

Status Report

Insurance Institute for Highway Safety | Highway Loss Data Institute

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Driving tech could help protect teens

Infrastructure bill draws on IIHS-HLDI work
A roundabout design with big benefits



Driving technology promises large safety gains for teens

Crash avoidance features and teen-specific vehicle technologies have the potential to prevent or mitigate up to three-quarters of fatal crashes involving teen drivers, a new IIHS study shows.

“We know these technologies don’t stop 100 percent of the crashes they’re designed to address, but our analysis shows that the potential benefits for teen drivers could be pretty stunning if they were widely used,” says IIHS Research Scientist Alexandra Mueller, the lead author of the paper.

Per mile driven, teen drivers are nearly 4 times as likely to crash as drivers 20 and older and more likely to be involved in a fatal crash than any age group except those 80 and above. That’s because of a unique set of risk factors that includes high rates of speeding, low seat belt use and inexperience.

Past research has shown that teen drivers are typically worse at recognizing hazards and controlling the vehicle than more experienced drivers, resulting in more loss-of-control and run-off-road crashes. Teen drivers are more prone to losing focus and less likely to lower their speed to compensate for slick roads or poor visibility. They are also often involved in rear-end and right-angle crashes.

All that means that the safety benefits of crash avoidance technologies like front crash prevention and lane departure prevention

could be particularly relevant for teen drivers, even though these features are designed for everybody.

Automakers and software developers also offer technologies that are specifically designed for teen drivers. In-vehicle technology suites like Ford’s MyKey and GM’s Teen Driver include features like parent-controlled speed limiters and gearshift or stereo system interlocks that activate when the front seat occupants aren’t buckled in. Smartphone apps like Hyundai’s BlueLink and Grom Social’s MamaBear can provide parents with driving report cards or real-time alerts when their teen is speeding or breaking nighttime driving curfews.

To estimate the maximum potential benefits of these technologies, the researchers analyzed passenger-vehicle crashes involving teen drivers that occurred on U.S. roads during 2016-19. They looked for crash scenarios relevant to three crash avoidance features (front crash prevention, lane departure warning/prevention and blind spot monitoring) and three technologies designed for teen drivers (speeding prevention features, nighttime curfew notifications and extended reminders or gearshift interlocks to encourage seat belt use).

Assuming those technologies were universally used and completely effective, the researchers concluded that together they could prevent or mitigate 41 percent of all crashes involving teen drivers and as many as 47 percent of teen driver injuries and 78 percent of teen driver deaths.

Considered separately, both the crash avoidance features and teen-specific technologies showed big potential benefits. Front crash prevention, lane departure prevention and blind spot monitoring could be relevant to about a third of teen driver

deaths and a quarter of teen driver injuries. Vehicle features and smartphone apps designed specifically to make teens drive more safely could apply to nearly a third of teen driver injuries and as many as two-thirds of teen driver deaths.

To prevent or mitigate all those crashes, the technologies would have to work perfectly, which may never be the case. However, even at current levels of performance, existing crash avoidance technologies could prevent a lot of crashes if they were universally adopted.

Previous research has shown that lane departure warning, blind spot monitoring and automatic emergency braking (AEB) reduce the types of crashes they’re designed to prevent by 11 percent, 14 percent and 50 percent, respectively. Based on those percentages, lane departure warning as it works now could prevent nearly 6,500 teen driver crashes a year, blind spot monitoring another 4,500, and AEB a further 110,000. Those are crashes of all severities; in the case of AEB, most of the rear-end crashes it is designed to prevent typically don’t involve serious injuries.

Less is known about the effectiveness of teen-specific technologies. However, some vehicle and smartphone apps have already been shown to reduce speeding and encourage seat belt use.

Even if these technologies are only moderately effective, they could prevent many injuries and deaths. The IIHS analysis showed that speeding contributed to almost 40 percent of teen driver deaths and about a fifth of teen driver injuries. About 40 percent of the teen drivers who were killed were not wearing a seat belt.

