TOYOTA

# NEW TECHNOLOGY TO MAKE AUTOMOBILES MORE FRIENDLY TO PEOPLE AND TO THE EARTH

By creating automobiles that are friendly to people and to the Earth, Toyota hopes to contribute to societies in which everyone can be happy. That's why we place such a high priority on automotive safety, congestion reduction, and environmental protection. At Toyota, the foundation of developing superior vehicles is safety. That's why we consider automotive safety from every angle, and work to develop the safest vehicles possible; ones you can drive in comfort and peace of mind.

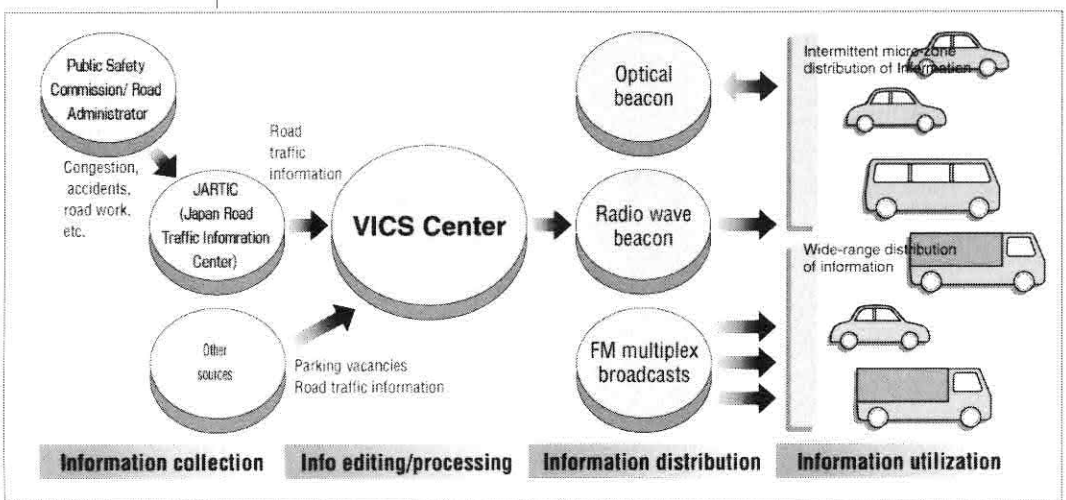
Safety and protection of the environment go beyond the production of motor vehicles. They also concern drivers and the traffic environment. At Toyota, we are working on systems that will make man-machine-infrastructure interfaces work smoothly and effectively. Toyota will continue to work toward new and better solutions for these issues.

## Intelligent Transport Systems (ITS)

Recent advances in information transmission technology are fueling the development of traffic information systems that will keep drivers informed on accidents, road construction, traffic congestion, and other driving conditions. Called the Vehicle Information and Communication System (VICS), this is attracting considerable attention in the automobile industry. The addition of such capabilities as automatic toll collection and automated vehicle-highway systems opens the door to comprehensive intelligent transport systems (ITS). The ultimate goal is to make driving safer, more convenient, and more enjoyable for everyone. Government, industry, and academia are working as one on research and development programs to integrate vehicles and infrastructure in a new ITS structure.

### Vehicle Information & Communication System (VICS)

R&D on VICS as the next-generation traffic information system is proceeding under the auspices of the National Police Agency, the Ministry of Posts and Telecommunications, and the Ministry of Construction. Toyota has already introduced some models with navigation systems with Global Positioning System (GPS) and voice guidance systems that can show the way to driver's destination on a map, and provide audible directions. While working to improve these systems, we are also actively involved in the VICS project. Toyota's two-pronged approach to developing driver information systems focuses on both practical applications and basic R&D.

