



DENSO helps guide the evolution of an advanced automotive society through the continued creation of innovative products made possible by powerful research and development capabilities.

The Automotive Industry Turns a New Corner

The automotive industry is entering a new phase of evolution, carried forward by technological advances in the environmental, electronics and information technology (IT) fields.

DENSO is targeting further growth and the enhancement of its corporate value through the development of innovative technologies that fulfill these vital priorities for the automotive industry. This work will continue to be guided by DENSO's values as a company whose members are driven by a passion not only for the tradition of *monozukuri* (the art of making things), but also by enthusiasm for the environment, safety, comfort and convenience.

Environmental Commitment

DENSO's environmental efforts began in 1966 with the development of an electronic fuel injection system to improve fuel efficiency and reduce exhaust gas emissions. Subsequent development successes have included a car air-conditioning system designed to use HFC-134a replacing the ozone-depleting refrigerant CFC-12, which



Engineers in Aachen Engineering Center evaluating diesel engine components



Solenoid injector for 1,800-bar CRS

went on sale in 1991, and the development in 2002 of the world's first car air-conditioning system based on the use of carbon dioxide as its refrigerant, further decreasing the environmental impact of refrigerants.

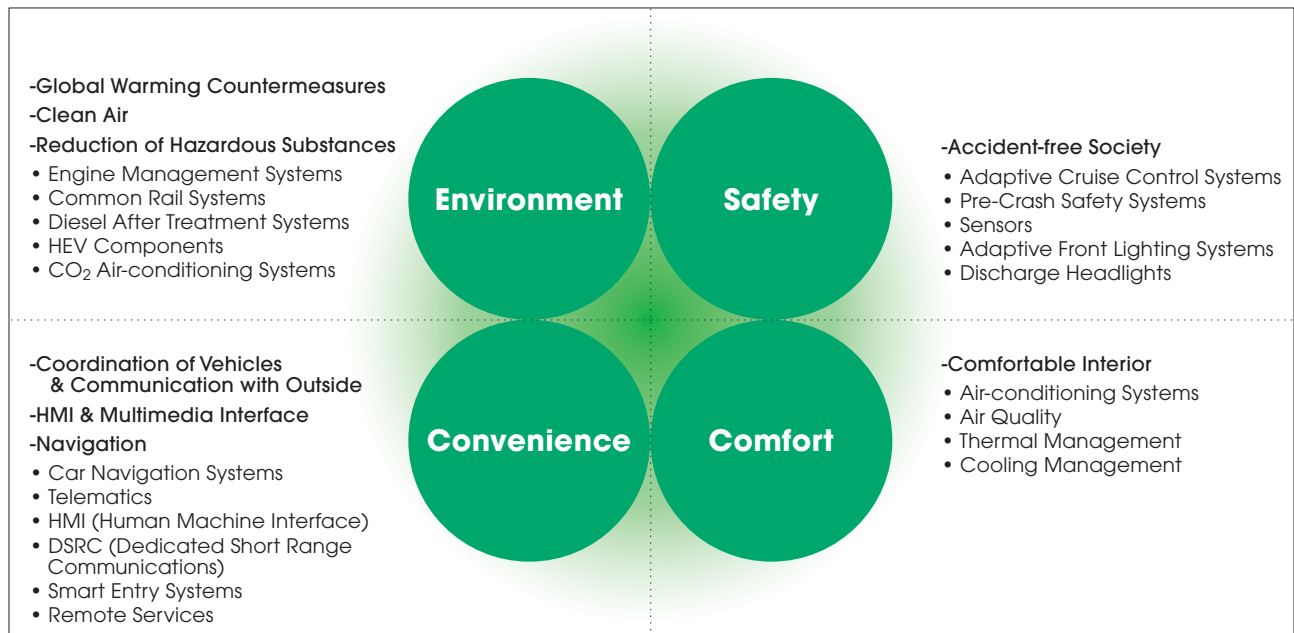
Particularly significant is DENSO's contribution to the technology of diesel engines, which emit less carbon dioxide than gasoline engines. Recognizing the potential environmental benefits, DENSO developed the world's first electronically controlled diesel common rail system (CRS). This system went on sale in 1995. DENSO has continued to make steady progress in this field of technology, and in 2001 it developed the 1,800-bar CRS, which produces the world's highest fuel injection pressure. Launched in the European market the following year, the 1,800-bar CRS has brought major improvements in engine efficiency, fuel consumption and emission levels. It also meets the Euro4 fuel emission standard introduced in 2005.