Similarly, about a fifth of injuries of 16- and 17-year-old drivers and a third of their

IIHS RESEARCH

“Teen driver crashes potentially preventable by crash avoidance features and teen-driver-specific safety technologies” by A.S. Mueller and J.B. Cicchino

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Insurance data show bigger benefits for young drivers from crash avoidance features

Crash avoidance features seem to benefit young drivers more than others, a recent series of HLDI studies show.

Crash avoidance systems are associated with larger reductions in the frequency of collision and property damage liability (PDL) claims for drivers under 25 years old than those ages 25 and older, HLDI found in separate studies of Honda, Kia and Subaru vehicles.

To estimate how crash avoidance technologies affected crash rates for drivers of different ages, HLDI analysts conducted studies of insurance claims for Honda, Kia and Subaru vehicles, comparing vehicles equipped with the manufacturers' crash avoidance packages against identical, unequipped models. They chose vehicles on which the presence or absence of optional crash avoidance features is discernible from the vehicle identification number or trim level, and they used data about the insured drivers to categorize the results by age.

Each manufacturer's crash avoidance systems are different, and features are bundled differently depending on the brand. However, all three of the bundles studied included lane departure warning and forward collision warning. Two, Kia's Drive Wise and Subaru's EyeSight, included automatic emergency braking. *Continued on next page >*

deaths occurred between 9 p.m. and 6 a.m. That suggests that apps that notify parents of curfew violations could deliver safety benefits if parents are serious about enforcing nighttime driving restrictions.

To deliver on any of that potential, of course, these features would have to be installed in the vehicles that teens drive, and teens would have to use them. For the parental notification features to be effective, parents would also need to monitor the alerts and take action if their teen violates the established restrictions.

All three of those requirements are likely to be serious hurdles.

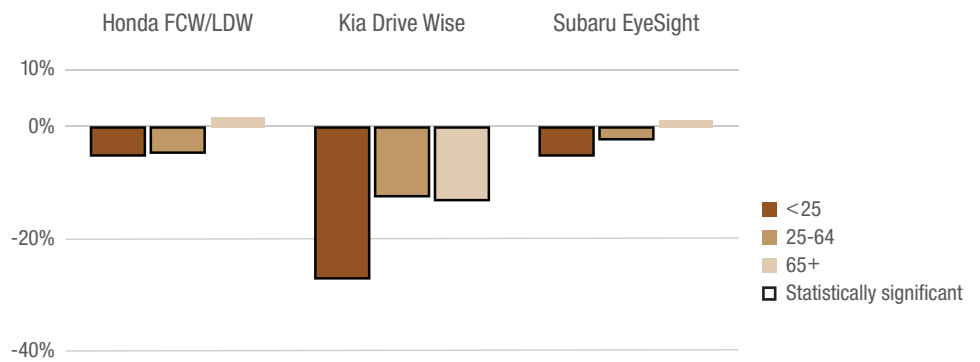
Only about a quarter of the vehicles on U.S. roads are likely to be equipped with AEB, lane departure warning and blind spot monitoring by 2023, according to forecasts from HLDI. Few of them are likely to be driven by teens — who tend to drive older, less well-equipped vehicles.

Many parents may not realize that their own, newer vehicles may be equipped with teen driver-specific technologies. Others may purposely decide not to use them.

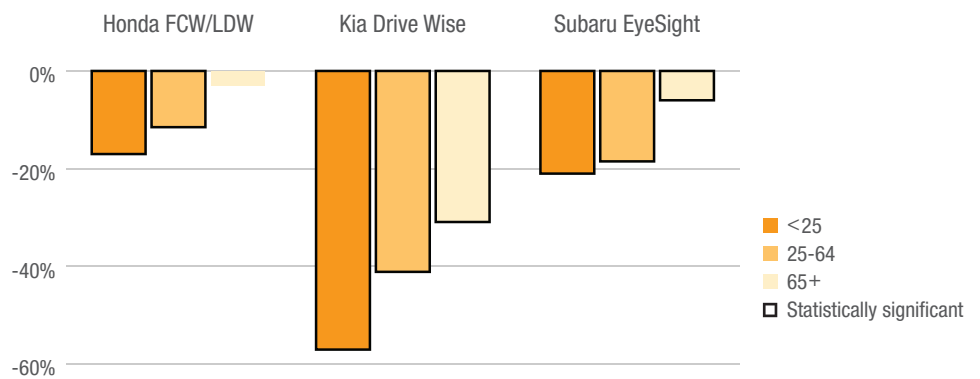
One recent IIHS study of parents who owned MyKey-equipped Ford vehicles found that only a little over half knew their vehicles had the teen-oriented technology suite available. Even among those who knew the technology was there, about a third didn't use it with their teens. Some said they didn't think that the feature had any safety benefits.

