Initiatives for Improving Traffic Safety

Basic Philosophy regarding Traffic Safety

According to a World Health Organization (WHO) survey, 1.24 million people worldwide die in traffic accidents each year, making them the eighth leading cause of death. While the number of deaths due to traffic accidents has been decreasing slightly in Japan, North America and Europe, it has been constantly increasing in emerging nations where traffic safety education and transportation infrastructure have not kept up with increases in the number of cars on the road. On a global scale, traffic fatalities continue to increase constantly, and it is predicted that they will become the fifth leading cause of death by 2030 unless countermeasures are implemented.

Toward achieving Toyota's ultimate goal of completely eliminating traffic casualties, the development of safe vehicles is of course important, but it is also essential to educate people, namely drivers and pedestrians, regarding traffic safety and to create a safe traffic environment.

Toward achieving a safe mobility society, Toyota believes it is important to promote an Integrated Three Part Initiative, involving people, vehicles, and the traffic environment, as well as to pursue "real-world safety" by learning from accidents and incorporating that knowledge into vehicle development. Toyota has also defined its Integrated Safety Management Concept as the basic philosophy behind technologies towards achieving the elimination of traffic casualties and is moving forward with developing such technologies.

Integrated Safety Management Concept

Toyota's approach is to enhance the safety level through development of various safety systems that work together in a car rather than thinking of each separately. The scope of responses, which previously focused on the moments immediately before and after an accident, is widened to provide optimal driver support during every stage of driving from parking to normal operation, the pre- and post-crash timeframe, and post-accident rescue. The Integrated Safety Management Concept seeks to create safer cars by achieving this.

Integration of Individual Technologies and Systems

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Pre-collision System

Basic Functions

Warnings

Pre-collision Brake Assist

Pre-collision Brake

Type

Conventional Type PCS with Rear-end Collision Avoidance

Advanced Function Type PCS w/ Pedestrian Detection and Lane-Crossing Alert
Traffic Accident Conditions and Toyota’s Safety Technologies

There were 4,373 traffic fatalities in Japan in 2013, and the total number has been decreasing every year for some time. Fatal accidents involving pedestrians and elderly drivers aged 65 and older, however, are declining at a very slow rate. Taking measures towards achieving zero traffic accident fatalities has long been a priority issue.

To address traffic accidents, Toyota seeks to provide optimal support for each driving scenario in accordance with the Integrated Safety Management Concept for manufacturing safe automobiles tailored to actual conditions. To achieve this, we are developing and putting into application not only safety systems that function independently, but also safety technologies that collaborate with one another to enhance safety even further.

For example, there are instances where a driver in a parking lot or garage does not notice a nearby pedestrian, resulting in an accident. Toyota developed the Panoramic View Monitor, which can confirm the presence of pedestrians in a 360-degree field around the vehicle, to help drivers not fail to observe a pedestrian.

Also, the Pre-collision System (PCS) has undergone continuous technological development since their commercial launch in 2003, and in 2008 we developed the PCS with Pedestrian Detection. Further refinements were made, and Toyota launched automatic braking that can reduce vehicle speed by up to 30 km/h and Pre-collision Brake Assist, which can reduce vehicle speed by a maximum of 60 km/h. Thus, we are taking measures to address issues concerning pedestrians, a high-priority matter for reducing the number of traffic fatalities.

The number of accidents involving elderly drivers has been increasing in recent years. The perception, decision-making ability, and operational abilities required for driving decline with advancing age. Approximately half of accidents caused by elderly drivers occur at or near intersections, and half of these accidents are caused by a failure to confirm safety. In response to these types of accidents at intersections, we believe that Vehicle-infrastructure Cooperative Systems that provide the driver with information about vehicles and pedestrians approaching areas with poor visibility through vehicle-to-road infrastructure communications and vehicle-to-vehicle communications can be an effective means of preventing accidents.

In addition, advanced driving support systems that use automated driving technology have substantial potential to reduce traffic fatalities and injuries by compensating for driver errors and reducing driving burdens to avoid accidents.

