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 and regions 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 are predicted to become the fifth-leading cause of death by 2030 unless countermeasures are implemented.

Toward achieving Toyota’s ultimate goal of complete elimination of 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 actual accidents and incorporating that knowledge into vehicle development. Toyota has also defined its Integrated Safety Management Concept as the basic philosophy behind technologies toward 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 developing 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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GOA
- Collision Safety
- Body Structure
- Airbags
- Seats
- Pop-up Hood

HELNET
- Emergency Response Systems
- Vehicle Information Systems
- Driver Support Systems
- Pedestrian Protection Systems

Basic Functions
- Warnings
- Pre-collision Brake Assist
- Pre-crash Brake

Type
- Convictional Type P2G with Near-end Collision Avoidance
- Radar Detection and Collision Avoidance Support Function

Integrated Safety Management Concept
- People
  - Lectures, etc. to raise awareness of traffic safety
- Vehicles
  - Development of technologies for accident avoidance and driver/passenger protection in a car collision
- Traffic environment
  - Information on traffic jams, and maintenance and management of traffic lights and more
- Investigation and analysis of accidents
- Pursuing "real-world safety"
  - Simulations
  - Evaluation of actual vehicles to pursue safe vehicles and incorporate preventive technologies into actual vehicles
  - Accident simulation to develop preventive measures

In the diagram, the Integrated Three Part Initiative is illustrated with concentric circles, emphasizing the integration of individual technologies and systems to enhance traffic safety. The diagram also highlights the steps of investigation and analysis of accidents, simulations, and evaluation to develop preventive measures.
There were 4,113 traffic fatalities in Japan in 2014, 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 toward achieving the complete elimination of traffic accidents 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 from failing to notice 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 recognition, judgment 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 can be an effective means of preventing accidents. They 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.

In addition, advanced driving support systems that use automated driving technology have substantial potential to reduce traffic casualties 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 automated driving technologies that will enable everyone to move safely and freely.
### Actual Results for the Previous Fiscal Year and Major Initiatives for the Current Fiscal Year

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<th>Major Initiatives during FY2014</th>
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<td>• Drafted a medium- to long-term safety technology scenario by anticipating future technological trends, laws and regulations, and assessments, and promoted the development of such technologies</td>
<td>• Develop a medium- to long-term safety technology scenario toward 2025</td>
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<td>• Started up a conference that spans multiple departments and promoted activities to improve the quality of the Toyota Safety Sense packages</td>
<td>• Promote the Toyota Safety Sense packages in Japan, North America, and Europe to popularize safe automobiles</td>
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<td>• Created a technological public relations strategy, and explained Toyota’s vision for its automated driving technologies and their status at the ITS World Congress and safety technology briefings</td>
<td>• Accelerate development of automated driving technologies that can be applied to both general roads and highways</td>
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<td>• Developed an automated driving system and completed public road testing over a total distance of 8,500 km</td>
<td>• Promote planning and development of safety systems that incorporate the Toyota New Global Architecture (TNGA) concept</td>
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### Major Initiatives during FY2014

#### Reducing Traffic Accidents through Intelligent Transport System Technologies

**Commercialization of Telecommunication-based Safety Technologies and Cooperative Driving Support Systems in 2015**

Cooperative driving support systems utilize road-to-vehicle and vehicle-to-vehicle communication at the dedicated ITS frequency (760 MHz). By capturing information that cannot be fully detected by sensors installed in vehicles, the systems complement autonomous systems and are therefore considered to be effective in further reducing the number of accidents.

Specifically, near intersections with poor visibility, the systems support safe driving, including alerting drivers, by acquiring information on oncoming cars and pedestrians detected by sensors installed on roads, as well as vehicle-to-vehicle proximity information based on vehicle-to-vehicle communication.

Toyota has also developed a Cooperative-adaptive Cruise Control technology that relies on vehicle-to-vehicle communication. By utilizing acceleration/deceleration information about the preceding vehicle acquired through vehicle-to-vehicle communication, in addition to detecting the distance to the preceding vehicle and its relative speed based on conventional millimeter-wave radar, the new radar cruise control technology is expected to be effective in improving tracking performance, reducing fuel consumption, and eliminating traffic congestion.

In 2015, Toyota commercially launched its cooperative driving support system, taking the first step toward its widespread adoption.

#### Active Safety (Preventing Accidents)

The pre-collision system detects an impending collision and helps reduce damage by preparing for it. When the system detects the possibility of collision, it sounds an alarm to prod the driver to operate the brake. If the possibility of collision further increases, the system activates the pre-collision brake to avoid the collision or reduce collision damage.

