**50 years of progress:**
**Where do we go from here?**

Presentation at

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I would like to begin by thanking Edmunds for inviting me to give this presentation. It is fitting, I think, because in 2009 we at IIHS celebrated our 50th anniversary as a remarkable organization funded solely by the private sector — insurers in the U.S. market — with a clear public health mission to identify and publicize effective strategies for reducing the deaths, injuries, and property damage from motor vehicle crashes. So I gladly accept this opportunity to examine where we've come in the past 50 years and where we might go in the future.

**Where we've been**

Fifty years ago, in 1961, the motor vehicle crash death rate had just reached an 11-year low of 49.2 per billion miles of travel on public roadways. The death rate was destined to increase in succeeding years, peaking at 55 deaths per billion miles of travel in 1966. Then began a long period of almost annual decreasing fatality rates, falling to a low of 11.3 deaths per billion miles of travel in 2009.

What happened to achieve this dramatic turnabout? It was a variety of factors and actions by a variety of players. A key factor was the creation in 1966 by Congress of the National Highway Safety Bureau, the forerunner of the current National Highway Traffic Safety Administration (NHTSA). In 1967 and 1968, the bureau issued the first federal motor vehicle safety standards, under the direction of Dr. William Haddon, Jr., a staunch public health advocate with a record of research in motor vehicle crashes and the mitigation of the damage from them. It was Haddon who developed the distinction among pre-crash, crash, and post-crash injury prevention strategies (i.e., 100, 200, and 300 series safety standards). A number of research publications document the favorable impact of these standards on subsequent injury and death rates in crashes (Graham, 1989; Kahane, 2004; Robertson, 1981).

As important as these standards are, though, we would be remiss if we did not recognize that other factors also played major roles in reducing the death toll. In the mid-1980s, safety belt use began to climb as states enacted belt use laws. Also in the mid-1980s, we began to see large reductions in alcohol-impaired driving as Mothers Against Drunk Driving and other organizations changed public acceptance of this problem and effective laws were enacted that increased the likelihood that drivers with high blood alcohol concentrations would be caught and punished (i.e., *per se* definitions of impairment and automatic license revocation) (Zador et al., 1989).

Graduated licensing laws contributed by reducing the number of teen drivers crashing on our nation's highways. Since these laws started in the mid-1990s, the fatal crash rate for passenger vehicle drivers ages 16-18 has fallen at a much faster rate (52 percent by 2009) than for drivers ages 30-59 (only 33 percent) (IIHS, 2011).

We also should recognize that some of the improved fatality rate is due to changes in the roads on which we travel. Much of the improvement in the 1970-80s reflected the increase in miles on roads with interstate designs.

There are other not-so-intentional influences. For example, increased congestion as people have moved to jobs in urban areas means a greater proportion of miles are being accumulated at speeds too slow to be lethal. Economic downturns have contributed to lower fatality rates, presumably because people are cutting down on discretionary driving, and the remaining travel is less risky. These and many other factors have contributed to the long downward trend in motor vehicle crash deaths.

Nevertheless, there can be no doubt that changes in vehicle design for occupant protection in crashes and the integration of new safety equipment have been key. Federal motor vehicle safety standards immediately required safety belts and energy-absorbing steering columns as standard equipment. Fuel tank integrity requirements, established in 1967, were upgraded in 1976 and again in 2003. Automatic protection was required for unbelted occupants beginning in 1986, and the frontal airbags that became the principal method of compliance added protection for belted occupants as well. Side impact protection was upgraded in 1990, with dynamic testing specified. Roof strength requirements were established in 1971 and upgraded significantly in 2009.

A major boost for vehicle crashworthiness began in 1978, when NHTSA for the first time anywhere in the world made comparative safety test information available to the public. It started with full frontal crashes, added side impact crashes in 1997, and this year has added a side-pole test. Essentially, NCAP opened the safety marketplace, offering consumers objective, 3rd party information on how well various car models are likely to protect people in crashes. Automakers began to improve vehicles beyond the basic standards to satisfy consumer demand and allay concerns about poor performance.