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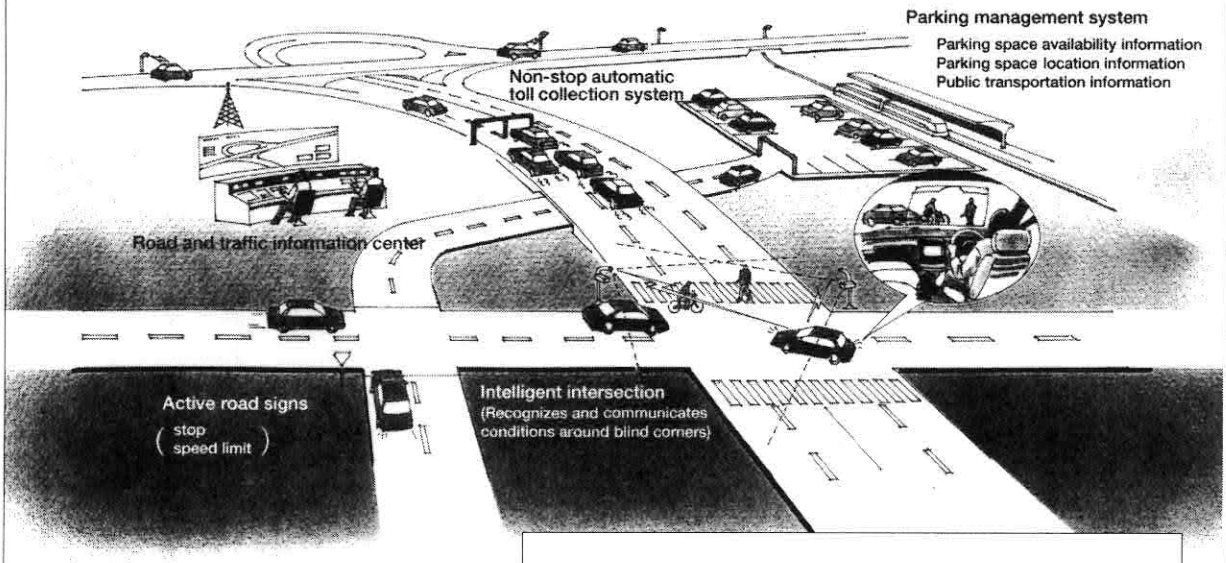
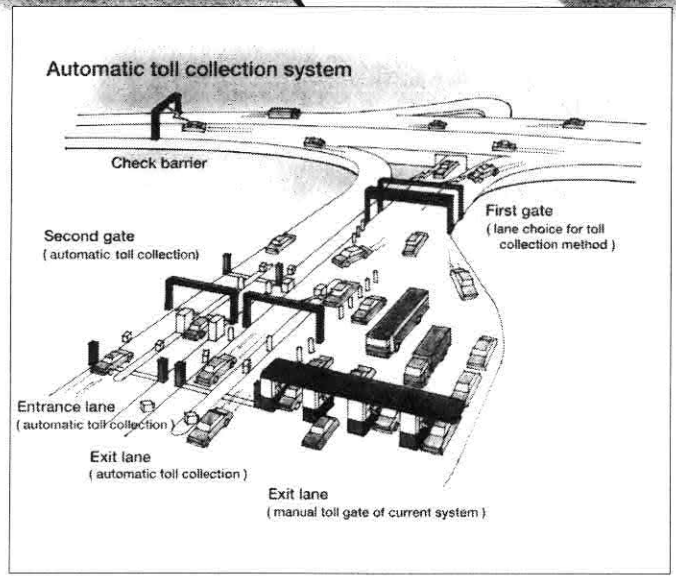
## Smoother traffic control

To relieve traffic congestion around expressway tollbooths, the Ministry of Construction is working on a system to automatically collect tolls without requiring vehicles to stop. Toyota has been involved in the development of this system, which involves the transmission of a signal between a device on the vehicle and the tollgate as the vehicle passes through the gate. This automatically deducts the toll from a prepaid card or bank account. In May 1995, Toyota was selected to participate in this public research project. As an automaker, our research centers on safe, easy-to-use vehicle-mounted transmission devices.

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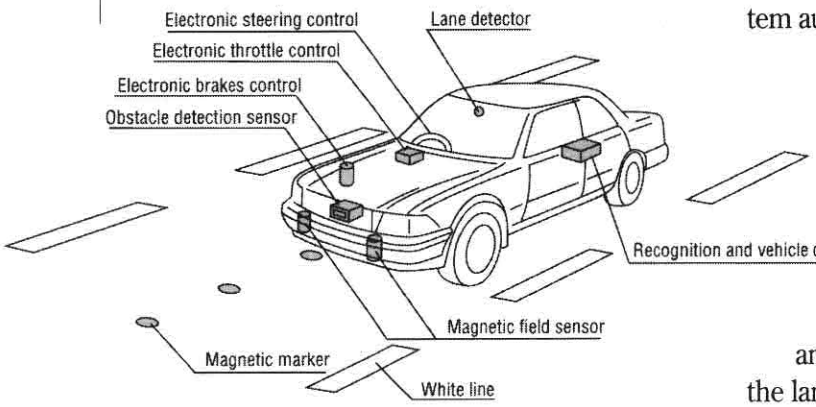
# Improved safety through automated driving systems