“Lack of access and lack of acceptance are two major barriers preventing these technologies from delivering on their full potential,” says Mueller. “Manufacturers should include these features in more vehicles and do a better job of communicating the benefits to parents and teens.” ■

Effect of crash avoidance features on collision claim frequency by driver age



Effect of crash avoidance features on PDL claim frequency by driver age



◀ *Continued from previous page*

These technologies use cameras and other sensors to monitor the roadway and alert the driver when the vehicle is approaching an obstacle or drifting out of its intended lane. Those with automatic emergency braking (AEB) also apply the brakes to avoid or mitigate a crash if the driver doesn't react to the warning swiftly. Research has demonstrated the technologies can help prevent front-to-rear and run-off-road crashes, which are more common among younger drivers.

Not surprisingly, the Subaru and Kia packages that included AEB and additional technologies were associated with larger reductions in claim frequencies than Honda's combination of forward collision warning and lane departure warning. But the age trend was similar for all three systems.

Collision coverage insures against crash-related damage to the insured driver's own vehicle when the insured driver is at fault. Property damage liability coverage insures against damage insured drivers cause to other vehicles and property. Under both coverages, claim frequencies generally dropped more for drivers under age 25 than for the 25-64 and 65+ age groups. The exception was for collision claim frequency with the Honda crash avoidance features, which had about the same benefit for the youngest drivers and drivers ages 25-64.

A few of the results for particular age groups and coverages were not statistically significant, and the results for the youngest drivers were based on the smallest sample. It is also possible to switch off the crash avoidance features on all three vehicles, and the researchers had no way to measure how much the different age groups actually used them. ■

/i\ HLDI RESEARCH

"Impact of Kia Drive Wise collision avoidance features on insurance losses by rated driver age." (April 2021)

"Impact of Honda Accord collision avoidance features on claim frequency by rated driver age." (April 2021)

"Impact of Subaru collision avoidance features on insurance losses by rated driver age." (December 2019)

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Years of work by IHS-HLDI paved way for safety provisions in infrastructure bill



The infrastructure bill passed by the U.S. Senate this month contains a slew of long-awaited highway safety provisions. Many of them are based on or supported by research carried out by IIHS and HLDI.

Among other things, the bill includes requirements for crash avoidance technology in passenger vehicles and large trucks, an update to the rear underride guard standard for large trucks that would align it more closely with IIHS tests, an update to headlight standards to require on-vehicle testing and to allow a new type of lighting technology, and a mandate to equip vehicles with passive alcohol detection technology.

“This bill pushes U.S. road safety policy forward in a number of areas, and we can see the work of IIHS-HLDI clearly reflected in many of the provisions,” says IIHS-HLDI President David Harkey. “In some cases, the legislation is catching up with industry changes that we have already set in motion; in others, the bill could tee up meaningful progress on issues that we have been sounding the alarm on for years.”

The bill, the result of a bipartisan compromise, has the support of President Joe Biden. As of this writing, it has not been voted on in the House, but Speaker Nancy Pelosi intends to shepherd it through.