In 1995 IIHS joined this consumer education effort, providing information from frontal offset crash testing to complement NHTSA's full-front test (safercar.gov) along with geometric ratings of heads restraints. In 2004 IIHS added a test that reflects the risk of injury when vehicles are struck in the side by larger passenger vehicles like pickups and SUVs and a dynamic test of head restraints. In 2009 we added roof strength to our menu of consumer crashworthiness information (iihs.org).

Other consumer organizations in the United States and around the world have joined this effort. Today, there is a genuine safety marketplace, shown most obviously in the United States by the ongoing competition of automakers for NCAP stars and IIHS *TOP SAFETY PICK*. Interestingly, the consumer appetite for safety information does not seem to be satiated by the increasing information. Rather, this appetite seems to be growing in some kind of a psychological positive feedback loop.

How important have these improvements in crashworthiness been? As part of IIHS's 50th anniversary celebration, we crashed 2 vehicles head on, both going at 40 mph. The cars were a 1959 Chevrolet Bel Air and a 2009 Chevrolet Malibu. Many of the test witnesses thought the much larger and somewhat heavier Bel Air would demolish the smaller Malibu. The opposite was the case. The unbelted driver dummy in the Bel Air was struck by an intruding steering wheel as the occupant compartment collapsed around him. At the same time, the restrained driver of the Malibu experienced relatively benign forces as the frontal structure collapsed in a controlled manner, largely preserving the occupant compartment intact.

**Where do we go from here?**

Much of the crashworthiness improvement has been accomplished through new technology and understanding of vehicle structure — for example, airbags for front and side protection and a better understanding of door beams and the relative stiffness of the safety cage in relation to the crush zone. Can technological improvements also help with crash avoidance? All of us certainly would like to think so, and we are flush with confidence after the recent success of electronic stability control.

**Technology and crash avoidance:** In addition, there is a growing array of technological innovations — electronic controls and sensors — that allow all sorts of new possibilities for helping drivers avoid crashes. Forward collision warning, lane-keeping and side-view assist, turn-by-turn navigation, and adaptive headlamps already are on vehicles. In addition, a lot of work is going into vehicle-to-vehicle and vehicle-to-infrastructure communications. I am sure all in this audience are aware of the Google autonomous car as well.

The potential of such technology is large. IIHS has estimated that just 4 features — forward collision warning, lane departure warning, side view assist, and adaptive headlamps — were relevant to almost 2 million crashes annually and more than 10,000 fatal crashes.

New technology also could help with alcohol-impaired driving. DADSS, a partnership of the federal government and automakers, is a 5-year initiative to develop new alcohol detection systems that ultimately could prevent drivers above the legal limit from operating their vehicles and endangering others. Now into its 3rd year, DADSS has zeroed in on 2 promising technologies — tissue spectrometry and distant breath spectrometry — that can measure blood alcohol levels accurately and unobtrusively. The question is whether they can be introduced effectively in the generally hostile operating environment of a motor vehicle. Again, the potential of this technology is huge. IIHS has estimated that as many as 7,400 crash deaths might have been avoided in 2009 if no car could have been operated by a driver with a blood alcohol concentration higher than 0.08 percent.

Clearly, the potential of crash avoidance systems is large, and we are beginning to see data indicating that some are working. Already, insurance collision analyses are promising for forward collision warning systems. Hopefully, we will have reports the Highway Loss Data Institute can share in a short time.

**Cautionary note:** At the same time, we need to remember that not all this technology is likely to perform in the real world as it appears to work in the lab. Translating lab results to the field will not be as easy for crash avoidance as for crashworthiness. Why? Essentially because technology that reduces the likelihood of crashing often affects the driving task, and anything that changes the driving task risks changing driver behavior as well. Put differently, once a crash starts the injury outcomes are straightforward outcomes of physics and biology. Preventing a crash introduces a third, much less determined factor — psychology.

