Electronic Vehicle Controls and Unintended Acceleration

National Academy of Science
Public Meeting
July 1, 2010

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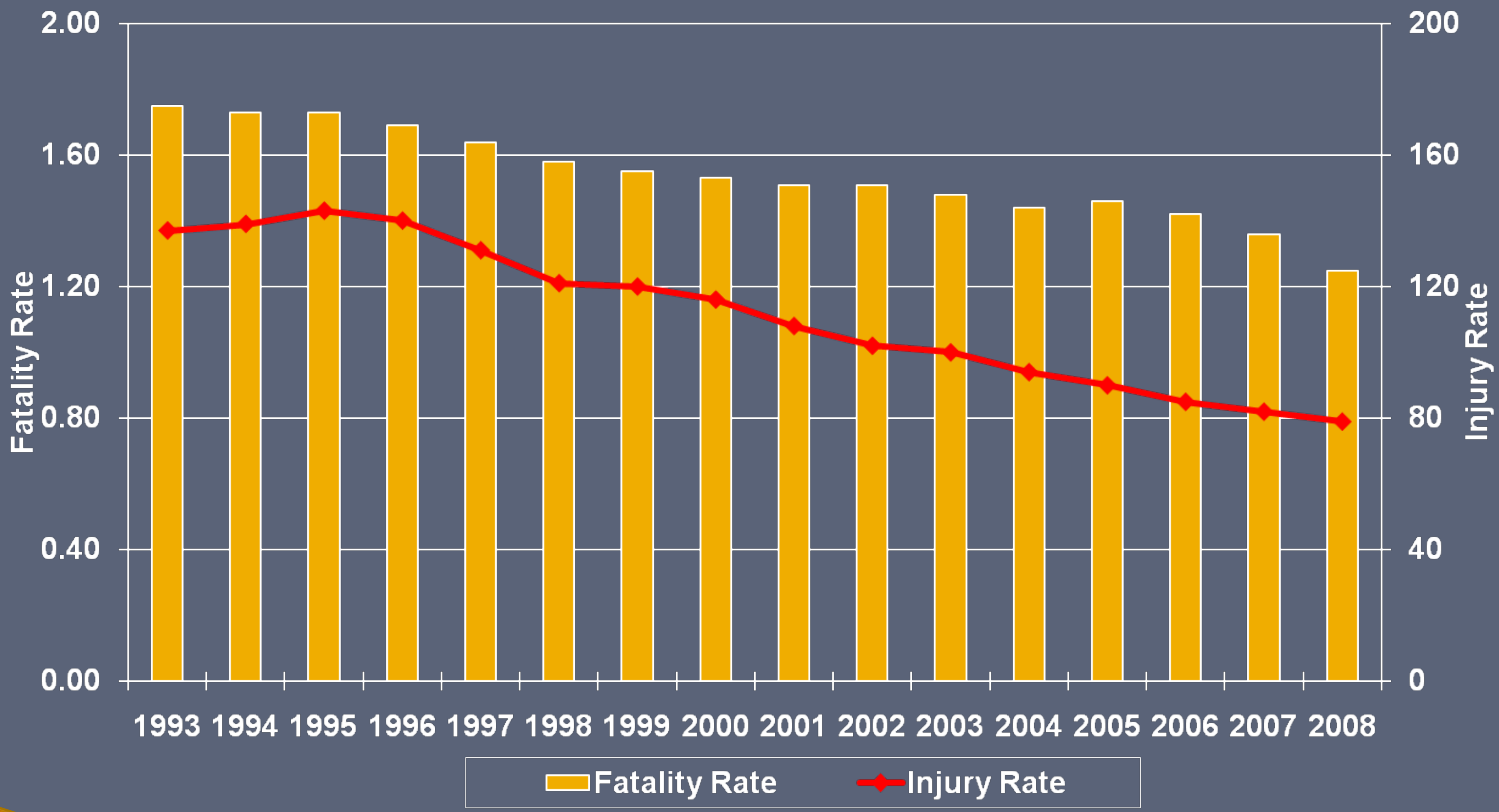
TOYOTA