Toyota believes that accidents and other issues of the traffic environment can be addressed by greatly enhancing the safety of traffic systems overall, not simply of an automobile itself. To achieve this, Toyota is developing technologies with the aim of application at the earliest possible time of advanced driving support systems that utilize automated driving technologies.
Main Initiatives during FY2013

Parking Support Systems

Panoramic View Monitor Supports Checking around the Vehicle from a Bird’s-eye View

The Panoramic View Monitor displays on the navigation system screen an image that appears to be looking down from above the vehicle. The image is created by seamlessly combining images from cameras located at the four corners of the vehicle. The display is automatically adjusted based on gear-stick operation, providing the driver with an unobstructed real-time view of conditions in the vicinity of the vehicle, which can be difficult to confirm visually from the driver’s seat. The system is also equipped with functions to support checking of the areas to the left and right of the vehicle with the monitor screen displaying persons or vehicles that appear from the side in a yellow frame and an auditory warning when pulling out of a parking spot or an intersection with poor visibility. The Panoramic View Monitor with this side view support was adopted on the Harrier in 2013.

* The scope of the images produced by the cameras is limited.

Reducing Traffic Accidents by Using ITS Technologies

Vehicle-infrastructure Cooperative Systems that Support Safe Driving to Reduce Traffic Accidents at Intersections

Vehicle-infrastructure cooperative systems that support safe driving use direct communications between road infrastructure and vehicles, between vehicles, or between vehicles and pedestrians to reduce the risk of accidents resulting from causes of poor visibility that cannot be avoided by vehicles alone.

Toyota is developing technologies for such systems and working in cooperation with the public sector to put systems into practical application including basic infrastructure development such as standardization of communications methods and conducting public-road verification tests.

<table>
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<th>System Type</th>
<th>Function</th>
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<td>Vehicle-to-infrastructure cooperative system</td>
<td>When waiting at an intersection with a traffic signal to make a turn across oncoming traffic, in-road sensors detect and gather information concerning oncoming vehicles that are proceeding straight and pedestrians crossing the road and warnings are provided to drivers.</td>
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<tr>
<td>Vehicle-to-vehicle cooperative system</td>
<td>At intersections with poor visibility, approaching vehicles exchange information, the presence and behavior of nearby vehicles are detected, and warnings are provided to drivers.</td>
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<tr>
<td>Vehicle-to-pedestrian cooperative system</td>
<td>Information on the presence of bicycle riders and pedestrians is gathered from portable devices in their possessions and notices provided to drivers to reduce the risk of collisions when crossing paths.</td>
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Vehicle to vehicle cooperative system
Vehicle to pedestrian cooperative system
The Pre-collision System with Pedestrian Detection Uses Automated Steering Technologies to Avoid Collisions

In 2012, Toyota integrated millimeter wave radar and stereo cameras to develop the Pre-collision System (PCS) with pedestrian detection to help drivers avoid collisions with pedestrians. The system was used on the Lexus LS.

In 2013, Toyota announced the Next-generation PCS with Pedestrian-avoidance Steer Assist as a future technology for avoiding collisions with pedestrians when automatic braking alone cannot stop the vehicle in time. When the system predicts the possibility of a collision based on the movement of a pedestrian detected by an on-board sensor and determines there is a risk of a collision, the driver is warned by a visual alert on the dashboard. If the risk of a collision with the pedestrian increases, the system issues an audio and visual alarm to encourage the driver to take evasive action, and activates the Pre-collision Brake Assist and automatic braking functions. If it is not possible to avoid a collision by braking alone, the system identifies if there is sufficient room for avoidance and steer assist is activated to help the driver avert a collision with the pedestrian.

Traffic Safety Education Activities

Toyota has been conducting a wide range of traffic safety education activities continuously since the 1960s targeting various human audiences including drivers and pedestrians. Recently, activities have also been conducted by overseas affiliates.

Focus

Crown Wins JNCAP First Prize in New Car Assessment Program with Highest Score Ever

In FY2013, the "Crown Royal" and "Crown Athlete" sedans received the Five-Star Award, the highest rank, under the Japan New Car Assessment Program (JNCAP*). The Crown also received a score of 189.7 points (out of a possible total of 208 points), the highest score since the program was introduced in FY2011, and won the JNCAP First Prize.