Most of us remember when antilock brake systems came on the scene in the late 1970s and 1980s. IIHS and other organizations had test track results demonstrating the clear superiority of this technology in emergency obstacle avoidance and braking in slippery conditions. Unfortunately, real-world studies of insurance claims and fatal crashes found no benefit of antilocks in lower crash frequencies. This is a conundrum still unresolved, though many proffered explanations involve driver reactions. My own guess is that all the explanations have some truth, and this simply demonstrates how difficult it is to predict how drivers will respond to new technology that changes how they operate their vehicles.

**Don't forget low-tech or past-tech:** While my presentation has focused on technology for crash avoidance as the next big thing in motor vehicle safety, we should not forget the myriad influences on safety in the past. Strategies that emphasize road improvements, enforcement of traffic laws, and crashworthiness still can contribute.

Roundabouts are intersection designs that both move more traffic and improve safety, and the United States is just beginning to take advantage of them. If just 10 percent of U.S. intersections with traffic signals were converted to roundabouts, we would prevent 70,000 crashes annually, 450 of them fatal. At the same time, we would reduce vehicle delays and fuel consumption (Bergh et al., 2005).

For signalized intersections that cannot be converted, we need to improve compliance with the signals. One proven method is the use of camera enforcement. In a recent IIHS report, we observed a 24 percent reduction in fatal red light running crashes in cities using cameras to enforce the law.

Finally we need to recognize that, promising as the new crash avoidance technology is, a crash-free environment is not on the horizon. Even in frontal crashes, where we have made the most progress, many people still are dying and we need to address the tree, pole, truck, and small overlap crashes that are killing them. The primary problem for safety professionals in road cashes is the transfer of mechanical energy to or from occupants at rates that exceed their injury thresholds. Until cars do not crash, we need to reduce the rates of energy change. This was illustrated in a recent IIHS report indicating that almost all the reduction in occupant death rates between 1995 and 2005 was accomplished by improved crashworthiness of vehicles (Farmer and Lund, 2006).

## Conclusion

We have had a fantastic 50 years of progress in reducing harm from motor vehicle crashes. Developing new information and electronic technology promises to do for crash avoidance what prior developments in structure and restraints technology have done for crashworthiness. We need careful research to sort out which technologies will be effective, though, as driver behavior is likely to be a much larger determinant of success in crash avoidance. And while this sorting out takes place, we should not forget that we already know some effective strategies for preventing cashes and injuries. Nor should we forget that, until we have a crash-free environment, it will be important to continue to demand vehicles that protect people and cargo from damage.

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# 50 Years of Progress in Highway Safety: Where do we go from here?

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**The Insurance Institute for Highway Safety**, founded in 1959, is an independent, nonprofit, scientific, and educational organization dedicated to reducing the losses — deaths, injuries, and property damage — from crashes on the nation's highways.

**The Highway Loss Data Institute**, founded in 1972, shares and supports this mission through scientific studies of insurance data representing the human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model.

Both organizations are wholly supported by auto insurers.



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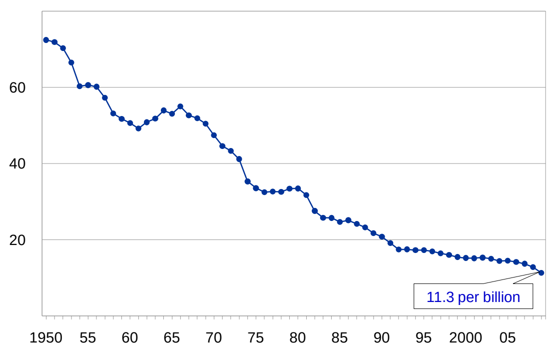
## Motor vehicle crash deaths per billion miles traveled

1950-2009



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## Factors involved in the improved safety of motor vehicle travel

- Federal Motor Vehicle Safety Standards – starting in 1967
- Safety belt use – starting in the mid-1980s with required belt use
- Reductions in alcohol impaired driving – starting in mid-1980s when laws focused on likelihood of detection and punishment
- Graduated licensing laws – starting in the mid-1990s
- Improved roads – gradual expansion of miles on interstate-design level roads
- Congestion – more miles at speeds where crashes aren't lethal
- Economic downturns – the silver lining of fewer crashes