Crash avoidance technology

In the catching-up category are instructions to the Department of Transportation (DOT) to require forward collision warning and automatic emergency braking (AEB) on passenger vehicles. These features are already set to be standard on the vast majority of new vehicles by the 2022-23 production year, thanks to a voluntary commitment by manufacturers brokered by IIHS and the National Highway Traffic Safety Administration (NHTSA). A regulation would help fill in some gaps and would also include lane departure warning and lane-keeping assist, two technologies that are often bundled with AEB but are not covered by the voluntary commitment.

Perhaps more significantly, the bill calls for a rule requiring newly manufactured large trucks to be equipped with AEB and for their drivers to be required to use the technology. This is an area in which the U.S. is behind; the European Union has required most new heavy trucks to have AEB since 2013.

IIHS and HLDI have been leaders in researching the effectiveness of crash avoidance technologies. For over a decade, HLDI has been using its trove of claims data to evaluate these features on passenger vehicles. More recently, IIHS researchers have strengthened the case for some of these features with analyses using police-reported crash data. For example, using police-reported crash data, IIHS has found that the combination of AEB and forward collision warning cuts front-to-rear crashes in half.

An IIHS study released last year found that AEB eliminated 2 out of 5 front-to-rear crashes by large trucks.

Truck underride

Another long-standing IIHS-HLDI priority included in the legislation is improvements to truck underride guards. The bill calls for an updated rear underride standard that would incorporate at least two of the three requirements for the IIHS TOUGHGUARD award: Guards would have to prevent underride by a passenger vehicle traveling 35 mph when it strikes the rear of a trailer in the center or with a 50 percent overlap. It also calls for regulators to consider requiring the most challenging part of the IIHS evaluation, the 30 percent overlap crash.

The legislation instructs DOT to conduct research into side underride guards, which have been shown to be effective in IIHS research tests.

Headlight technology

An update to headlight regulations to allow for adaptive driving beams is another item from the IIHS-HLDI wish list. The infrastructure bill instructs DOT to complete this within two years.

IIHS tests have shown that many of today’s headlights do not provide adequate visibility, and research has shown that drivers do not take full advantage of high beams when appropriate.

Adaptive driving beams are a promising solution. Instead of switching the high beams on and off, these systems continuously adjust the high-beam pattern to create a shadow around other vehicles. In this way, adaptive driving beams offer high-beam visibility except for the segment of the beam that is blocked out to limit glare for oncoming or leading drivers. IIHS research showed that glare from adaptive high beams is lower

than the glare from many of the low-beam systems sold in the U.S.

The bill also requires headlights to undergo on-vehicle testing like the evaluations IIHS conducts for its ratings. Currently, only static measurements of light intensity from headlamps placed on a test rig are required. IIHS was the first to evaluate headlights by measuring their illumination from a moving vehicle, which takes into account mounting height and aim.

Alcohol-impaired driving

Drinking and driving remains a persistent highway safety problem, and progress on it has largely stalled since the 1990s. The legislation calls on DOT to require a technological solution if feasible, citing IIHS research that found that limiting all drivers to a blood alcohol concentration below 0.08 percent would save 9,400 lives a year.

The Driver Alcohol Detection System for Safety (DADSS), which can unobtrusively detect the level of alcohol in the driver’s blood and prevent the vehicle from moving if it is higher than a predetermined limit, has been in development by a public-private consortium for several years. IIHS is a member of the DADSS stakeholder group.

Other priorities

Other key issues dealt with in the bill include updates to NHTSA’s New Car Assessment Program, distracted driving prevention and autonomous vehicles. Also of note is a new emphasis on vulnerable road users. This includes nudging regulators toward evaluating pedestrian AEB systems, as IIHS has been doing since 2019, and requiring at least 15 percent of a state’s highway safety improvement program funds to address pedestrians, bicyclists and other nonmotorized road users if these groups make up 15 percent or more of the state’s crash fatalities. IIHS-HLDI will be analyzing the details of the enormous bill in more detail in the coming weeks and months.

“The Institutes’ influence is clearly visible in many provisions of this landmark legislation,” Harkey says. “The degree to which we can classify these as safety wins will depend on how regulators carry out the instructions. We look forward to providing our input during the rulemaking process on each of these issues.” ■

Unusual design slashes injury crashes for Roundabout City

An unusual kind of roundabout has delivered big benefits for the Indianapolis suburb dubbed “Roundabout City,” a recent IIHS study found.