Outline

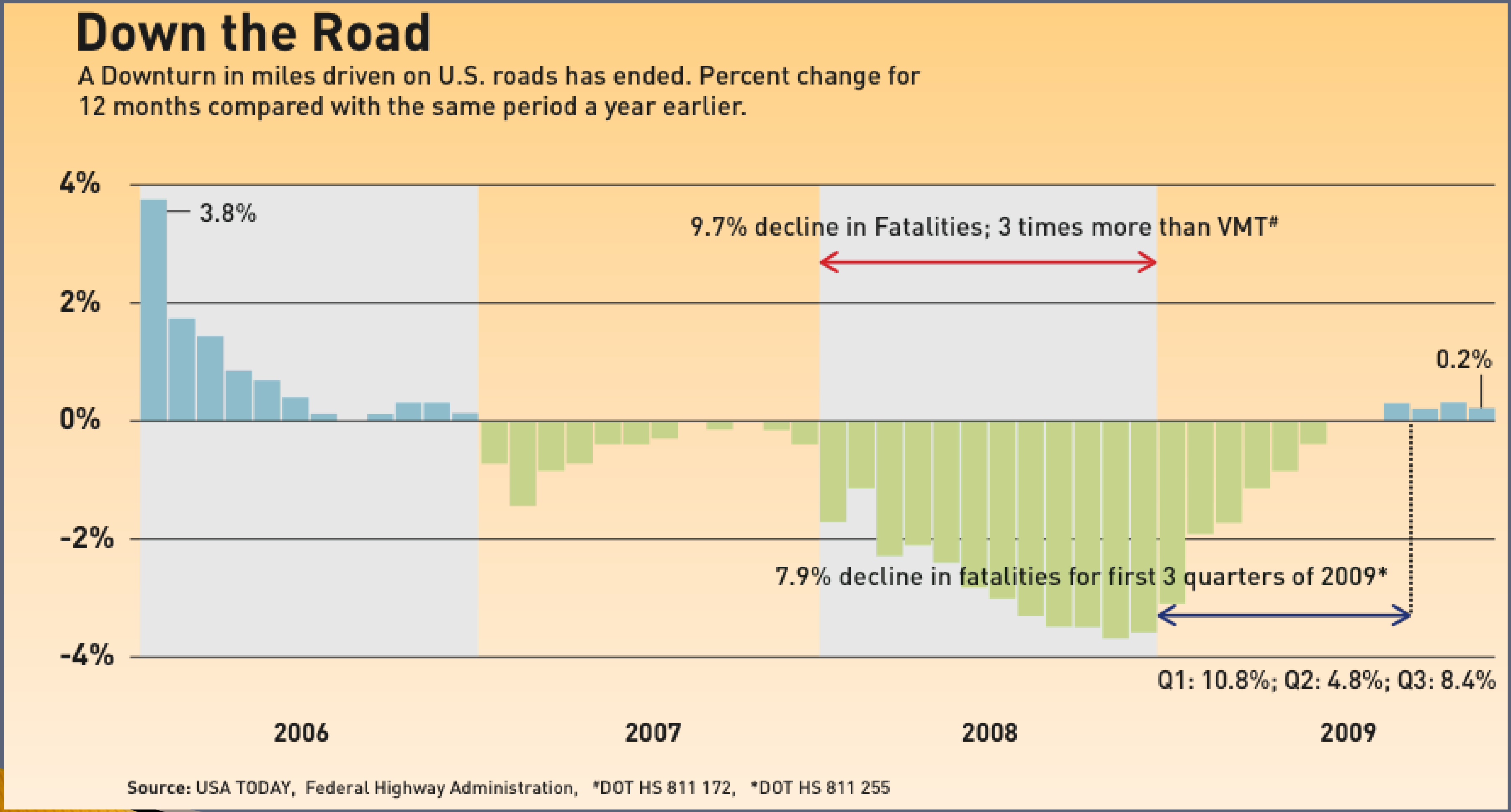
- Motor Vehicle Safety Trends
- Reinventing the Automobile
- Assuring Electromagnetic Compatibility
- Invitation