## Vehicle crashworthiness improvements

- US federal motor vehicle safety standards – 1967
  - Safety belt installation and energy absorbing steering columns
  - Fuel tank integrity in rear collisions – 1967, upgraded 1976 and 2003
  - Automatic protection requirement for unbelted – 1986
  - Side impact dynamic test – 1990
  - Roof strength in rollover – 1971, upgraded 2009
- Consumer information crash tests introduced by NHTSA
  - First time in world that people had access to objective information about safety of cars in foreseeable crash scenarios
  - Started with full frontal crashes in 1978, extended to side impacts in 1997, and side impact pole tests in 2011
  - Tests based on standard federal tests but conducted at higher speeds



## Vehicle crashworthiness improvements, continued

Consumer information from IIHS

- Consumer information from IIHS
  - Frontal offset crash test in 1995
  - Head restraint evaluations in 1995, dynamic test added 2004
  - Side crash test in 2004
  - Roof strength test in 2009
- Safety marketplace created
  - Consumers looked for objective info about safety
  - Automakers competing for NHTSA 5-Star Safety Ratings and IIHS TOP SAFETY PICK
- Consumer organizations around the world have joined in



## 1959 Chevrolet Bel Air and 2009 Chevrolet Malibu

Highway safety: then and now



## 40 mph frontal offset crash test

1959 Chevrolet Bel Air and 2009 Chevrolet Malibu

INSURANCE INSTITUTE
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## Where do we go from here?



## Technology improved crashworthiness

Can technology help with crash avoidance?

- Safety advocates – flush with confidence from the success of electronic stability control
- Advances in electronic controls and sensing allowing all sorts of new possibilities for helping drivers
  - Forward collision warning and automatic braking
  - Lane keeping and side view assistance
  - Turn by turn auditory navigation (no more maps on steering wheel)
  - Adaptive head lamps

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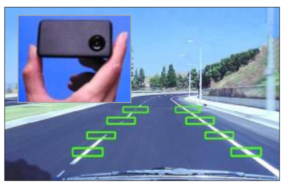
## Advanced information technology for safety

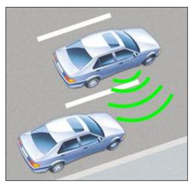


lane departure prevention

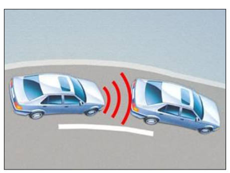
EMERGENCY MEDICAL SERVICES

OnStar by GM

crash notification

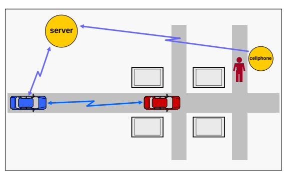


blind spot detection



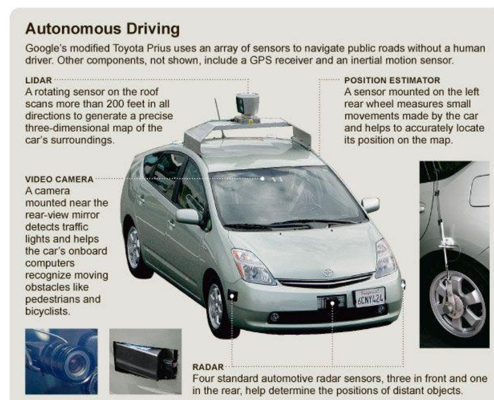
forward collision warning and auto braking

adaptive headlights




vehicle-to-vehicle communication

## Google autonomous car




Source: Google

THE NEW YORK TIMES; PHOTOGRAPHS BY RAMIN RAHIMIAN FOR THE NEW YORK TIMES

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## Annual crashes potentially prevented or mitigated

By type of system

| | all | injury | fatal |
|---|---|---|---|
| forward collision warning | 1,165,000 | 66,000 | 879 |
| lane departure warning | 179,000 | 37,000 | 7,529 |
| side view assist | 395,000 | 20,000 | 393 |
| adaptive headlights | 142,000 | 29,000 | 2,484 |
| total unique crashes | 1,866,000 | 149,000 | 10,238 |