The automated vehicle/highway system is a futuristic expressway system being promoted by Japan's Ministry of Construction and by the U.S. Department of Transportation (DOT). The system under development at Toyota fulfills two basic functions. The first is a lane tracking system that automatically keeps vehicles in their proper lanes. The other is an obstacle avoidance function that detects other vehicles or debris on the roadway, and automatically maneuvers the car around them. In our in-house tests, cars have traveled at 100km/hour, successfully performing evasive actions and emergency stops. This system holds great potential for preventing accidents, reducing driver stress and fatigue, and improving the flow of traffic.

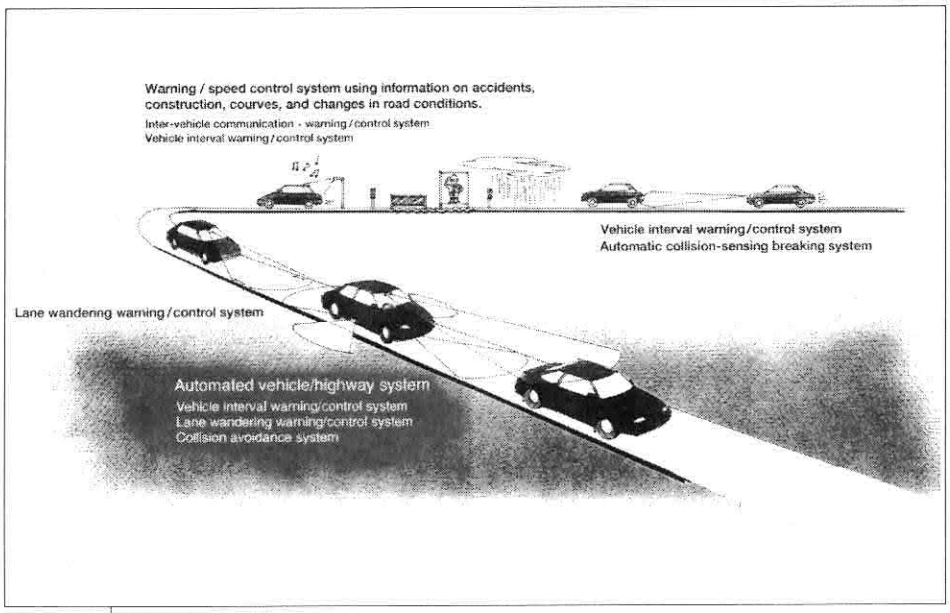
## Lane tracking

We have developed a magnetic-marker lane tracking function, which relies on a vehicle-mounted sensor that detects magnetic sensors buried under the roadway at one-meter intervals. Based on these signals, the system confirms that the vehicle is in the correct lane, and makes minor steering corrections to keep it on track. Under this system, vehicle control is quite flexible. When it detects slow-moving vehicles ahead, for example, it checks the next lane over; if it is clear, the vehicle changes lanes and passes the cars ahead. If the other lane is occupied, the system automatically slows the vehicle. We are also working on a system that uses buried guidance cables instead of magnetic markers.




## Avoiding obstacles

The obstacle avoidance function relies on a lane detection sensor consisting of a CCD camera and visual processing system that detect the lane the vehicle is running in, and an obstacle detection sensor that spots other vehicles or debris in the road ahead. It also features small CCD cameras and visual processing sensors mounted at the bottom of the door mirrors to detect such things as approaching vehicles. These systems work together detects cars approaching from behind and automatically avoid obstacles.

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# Toyota Advanced Safety Vehicle (ASV)

Toyota works to create safer vehicles from two points of view: preventing accidents from happening in the first place (active safety), and minimizing damage and injuries if an collision does occur (passive safety). Working with a broad range of advanced technologies, the company has promoted the development and commercialization of continually improving safety technology. To meet society's demands for an even higher level of automotive safety, Toyota is taking part in the Ministry of Transport's Advanced Safety Vehicle (ASV) project. The goal is to have a production ASV on the road early in the next century. The concept behind Toyota's ASV is the application of electronics technology to create an "intelligent" vehicle that offers improved safety. Our two experimental ASVs were manufactured as part of Toyota safety R&D. One car demonstrates active safety, the other passive safety. Between them they use 17 advanced safety technologies now being evaluated. As we move toward commercialization, many issues remain to be solved. For example, Toyota must be able to ensure reliability and durability, keep prices reasonable, and make proposals for and stay abreast of changes in traffic regulations and the roadway infrastructure. Toyota believes its work on the ASV will lead to a new generation of cars that are safer than ever before.