Fatality and Injury Rates per 100 Million VMT, by Year



Source: FARS, NASS GES / FHWA

Change in Vehicle Miles Traveled
2006 – 2009



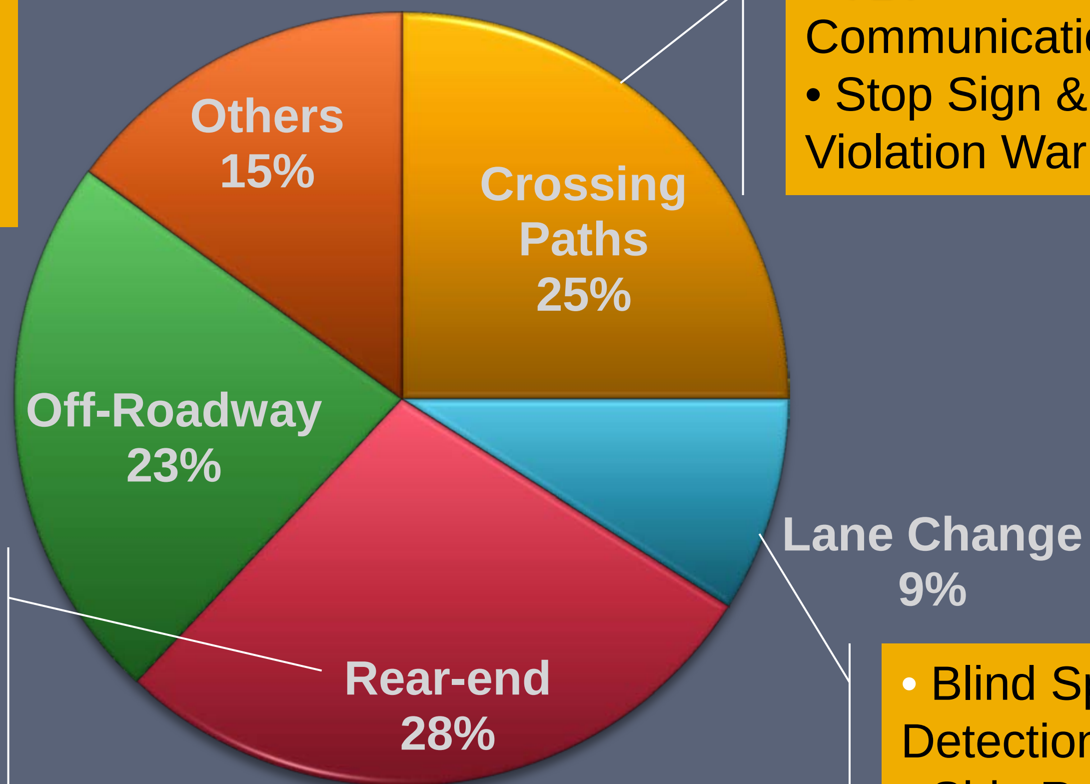
Advanced Safety Technologies
Estimated Safety Benefits

Automaker-Developed Safety Innovations	Estimated/Potential Lives Saved Annually (Not Additive)
Electronic Stability Control (ESC)	5,300 – 9,600
Lane Departure Warning (LDW)	1,138 – 2,736
Safety Belt Reminders (90% Usage Nationwide)	1,652
Side Airbags	1,029
Forward Collision Warning (FCW) with automatic braking	632
Emergency Brake Assist	271
Adaptive Headlamps	225
Blind Spot Information System (BLIS)	38