For further details on Toyota Safety Sense, see Special Feature 01 (pp. 03-02–03-03)
LED Cornering Lights to Enhance Visibility at Intersections

Toyota has started using LED cornering lights, safety devices that can contribute to pedestrian safety and helping prevent accidents at intersections, etc. When an equipped vehicle is being driven with its headlights on, LED cornering lights go on in conjunction with operation of the blinkers or steering wheel. When the vehicle is about to enter an intersection to turn left or right, the LED cornering lights help ensure the visibility of pedestrians and other obstacles. When the vehicle is travelling at 40 km/h or slower with its headlights on, an LED cornering light goes on if the blinker goes on or the steering wheel is turned by 80 degrees. Furthermore, when the shift lever is moved to the Park (P) position, both the left and right LED cornering lights go on simultaneously. As shown in the figure, LED cornering lights allow the driver of the vehicle to see all four corners of the intersection whether going straight or turning. LED cornering lights were installed in some grades of the Alphard and Vellfire, which underwent a full model change in January 2015.

Next-generation LED Array Adaptive High Beam System (LED Array AHS) That Provides Reliable Illumination during Nighttime Driving

The new LED Array Adaptive High Beam System (LED Array AHS) uses multiple independently controlled LEDs arranged in a single row, giving a wider range of illumination than earlier systems without dazzling the drivers of preceding and oncoming vehicles. For example, LED Array AHS can illuminate the gaps between preceding vehicles and oncoming vehicles, making it easier to detect pedestrians crossing the road. It also adapts the distribution of light to a wide range of driving circumstances: in an urban setting, for example, a wide area will be illuminated, whereas long-distance illumination is used during high-speed driving on highways.

The system also adjusts the distribution of light based on the operation of the steering wheel, improving visibility ahead of curves.

LED Array AHS combines these functions to provide reliable illumination during nighttime driving.

Parking Assist System

Toyota’s First Intelligent Clearance Sonar (with Eight Sensors) to Help Avoid Collisions and Reduce Collision Damage

Toyota’s existing clearance sonar helps to reduce contact with an obstacle by detecting obstacles the vehicle is at risk of colliding with, during a parking maneuver for example, indicating this information on the display and sounding an alarm. Toyota has added new functions to develop Intelligent Clearance Sonar, which helps avoid a collision during low-speed operation or reduces damage by softening a collision, regardless of whether the accelerator or brake pedal is being depressed or not.

The eight sensors installed on the front and rear of vehicles extend the detection distance and expand the detection range. If an obstacle such as a wall is detected ahead, the system reduces the engine or motor output and automatically applies the brakes if the distance to the object is further reduced.

Intelligent Clearance Sonar not only reduces damage caused by pedal misapplication as before, but also helps avoid collision with the preceding car or reduces collision damage during low-speed driving in parking lots or pulling into parking spaces.
New Panoramic View Monitor Features World’s First* See-through View Function

The Panoramic View Monitor is a safety check support system that displays an image of the vehicle’s surroundings on the navigation system screen through operation with a switch. The system’s Moving View, which displays video images as though looking down on the vehicle, has now been enhanced with See-through View, the world’s first screen mode that makes it easier to detect obstacles. The new Panoramic View Monitor was installed in some grades of the Alphard and Vellfire, which underwent a full model change in January 2015.

See-through View gives a driver’s perspective view of the vehicle’s surroundings as if the vehicle itself were transparent. Compared to Moving View, See-through View displays obstacles larger, making them easier to identify. The driver can check safety at the press of a button.

The Panoramic View Monitor also features a Cross Traffic Detection Function, which checks for people or vehicles that might appear from the side and alerts the driver of their presence before the vehicle starts moving.

*As of January 2015 (according to a survey by Toyota Motor Corporation)

World’s First Intelligent Parking Assist 2, Featuring Automatic Steering Operation, Etc.

Intelligent Parking Assist 2 is an advanced safety system that uses ultrasonic sensors and a camera to detect parking spaces and automatically sets the targeted parking position. It has three new advanced functions in addition to the existing functions.

Collision avoidance and damage reduction support: By working with the Intelligent Clearance Sonar, the system uses automatic braking to avoid collisions and reduce collision damage.

Multi-point turn support: In tight parking situations requiring multi-point turns, the system automatically operates the steering wheel to help the driver safely and smoothly pull the vehicle into a parking space.

Parallel parking departure: As when pulling into a parking space, the system automatically operates the steering wheel to help the driver get out of a tight parallel parking space. For both the multi-point turn support and parallel parking departure functions, shifting, accelerating, and braking are performed by the driver.

Intelligent Parking Assist 2 was installed for the first time in the world* in some grades of the Alphard and Vellfire, which underwent a full model change in January 2015.