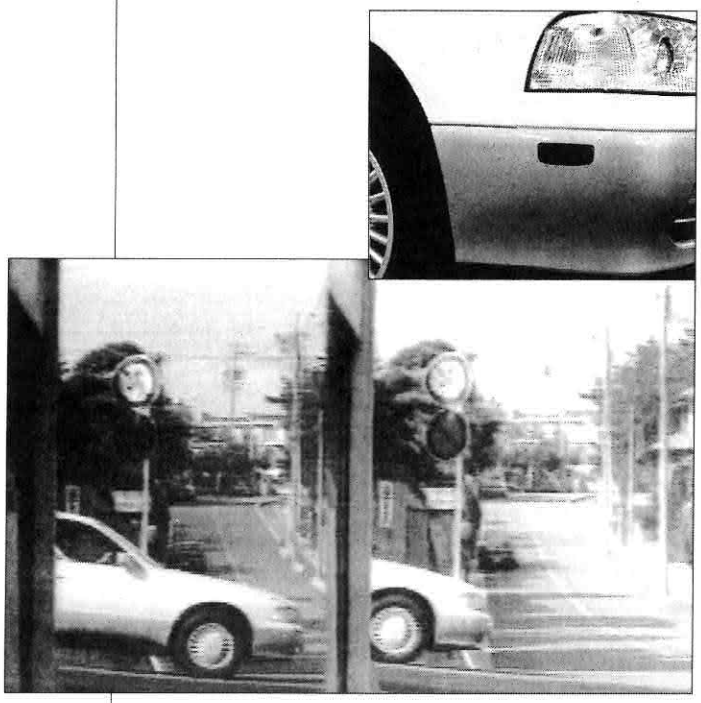

## Preventative safety

**Drowsy driving warning system**
A steering angle sensor in the steering wheel and a pulse sensor attached to the driver's wrist detect the earliest signs of drowsiness. If the sensors indicate that the driver's alertness is falling, the system triggers a dashboard display and an audible alarm, telling the driver to take a break. If the driver's consciousness level declines even further, the system vibrates the seat. If there's no response, the electronically controlled brakes will automatically stop the vehicle.

**Tire pressure warning system**
Wheel speed sensors continually check the air pressure on each tire. Insufficient air pressure sets off an audible alarm and a dashboard display to remind the driver to check the tires.

**Fire alarm system**
Temperature sensors and gas sensors in the engine compartment detect fires and trigger audible and visual alarms, and tell the driver to take action.

**Automatic headlight arrangement system**
This systems is equipped with millimeter wave radar and CCD cameras to monitor ahead for oncoming traffic or vehicles being overtaken. It then automatically controls the light pattern so it does not dazzle other drivers. Thus the driver is offered the brightest possible view of what's ahead. The system also detects curves and controls the light pattern toward the turn.



**Blind corner monitor system**
CCD cameras mounted on either side of the front bumper and a dash-mounted display provide a view of what's around the corner. That means the driver can see into blind intersections without having to edge out into the roadway.

**Next generation information display system**
In addition to conventional vehicle warning systems, the ASV features a display screen that shows potential dangers such as vehicle problems, distance to other vehicles, and so on. The display color, location, and audible warnings vary according to the degree of danger.