Source: Derived from NHTSA, IIHS

Crashes of All Severities
Safety Technologies

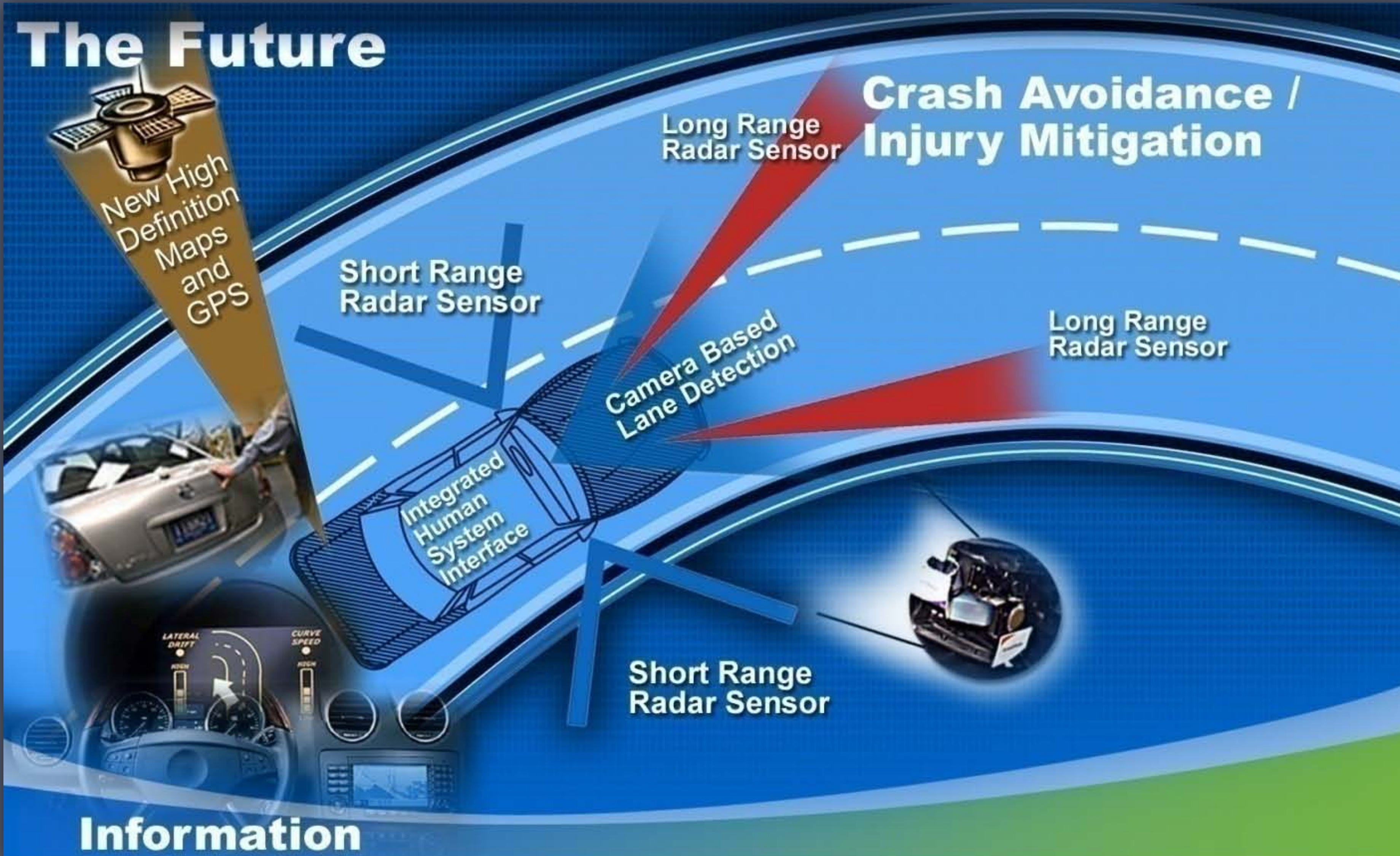
- Lane Departure Warning
- Lane Keeping
- Curve Speed Warning



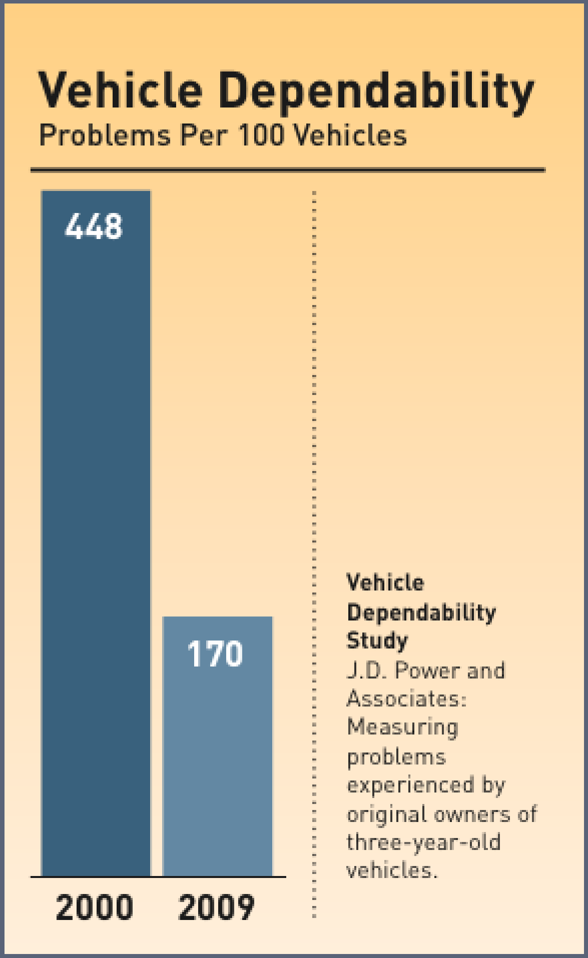
- *V2V* Communications
- Stop Sign & Signal Violation Warnings

