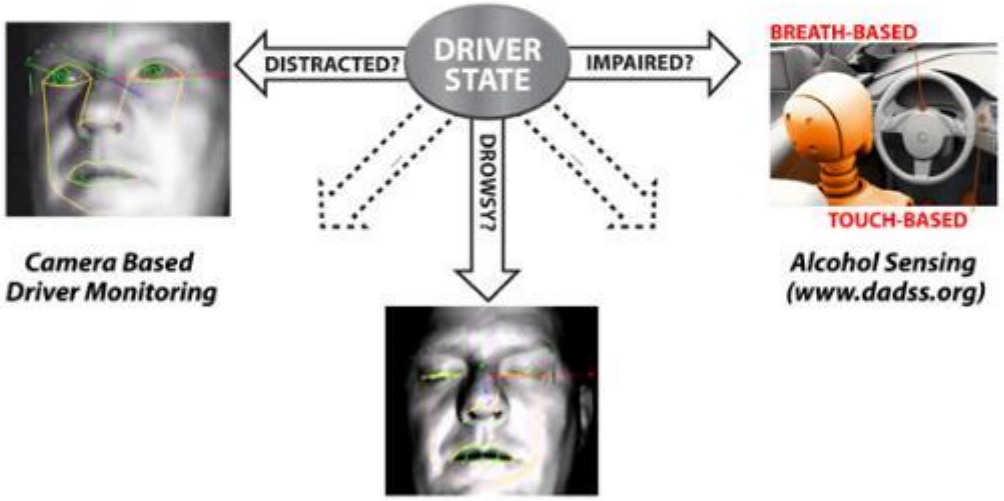
Adaptive Headlights

- Semi-automatic beam switching is offered on approximately 55% of all 2017 models
- No specific benefit studies exist, but NHTSA believes this technology could lead to reductions of injuries and fatalities, particularly for pedestrians
- ~ 3,500 pedestrian fatalities occurred in dark conditions
- Hypothetically, if this technology could reduce fatalities and injuries by up to 10%. This could reduce fatalities by up to ~ 961 and injuries by up to ~ 21,300, representing a potential $17.5 Billion annual cost saving to society.

Based on NHTSA VSL and ASC estimates

Driver State Monitoring





Camera Based Driver Monitoring

Alcohol Sensing (www.dadss.org)

- **Driver behaviour is leading cause of traffic accidents**
  - **94% due to driver error**
  - **Critical errors ▸ Recognition(41%), Decision(33%), Performance(11%), …**
- **Safety Opportunity: Provide support based on driver state**
  - **Sensors ▸ monitor driver condition**
  - **Classification ▸ determine support based on threat**
  - **Countermeasures ▸ apply support (warnings, actuators)**
- **Potential Societal Benefits**
  - **It is estimated that 100% inclusion of driver distraction and alcohol impaired driving mitigation technologies could reduce annual fatalities by up to ~7,440 and injuries by up to ~ 474,000.**
  - **This represents a potential $255 Billion annual cost saving to society.**

*** NHTSA VSL published data and ASC estimate**

Driver State Monitoring

VIDEO

Driver State Monitoring

The Mission:

The mission of the Automotive Safety Council is to improve the safety of people throughout the world through the development, production and implementation of the latest automotive safety equipment by preventing accidents, protecting occupants and pedestrians when in a collision and to notify emergency responders after the collision when necessary.

The mission utilizes voluntary, regulatory and legislative directed use of these lifesaving products in order to make it available to the most people in the lowest cost manner to save the most people from injuries and fatalities.

Continuum from ADAS to Automated Driving

ADAS

Automated Driving

Level 0	No Automation	Hands On Feet On Eyes On	Forward Collision Warning Lane Departure Warning Blind Spot Warning
Level 1	Driver Assistance	Hands On Feet On/ Off Eyes On	AEB Adaptive Cruise Control Lane Keep Assist
Level 2	Partial Automation	Hands Off Feet Off Eyes On	Traffic Jam Assist Highway Assist Self Parking
Level 3	Conditional Automation	Hands Off Feet Off Eyes On	Collision Avoidance by Steering Highway Pilot Traffic Jam Pilot
Level 4	High Automation	Hands Off Feet Off Eyes off	Valet Self Parking Automated Highway Automated Urban
Level 5	Full Automation	Hands Off Feet Off Eyes Off Mind Off	Automated Mobility on Demand Highway Point to Point Urban Point to Point

Automated Driving – Level 2

- A Level 2 system is able to control a vehicle's speed and separation, and steer the vehicle, for extended periods of time – e.g. driving on a highway
- The driver is expected to monitor the road ahead and supervise the automated driving system - "eyes on the road", and is the back-up/ redundant sensing and vehicle control system

- Examples:
  - Traffic Jam Assist
  - Highway Driving Assist
  - Automated Parking Assist

- Minimum Sensor / Technology Needs
  - Front or rear facing sensors (e.g. radar and camera) to detect and track other vehicles and lane markings

Automated Driving – Level 3

- A Level 3 system is able to control a vehicle's speed and separation, and steer the vehicle, for extended periods of time – e.g. driving on a highway
- The driver is not expected to monitor the road ahead and supervise the automated driving system continuously, but is expected to be able to retake control immediately if needed - "eyes temporarily off the road", and is the back-up/ redundant sensing and vehicle control system

- Examples:
  - Traffic Jam Chauffeur
  - Highway Driving Chauffeur

- Sensor / Technology Needs
  - 360° facing ADAS sensors e.g. radar, camera and / or lidar, with central data processing unit to detect and track other vehicles and lane markings and enable automated lane changes