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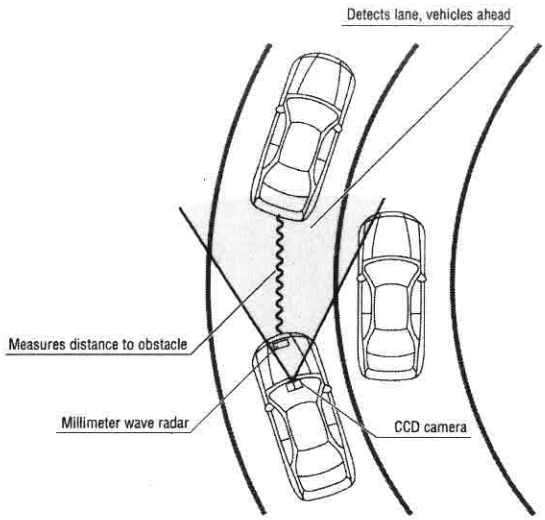
**Lamp-based intervehicle information transmission system**
This system lights up or flashes existing indicator lights and auxiliary lamps to transmit the driver's intentions or other signals to other vehicles or pedestrians. Signals could mean "After you," "Braking soon," "Crossing ahead," and "Help me!" By improving communication among drivers and pedestrians, this system will ensure a smoother, safer traffic flow.

**Navigation system for road traffic information**
Via links to the traffic infrastructure, this system tells the driver the vehicle's current location, offers route guidance, warns of congestion and accidents, tells where they are occurring, and even helps find vacant parking. All this information will help smooth out the flow of traffic. (See ITS technological information, VICS page.)

## Avoiding accidents

**Automatic collision reduction braking system**

CCD cameras mounted on the inside rear-view mirror monitor the traffic lane and vehicles ahead. If the system spots an obstacle, a millimeter wave radar mounted on the front of the vehicle determines its distance from the vehicle. When it judges the situation to be dangerous, the system issues audible and visual warnings, and tells the driver to take evasive action. If the driver does not respond, the system automatically applies the brakes to avert or at least reduce the severity of a collision.




**SOS vehicle stop system**

This system automatically brings the vehicle to a stop at the touch of a switch when the driver suddenly becomes ill or otherwise incapacitated and cannot keep driving. As the vehicle comes to a stop, the system begins flashing exterior lamps to warn cars approaching from behind to avoid collision and to ask for assistance. (See lamp-based intervehicle information transmission system)

## Minimizing collision damage

**Seatbelt pretensioner system**

In case of a collision, the pretensioners automatically retract any slack from the seatbelts to more effectively restrain the occupants.

**Side airbag system**

In a side-on collision, airbags built into the doors inflate to protect the passengers.

**Collision-sensing automatic braking system**

When sensors detect a collision, the system automatically applies the brakes to prevent multiple collisions.

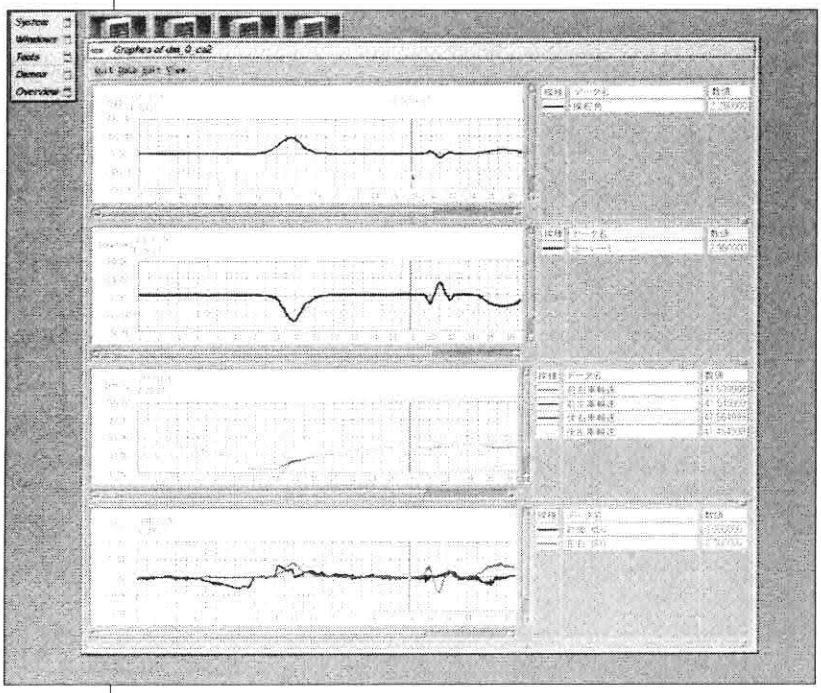
**Hood airbag system**

When sensors in the front bumper and hood detect a collision with a pedestrian, an airbag mounted on the hood deploys to prevent the pedestrian's head from striking the hood.