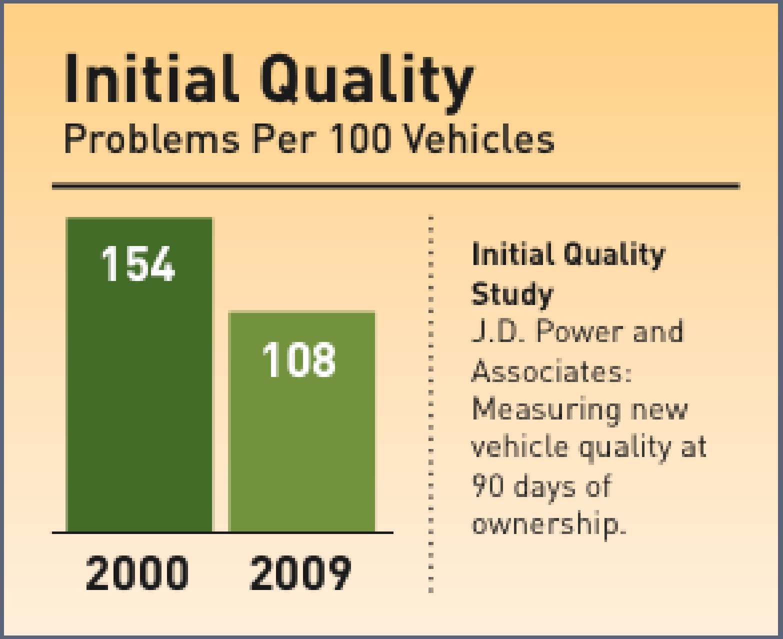
- Forward Crash Warning
- Adaptive Cruise Control