The double-teardrop design that Carmel, Indiana, installed along Keystone Parkway and at other busy intersections slashed injury crashes by 84 percent and reduced all crashes at these locations by nearly two-thirds, the IIHS analysis showed. Combined, the double-teardrop interchanges and more conventional roundabouts cut injury crashes in half.

“Our results show that Carmel’s double-teardrop roundabouts are remarkably effective in preventing the most severe crashes,” says IIHS Vice President of Research Jessica Cicchino. “The main reason is that their design allows them to be installed at the most dangerous intersections.”

Carmel boasts more roundabouts than any other city in the United States, with more than 100. Mayor James Brainard, who has made their construction a key focus of his seven consecutive terms, credits them with reducing emissions, easing traffic flow and keeping crash numbers low, even as the city’s population has soared from around 25,000 in the 1990s to nearly 100,000 people today.

To quantify how much they have affected road safety, IIHS researchers examined crash data from 64 roundabouts over the two years before and after their construction. Because information on historical traffic volumes was not available, they compared crash numbers from each converted intersection to a conventional intersection with similar characteristics nearby.

The sample included 21 single-lane, 10 double-teardrop, and 33 other multilane roundabouts built between 2005 and 2017. Before conversion, 25 of the intersections were controlled by traffic signals, 19 were four-way stops, four were three-way stops, and 16 were two-way stops.

The IIHS analysis showed that the conversion to roundabouts resulted in a 47 percent reduction in injury crashes overall, compared with the number the researchers projected would have occurred if roundabouts had not been adopted.

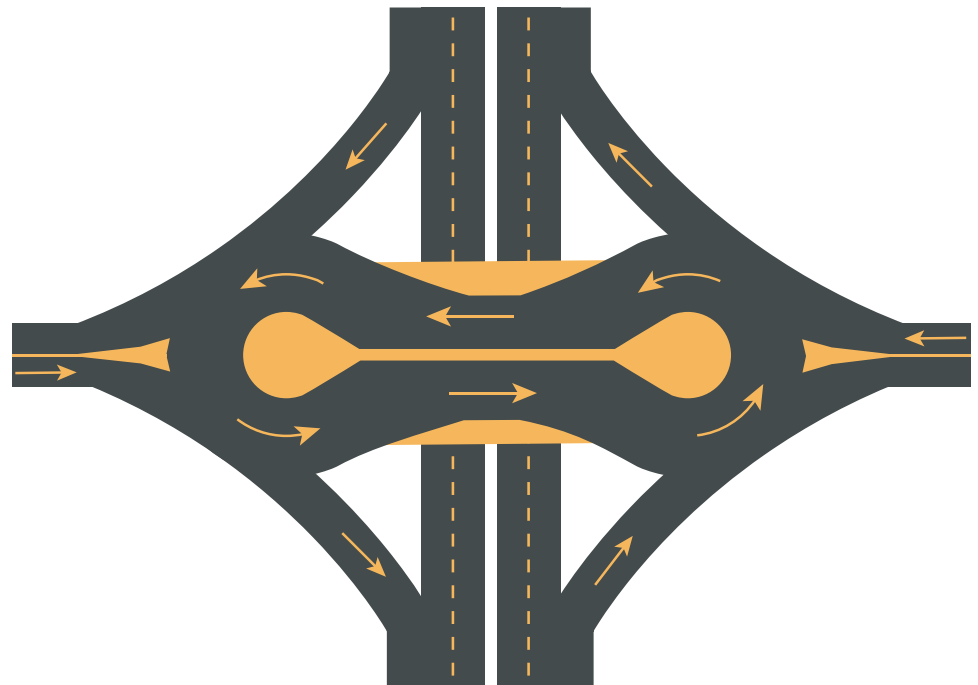
Single-lane roundabouts reduced total crashes and property-damage-only crashes by 51 percent and 50 percent, respectively, while multilane roundabouts were

The impact of the double-teardrop roundabouts was more striking. At locations where that design was used, injury crashes fell 84 percent, and total crashes dropped 63 percent, the researchers found.