# Minimizing post-collision damage

**Fire extinguishing system**
Fires in the engine compartment can be quickly put out from the driver's seat at the touch of a switch. If the built-in fire extinguisher fails to put out the fire, the hood latch automatically opens to make it easier to extinguish the fire from outside the vehicle. (See the fire alarm system in the section on preventative safety.)

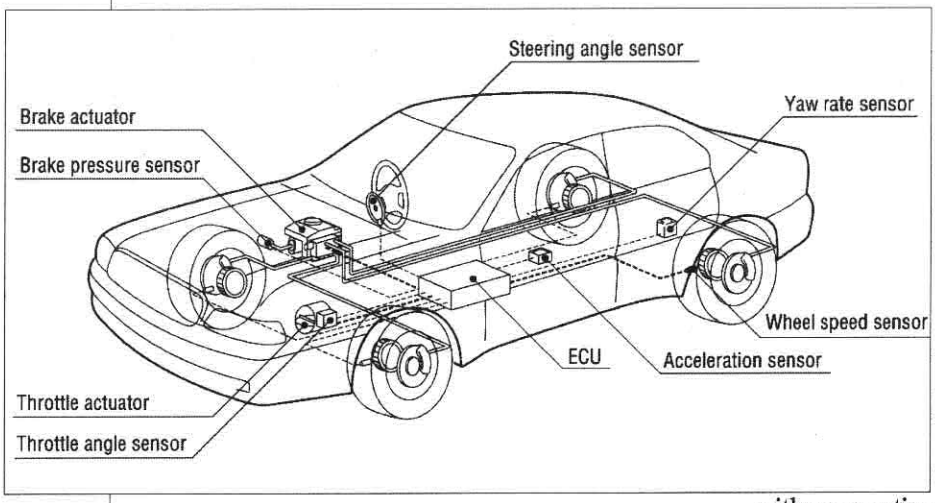
**Accident reporting system**
Activation of the collision detection sensor, the SOS vehicle stop switch, or the accident reporting switch will automatically report the precise location of the vehicle and other vital information to an emergency dispatch center.



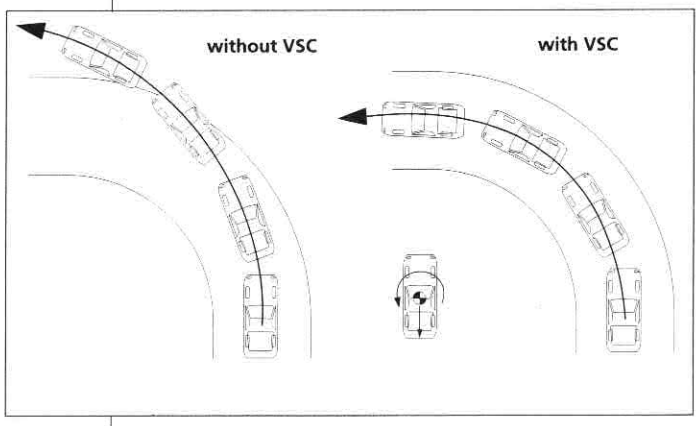
**Drive recorder system**
IC card recordings of conditions immediately before and after an accident, such as changes in vehicle speed, rate of deceleration, steering wheel angle, braking conditions, and so on, can be used to reproduce the accident in a computer graphics format. The system can analyze the causes of the accident and help prevent similar accidents in the future. The recorder uses an endless loop that records over old data after a specified period of time.

# NEW TECHNOLOGY FOR THE NEW CROWN

## Vehicle Stability Control (VSC)



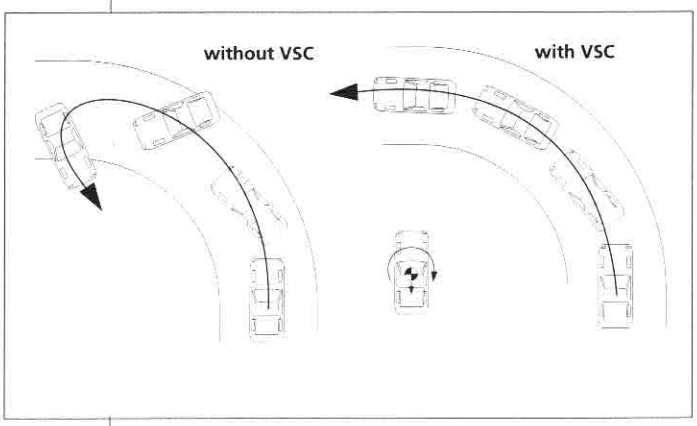

Many accidents are caused by lateral skids that result from sudden steering changes as drivers negotiate curves on slippery roads or try to avoid obstacles. Toyota has developed vehicle stability control (VSC), which independently controls the braking of each wheel and adjusts engine output to control lateral skids beyond the ability of the average driver. When combined with conventional 4-wheel ABS and TRC (traction control) vehicle stability controls, it greatly enhances stability during turns.