- Blind Spot Detection
- Side Radar

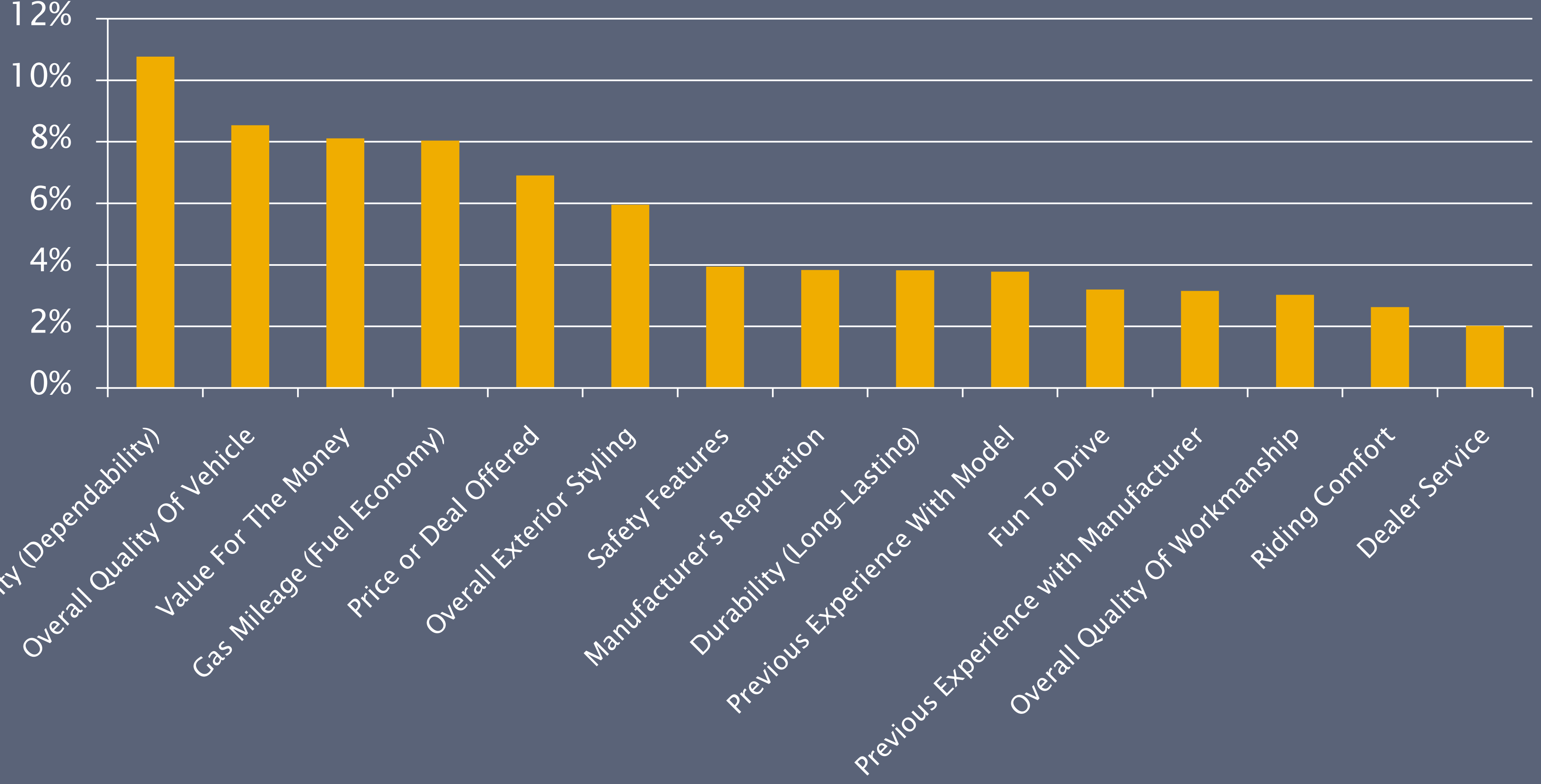

The Future
Crash Avoidance / Injury Mitigation
Long Range Radar Sensor
New High Definition Maps and GPS
Short Range Radar Sensor
Camera Based Lane Detection
Long Range Radar Sensor
Integrated Human System Interface
LATERAL DRIFT
CURVE SPEED
Short Range Radar Sensor
Information

Vehicle Dependability/Quality Trends



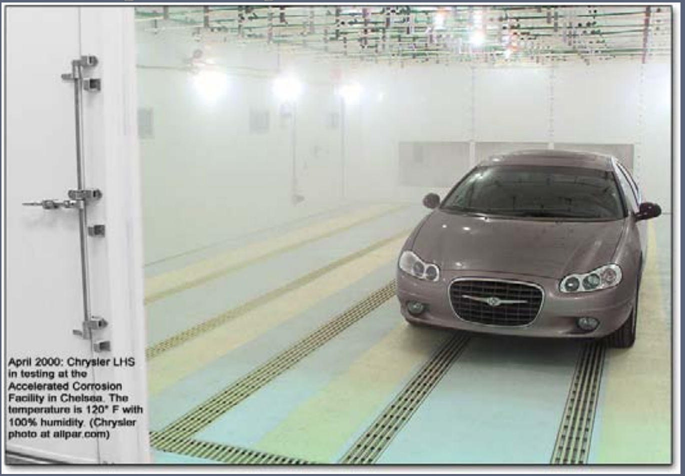


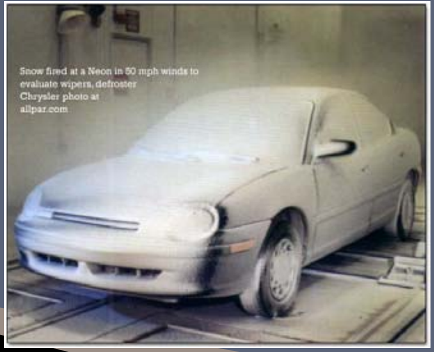
Most Important Purchase Reason
Top 15 Reasons out of 49 Given



Source: Maritz Research

Environmental Stress Testing
Thermal Loading, Salt Spray, Corrosion





Environmental Stress Testing
Electromagnetic Interference

Electromagnetic Compatibility

Radiated

(propagated through the air)

Conducted

(propagated via wiring harness)