## Driver alcohol detection system for safety

- Partnership between federal government and automakers
- 5-year initiative
  - Research, develop, and test advanced alcohol detection technology suitable for all vehicles
  - Build public support for vehicle-based approach

dadss
Driver Alcohol Detection System for Safety



## Potential advanced technology: tissue spectrometry

- Estimates BAC by measuring light absorption at a particular wavelength based on measurements of light reflection from skin
- Touch-based systems require skin contact



## Potential advanced technology: distant breath spectrometry


- Uses “sniffer” to detect alcohol in vehicle
- Nondispersive infrared measurement of alcohol concentration in exhaled breath in vehicle compartment
- Measures concentration of alcohol and carbon dioxide near driver

## Potential lives saved in 2009 if driver BACs reduced to various maximums

| maximum BAC permitted | lives saved |
|---|---|
| zero | 11,323 |
| < 0.05 g/dL | 9,294 |
| < 0.08 g/dL | 7,440 |



## Do car antilocks reduce crashes?

HLDI and IIHS antilock brake studies

- In 1994-95, HLDI compared insurance claims for groups of otherwise identical cars with and without antilocks, finding no differences in the overall frequency or cost of crashes
- HLDI also studied insurance claims experience in 29 states during winter months, finding no difference in the frequency of insurance claims for vehicles with and without antilocks
- A 1997 Institute study and a 2001 update reported no difference in the overall fatal crash involvement of cars with and without antilocks



## Don’t forget low-tech solutions!



## Roundabouts are safer and more efficient

## If 10 percent of signalized intersections in the United States were converted to roundabouts

- Approximately 70,000 crashes prevented annually including:
  - 450 fatal crashes
  - 45,000 injury crashes
- Vehicle delays reduced by about 800 million hours
- Fuel consumption reduced by more than 500 million gallons



SPECIAL ISSUE: RED LIGHT RUNNING

STATUS REPORT

INSURANCE INSTITUTE FOR HIGHWAY SAFETY

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The red light runners think they've been wronged. They're convinced that the cameras documenting their violations are nothing more than a scheme to pick motorists' pockets. The truth is much simpler:

**RED LIGHT RUNNING KILLS**

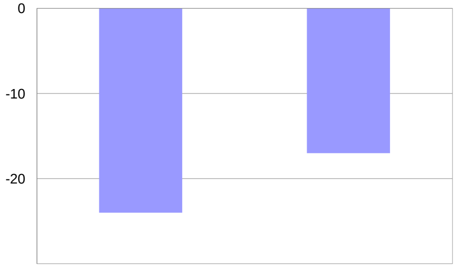
and red light cameras save lives. In fact, they saved 159 lives in 2004-08 in the 14 biggest US cities with cameras, a new Institute analysis shows. If cameras had been operating during that period in all cities with populations of more than 200,000, a total of 815 fewer people would have died.

Camera opponents never acknowledge the connection between those whose red light running sets off a benign flash and those who cause a deadly collision. Instead, they argue about "big brother" and equate fines for violations with taxes on drivers.

Not everyone who runs a red light is part of this group. No doubt, most violators calmly take their lumps, paying their tickets and vowing to be more careful. But



## Percent difference in actual fatal crash rates during 2004-08 in cities with red light cameras vs. expected rates without cameras






## Don't forget crashworthiness

## Putting people in packages that protect them in crashes remains a top priority

- A crash-free environment is not on the immediate horizon
- More than 10,000 occupants are still killed annually in frontal crashes of passenger vehicles
  - Small overlaps, pole crashes, and large truck underrides account for many
- The primary problem for safety professionals in road crashes is the transfer of mechanical energy to or from occupants at rates that exceed their injury threshold
  - Until cars don’t crash, we need to reduce the rates of energy change
- Most of the improved safety of motor vehicles during the decade from 1995 to 2005 involved improved vehicle crashworthiness

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