Front wheel traction control

### Front wheel traction control

When the front wheels slip laterally, appropriate braking force is applied to each wheel, and engine output is reduced. The deceleration and vehicle body moment into the curve helps restore the tires' grip for stable cornering.

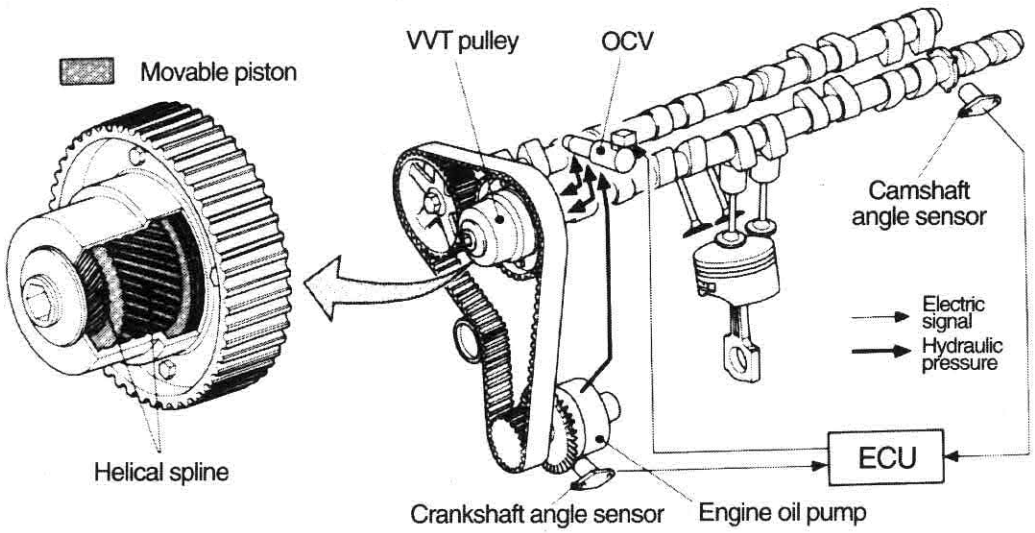


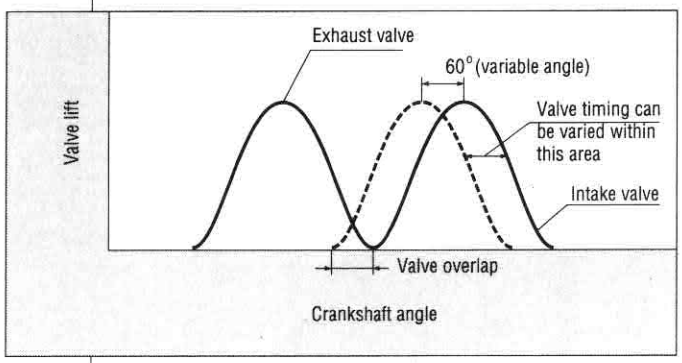

Rear wheel traction control

### Rear wheel traction control

When the rear wheels slip laterally, braking force is automatically applied to the front outside wheel, giving the vehicle body moment in the opposite direction from the skid. This controls the lateral slip of the rear wheels and allows the vehicle to negotiate the corner.

## VVT-i (Variable Valve Timing-intelligent)




### 2JZ-GE engine

High performance with low fuel consumption is the perennial goal of engine designers. At any rate, today's drivers want both dynamic performance and responsiveness to societal demands such as resource conservation and reduction of global warming. Toyota has made great strides in Variable Valve Timing (VVT), which has been in use since 1991. These advances are reflected in Toyota's new VVT-i engine technology. By continuously changing the open/close timing of the intake valves, VVT-i assures optimum valve timing for all conditions. It increases torque and power output, improves fuel economy, and reduces NOx and HC emissions.