*As of January 2015 (according to a survey by Toyota Motor Corporation)
Toyota has been conducting various traffic safety education activities continuously since the 1960s targeting a wide range of audiences including drivers and pedestrians. Activities have also been conducted by overseas affiliates.

For details, see: Social Contribution Activities (Traffic Safety: pp. 12-10–12-15)

Focus

Voxy/Noah/Esquire and Harrier Receive the Five-Star Award under the JNCAP New Overall Safety Performance Assessment Program

The Voxy/Noah/Esquire and Harrier received the highest Five-Star Award from the Japan New Car Assessment Program (JNCAP) vehicle-safety evaluation tests in FY2014 under the new overall safety performance assessment program.

The two models are equipped with various safety technologies and features, such as an impact-absorbing body and high-rigidity cabin, as well as seven SRS airbags including an SRS driver-side knee airbag and SRS side and curtain shield airbags, providing a superb level of occupant protection. In addition, these models feature a vehicle body structure to lessen pedestrian injury, achieving high pedestrian protection performance. These features helped the models win the award.

In the past, the Lexus CT 200h, Corolla, and Crown also received the Five-Star Award. Of these, the Crown received the JNCAP Grand Prix award, scoring 189.7 points (out of 208 points), the highest score received since the new overall safety performance assessment structure was introduced in FY2011. Since this score has never been broken, the Crown continues to hold the Grand Prix award, which is given to the highest-scoring vehicle in the history of the award program.

Toyota and Lexus vehicles have been receiving high scores in car assessment programs throughout the world. For example, in 2014, eight models received the TSP+ rating and four models received the TSP rating according to vehicle assessment by the U.S. Insurance Institute for Highway Safety (IIHS). In addition, in the U.S. NCAP, 14 models received the five-star rating.

1 This joint program between Japan’s Ministry of Land, Infrastructure, Transport and Tourism and the National Agency for Automotive Safety & Victim’s Aid has been publishing vehicle safety information since FY1995 with the aim of promoting the spread of safe automobiles
2 Top Safety Pick
3 A vehicle assessment program administered by the United States National Highway Traffic Safety Administration
Focus

**Toyota’s New $35 Million Commitment to U.S. Collaborative Safety Research Center**

Toyota’s Collaborative Safety Research Center (CSRC) was established with a 50-million dollar investment plan in January 2011 at the Toyota Technical Center (TTC) in the state of Michigan for the purpose of conducting joint research with U.S. academic and research institutes. By sharing outcomes with communities and industries, the Center hopes to contribute to realizing a safe automobile-based society in North America.

Past research projects have focused on active safety, reducing the risk of driving when not paying attention to the road ahead, and protecting vulnerable road users such as children and senior citizens. As of February 2015, a total of 15 of the 34 research projects launched with 17 partner institutions have been completed, and this current first phase of research is planned to conclude in FY2016.

Two typical research outcomes achieved during this first phase are a pedestrian crash test dummy jointly developed with other institutes for safety performance assessment tests of automatic emergency braking (AEB) systems, and a distraction study of 5,600 teens and adult drivers. When the results of these CSRC projects were released publicly, they were also reported to the federal agencies to support the creation of regulations, and safety performance assessments.

In September 2014, CSRC announced a new financial commitment to continue its initiatives to research advanced automotive safety technologies with the goal of making tomorrow’s driving safer and more reliable. This investment will support CSRC activities from 2017 through 2021, with a particular focus on automated- and connected-vehicle technologies, as it works toward the early realization of society’s transition to safe future mobility.

CSRC remains committed to exploring the potential of the relationship between future mobility and broader, more complex social trends and concerns in the market such as the “Quantified Self” associated with the potential rise in the latest wearable devices.

Specific research to be conducted going forward will focus on new technologies and new challenges that will likely continue developing over a long period of time, including the development of human/machine interface (HMI) guidelines for automated and connected vehicle technologies, research on the user skills needed to operate these technologies safely, and the issues faced when conventional and automated vehicles travel on the same roads.

CSRC Director Chuck Gulash said: “CSRC hopes to pave the way for the safe introduction of the new automated- and connected-vehicle technologies expected to be more widely used in the future, not only by refining the technologies, but also by focusing on the drivers who will be using them—with the goal of realizing Toyota’s ultimate hope of a society free of traffic casualties.”

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1. Pedestrian Automatic Emergency Braking (AEB): System for detecting obstacles ahead and automatically braking where there is the possibility of a collision
2. Quantified Self: A term currently used in the U.S. and other countries to refer to initiatives to acquire new knowledge by quantifying human actions and conditions using such things as sensors and information and communications devices
3. Latest wearable devices: Wristwatch-type, spectacle-type and other wearable information and communications devices and electronic devices