The JNCAP is a five-stage comprehensive safety assessment that combines protection performance of both passengers and pedestrians during a collision. The Crown is equipped with an impact-absorbing body and high-rigidity cabin, and all grades have seven airbags and seatbelt reminders for all seats as standard features, providing a superb level of occupant protection. In addition, all hybrid models feature a pedestrian-injury-lessening vehicle body structure and the latest pop-up hood, achieving high pedestrian protection performance.

The Crown is also equipped with a Pre-collision System with enhanced Brake Assist and automatic braking functions, Intelligent Clearance Sonar that reduces damage from accidents caused by pedal misapplication, and Drive Start Control system that limits sudden starts when operating the gear shifter. The Crown also boasts advanced active safety systems including a Panoramic View Monitor, Adaptive High-beam System that provides excellent forward visibility when driving at night, and advanced Vehicle Dynamics Integrated Management (VDIM) system. These various systems collaborate to provide comprehensive and optimal support, achieving high levels of safety under all driving circumstances from parking to active safety, the pre- and post-crash timeframe, and post-accident rescue.

For details, see: Social Contribution Activities (Traffic Safety; "12-09" – "12-13")
Advanced Driving Support Systems that Use Automatic Driving Technologies

Toyota seeks the practical application at the earliest possible time of advanced driving support systems that employ automatic driving technologies to provide safe and secure means of transportation that respect the wishes of the driver, the key player in driving, and maintain the fun-to-drive aspect of controlling a vehicle without compromise. Toyota has been conducting research and development on automatic driving technologies since the late 1990s and is currently conducting public road tests* in the United States and Japan.

Based on the knowledge obtained from this R&D and testing, we aim to provide safe driving support that enables all drivers to exhibit the driving capabilities of a veteran driver under all conditions and hope to contribute towards achieving zero fatalities and injuries from traffic accidents, the ultimate objective of any society that values mobility.

* During testing, the driver maintains awareness of safety conditions and takes control of the vehicle whenever necessary.

Towards a Safer and More Comfortable Mobility Society

Specific measures to create advanced driving systems include the announcement in 2013 of Cooperative-adaptive Cruise Control, which uses wireless communications with a preceding vehicle to maintain a safe distance, and Lane Trace Control, which aids steering along an optimal route based on lane markings and other information.

Cooperative-adaptive Cruise Control employs millimeter wave radar and next-generation vehicle-to-vehicle ITS communications technology to synchronize acceleration and deceleration with a preceding vehicle to maintain a constant distance and facilitate stable driving. The system also reduces unnecessary acceleration and deceleration, contributing to improved fuel efficiency and reducing traffic congestion.

Lane Trace Control uses sensors to detect lane markings and even on sharp curves automatically decelerates to maintain smooth driving. The system then returns the vehicle to its original speed and precisely adjusts the steering, drive power, and braking force to maintain an optimal driving line at all vehicle speeds.
Focus

Activities of the Collaborative Safety Research Center in the U.S.

The Collaborative Safety Research Center (CSRC) was established in January 2011 to contribute to the creation of a safe mobility society in North America through the broad application of research results conducted in collaboration with American academic organizations and research institutions. The research results support not just Toyota’s R&D, but wide-ranging improvements in safety technology through sharing and use throughout the automobile industry.

Research fields include (1) collection and analysis of traffic accident data and driver behavior data, (2) development of evaluation methods to encourage the widespread adoption of active safety systems, (3) research on measures to support vulnerable road users (pedestrians, children, seniors, drivers in their teens), and (4) research on human factors such as driver distraction. The CSRC conducts activities with these research fields as its pillars.

Examples of Joint Research Topics

| Development of pedestrian PCS evaluation methods | The pedestrian Pre-collision System (PCS), which detects pedestrians crossing the street and avoids collisions, is expected to have a major effect on reducing casualties. The CSRC and Transportation Active Safety Institute (TASI) started research on methods of assessing the pedestrian PCS and designing and creating prototype model pedestrians, which is needed for evaluation, as the core technologies for the widespread use of the system. The photo to the right shows one aspect of the evaluation, and government agencies and other auto manufacturers have already expressed interest. |
| Electronic monitors for drivers in their teens | Preventing accidents by inexperienced teen drivers is a major issue in the United States. The CSRC is creating a system that uses cameras to record the driving behavior of teen drivers for review by drivers with their parents so they can improve dangerous conduct. The system is in use by families for testing purposes and the CSRC verifying the effects. |