Radiated Immunity

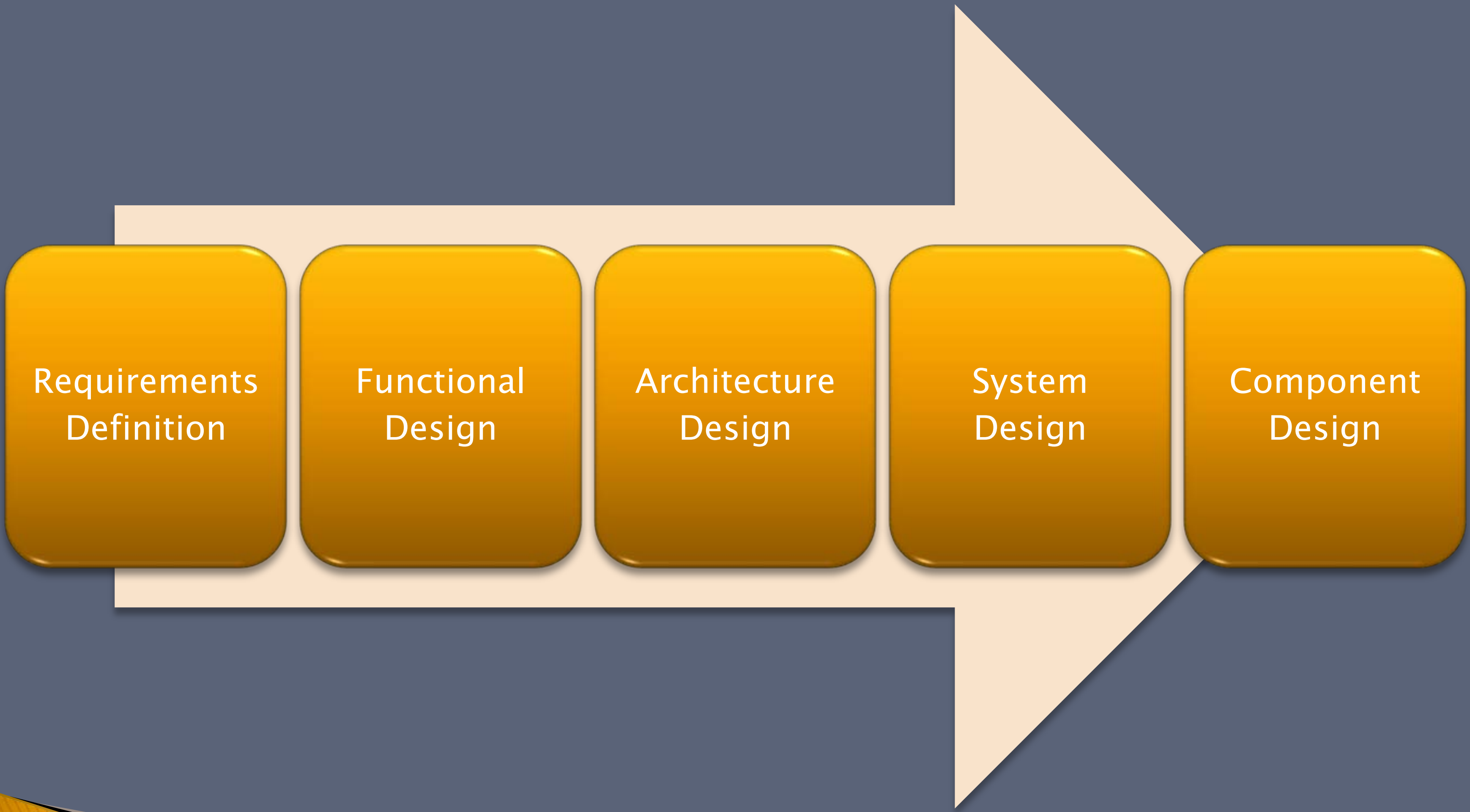
Radiated Emissions

Conducted Immunity

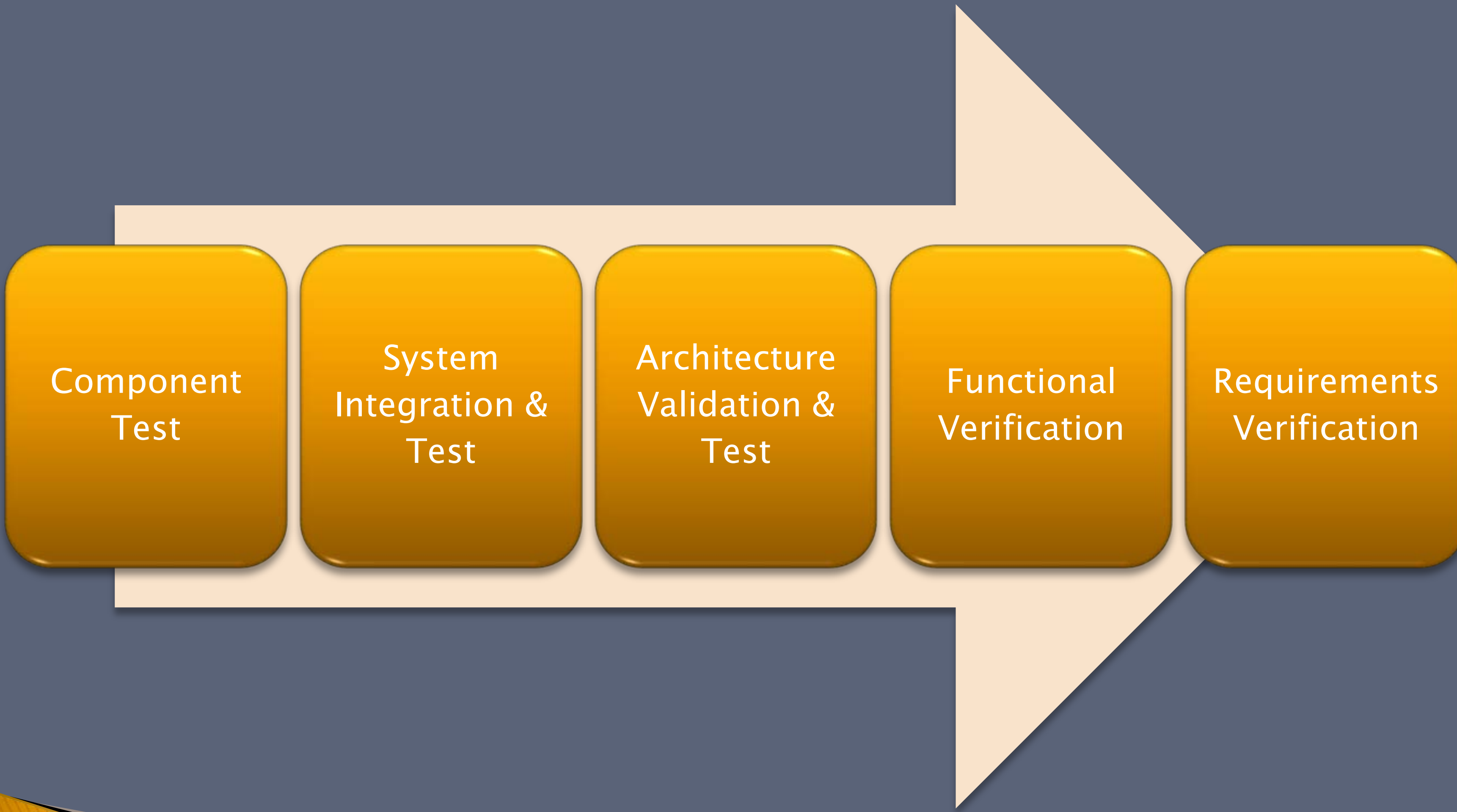
Conducted Emissions

Electrostatic Discharge

Representative Design & Validation Process – Design



Representative Design & Validation Process – Validation



Overall EMC Validation Philosophy

- RF energy has the potential to affect electronic circuits (hardware), but does not change software
  - Non-linear junctions in semiconductors are vulnerable to RF rectification, producing RF-induced DC biases. This can lead to
    - False activation of diodes and transistor junctions
    - Corruption of voltage regulator outputs or comparator inputs, causing false gate switching
    - Corruption of input/output drivers to memory look-up/storage locations/registers, etc., impacting checksums, lookup parameters, etc.
    - Latch-up of CMOS junctions
    - Electrical overstress (burn-marks on IC die, open bond wires, etc.)
  - Electronic modules must be designed for Electromagnetic Compatibility (EMC) – <u>it will not happen on its own</u>

EMC Impact on Electronics

- **Regarding Radiated Immunity (RI):**
  - Off-Board RI sources (radars, AM/FM transmitting towers, etc.)
    - Can create isolated “hot spots”
    - Typically localized to an area in the vicinity of the high-power transmitting towers (not on public roadways)
    - Exist in a very small spatial area (due to RF wavelength characteristics)
  - On-Board RI sources (land mobile radios, cellular phones, etc.)
    - Can create “hot spots” within the vehicle while transmitting
    - Typically in close proximity to the phone
    - Exist only while transmitting
  - If EMC is <u>not</u> designed into products, RI typically can cause <u>momentary</u> deviations while RF present, but damage and electronic latch-up is much less likely; normal operation typically resumes when RF energy is removed

EMC Impact on Electronics

- **Regarding Conducted Immunity (CI) & Electrostatic Discharge (ESD)**
  - Can produce damage or latch-up type of deviations in electronic circuits
  - Effects can last after the transient or ESD event
  - May not show signs of damage upon analysis if latch-up occurs (removal of power resets latch-up condition)
  - CI sensitive to harness build variations (so every vehicle can be different)
  - ESD tends to be geographic or seasonal (low humidity and low-to-moderate temperatures)

Conclusions

- As we reinvent the automobile, we welcome the Panel's "second set of eyes"
- Alliance members look forward to briefing the Panel in more depth regarding their individual:
  - Design and validation processes used;
  - Redundant systems and fail safe strategies employed; and
  - Other relevant matters
- The electronic systems in today's automobiles are as rigorously designed and tested as the vehicles into which they are installed

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