Roundabouts reduce crashes — especially injury crashes — because the circular median and tight turning radius force drivers to slow down. The most severe types of intersection crashes — right-angle, left-turn and head-on collisions — are also unlikely because vehicles are no longer crossing perpendicularly.

Double-teardrop roundabouts, also known as “dogbone” interchanges, work the same way, except the circle is squashed at the center (see diagram). This design allows

Traffic flow in a double-teardrop roundabout



/i\ IIHS RESEARCH

“Safety effects of roundabout conversions in Carmel, Indiana, the Roundabout City”
by J. Wang and J.B. Cicchino

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associated with increases in total crashes and property-damage crashes. Injury crashes dropped 50 percent at single-lane roundabouts and 15 percent at multilane roundabouts, though these estimates were not statistically significant.

them to be used in locations where surface roads intersect a freeway or other high-speed thoroughfare.

That may explain why double-teardrop roundabouts showed such large safety benefits in Carmel. They were installed at crossing



A double-teardrop roundabout on Keystone Parkway in Carmel, Indiana (*American Structurepoint, Inc./Above All Photography*)

points with higher-speed roads at intersections that had more injury crashes in the period before the conversion than other converted intersections. These intersections also may have benefited more from the speed reductions associated with roundabouts.

For example, Carmel converted the former State Road 431, a congested state highway, into the Keystone Parkway. Scraping the Indiana Department of Transportation's plan to widen the major arterial road from four to six lanes, Carmel instead replaced its major intersections with double-teardrop roundabouts that allow traffic on the parkway to flow much as it would on a true freeway.

For everyday users, the reduction in traffic congestion associated with all types of roundabouts is more noticeable than the drop in crashes. Depending on the intersection, previous research has shown roundabouts can reduce traffic delays by as much as 90 percent.

Not surprisingly, locals have embraced them — though construction-related traffic and the costs of building and beautifying the roundabouts can sometimes generate ire.

“Generally, people who don't support them don't live here, so they don't have much

experience with how well they work,” says 38-year-old Brandon Lust, a cycling and pedestrian advocate who recently moved to Carmel specifically because of its street design. “Driving in Carmel is unlike any other American city. I can drive from one end of Carmel to the other without ever going through an [ordinary] intersection.”

Heather Ward Miles, a 40-year-old artist, also likes the roundabouts.

“Now, every time I approach something that's congested because there's no roundabout, I feel irritated,” she says. That's especially noticeable on the state highways near the Keystone Parkway that are still using conventional interchanges, she adds.

“[On Keystone Parkway] there are no backups,” she says. “On [Interstate] 465, when you're trying to get off to other streets like [State Road] 37, there are big backups because people are stuck at lights.”

The increase in minor crashes at multi-lane roundabouts adds to a growing body of evidence showing that drivers find them especially challenging. An earlier IIHS study of two multi-lane roundabouts near Bellingham, Washington, for instance, found that a year after construction was completed, more than 40 percent of drivers remained

confused about what speed to drive and which lane has the right of way when exiting.

On the other hand, a larger study of roundabouts in Washington state found that the problem improves with time, as the number of crashes at two-lane roundabouts decreased on average 9 percent per year. Since the current study of Carmel's roundabouts examined the number of crashes two years before and two years after each roundabout was built, that learning curve was still in its early stages.

The benefit from all three types of roundabouts in Carmel may actually have been even larger than estimated in the new study, says IIHS Research Transport Engineer Jin Wang, the lead author of the study. Carmel's population nearly doubled between the beginning and end of the study period, and, according to city officials, roundabouts tend to be built in the highest-growth locations first.

“If traffic increased more at roundabouts than it did at other intersections, our estimates of the crash reductions at all roundabouts would be too low and our estimates of the increase in fender benders at multi-lane roundabouts would be too high,” Wang says. ■



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HLDI 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.

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