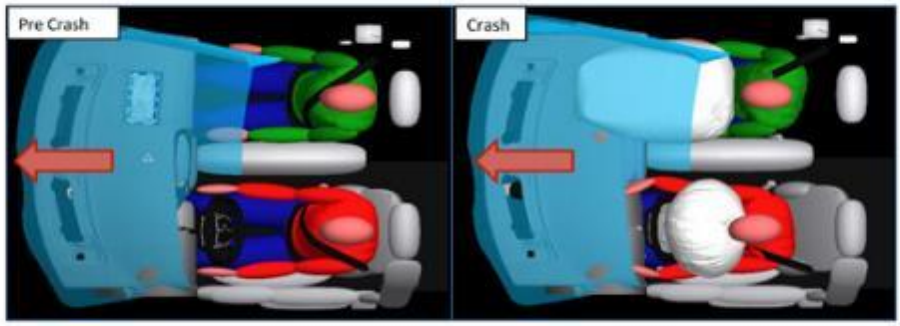
Automated Driving – Level 4 & 5

- A Level 4 system is able to control a vehicle's speed and separation, and steer the vehicle, for all driving conditions within a use–case – e.g. driving on a highway or in a city
- Level 5 systems can control and steer the vehicle, for all driving conditions – e.g. driving on a highway and in a city
- The driver is not expected to monitor the road ahead and supervise the automated driving system continuously - "eyes off the road"; the vehicle has sufficient back-up/ redundant sensing and vehicle control systems to allow this
- Examples:
  - Traffic Jam Pilot
  - Highway Driving Pilot
  - Automated Valet Parking

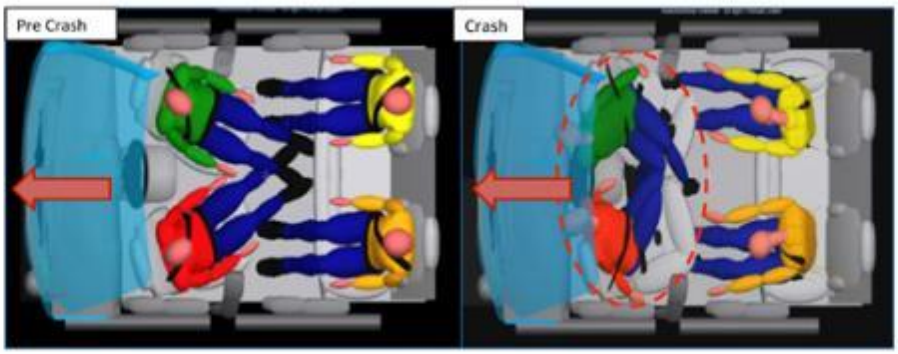
- Sensor / Technology Needs
  - 360° facing ADAS sensors e.g. radar, camera and / or lidar, with central data processing unit to detect and track other vehicles and lane markings and enable automated maneuvering
  - Redundant braking and steering systems

Autonomous Vehicle Layout Impact on Occupant Safety

Traditional Front Occupant Seating Position – Frontal Impact



Autonomous Vehicle Non-traditional Seating – Frontal Impact?



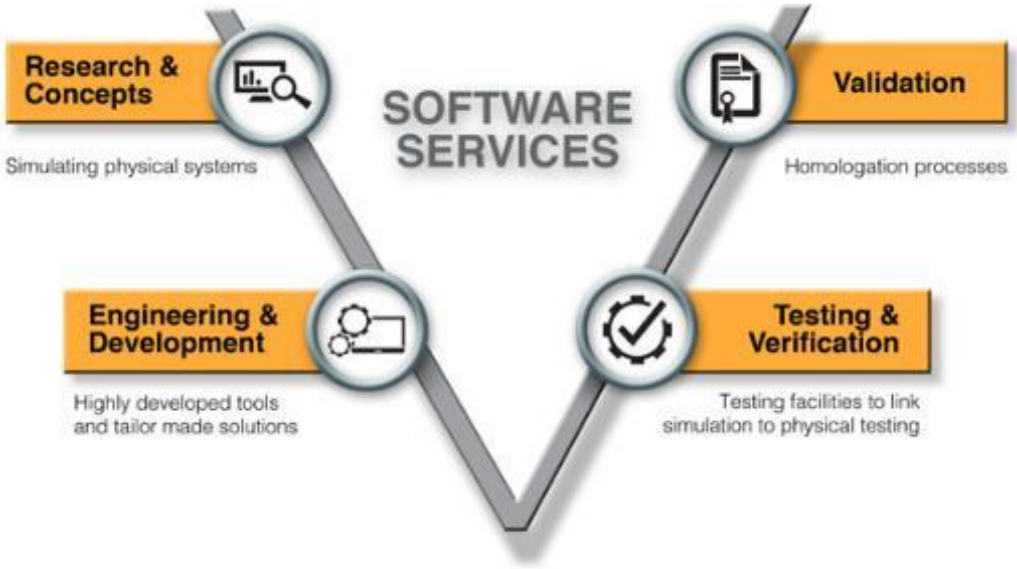
- Frontal impact crashes could become Side, Rear or Oblique Impacts with respect to the occupant seat orientation depending on seat layout
- Need for deployment of active pre-crash systems coupled with redesigned passive restraint systems to improve outcome for occupant in non-traditional seating positions

Test Tracks + Simulation = Production Ready

- **Problem**
  Collecting field data is not robust enough to ensure safe automated vehicles

- **Solution**
  Test Tracks and Simulations
  - **Safe Testing**
  - **Billions of tests**
  - **Cost Effective**

Development Methodology



Functional Validation for ADAS/ Automated Driving

VIDEO

Simulation Test Track

Prevent. Protect. Notify.

The trade association of the leading Active, Autonomous, Passive, Child and Interiors safety industry manufacturers and suppliers.

The Council speaks for the industry, representing its interests and presenting its views on any and all national and international levels.