In addition to 1,800-bar pressure, DENSO's CRS delivers up to five high-accuracy injections during each combustion stroke. These two features reduce particulate matter (PM) and nitrogen oxide (NOx) emissions and achieve a quietness that is equivalent to gasoline engines. This state-of-the-art technology is an example of DENSO's advanced knowledge in this field.

DENSO continues to target improvements in fuel efficiency and power output and reductions in emissions through the development of additional advanced CRS technologies, including systems with higher pressures, and high-speed piezo injectors. It is working to develop a 2,000-bar CRS, which is expected to reach the market within two to three years. DENSO has also succeeded in commercial development of the world's first 1,800-bar CRS with piezo injectors and launched the system in the European market in May 2005. The pilot injection interval has been reduced to just 0.1 milliseconds.

The reduction of environmental loads remains a priority for DENSO. In 2002 it eliminated the use of lead from all brushes used in its automotive electric motors. And in 2004, in conjunction with Koito Manufacturing Co., Ltd. (Koito) and Royal Philips Electronics, DENSO developed the world's first mercury-free, high-intensity headlamp system.

FOUR KEY DEVELOPMENT AREAS



In recent years hybrid electric vehicles (HEVs) have become an increasingly important presence in the market. DENSO has developed a wide range of components for HEVs, including battery electronic control units (ECUs), DC-DC converters, inverters and electrically driven air-conditioning systems. It is also helping to develop next-generation environment-friendly vehicles, including the development of components for fuel cell hybrid vehicles.

Commitment to Safety

DENSO's vision for safety is a society in which there are no traffic accidents. It is working toward this ideal through the development of technology that is based on a consideration for all segments of society, including pedestrians and the aged.

This commitment to safety dates from the 1970s and has led to the development of many important stability control and safety products, including an anti-lock braking system in 1986, and an airbag sensing system in 1989. Safety technology generally focuses on two distinct areas: active safety for collision warning and avoidance, and passive safety for damage minimization in the event of collision. DENSO develops technology for both areas.



Electronic control unit for AFS



Millimeter-wave radar for pre-crash safety system

Active safety systems provide driver perception assistance, driver decision assistance and help provide vehicle control for the driver. In 2003, DENSO launched the world's first adaptive front lighting system (AFS), the result of a joint development project with Toyota Motor Corporation (Toyota) and Koito. This system enhances driver perception at night by adjusting the headlamp beam to illuminate in the direction of travel around curves. Another innovation launched in 2003 was the world's first pre-crash safety system developed in conjunction with Toyota. This system identifies inevitable obstacles a split-second prior to collision. Then it automatically tightens passenger seat belts, while helping to activate a pre-crash braking system to reduce vehicle speed.

In 2004, DENSO began to supply components for the world's first adaptive cruise control (ACC) system, which can regulate speed at rates from zero to 30 km per hour. Conventional ACC systems only regulate speeds around 40 km per hour and higher. This new system allows drivers to use cruise control in high traffic areas, without having to continually brake and accelerate.

The most important requirement for products designed to improve safety is information reliability. DENSO has achieved dramatic improvements in the accuracy of external sensing and situation interpretation through the development of key technologies for millimeter-wave radar, laser radar, and image recognition algorithms. DENSO is also exploring the use of biological sensing technology to prevent accidents resulting from human error by detecting driver drowsiness, fatigue and other conditions. Another development focus is the use of sensor technology to detect and protect pedestrians.

Making Driving More Comfortable

DENSO has continually sought ways to prevent fatigue and enhance the enjoyment of driving through improvements to passenger and driver comfort. In the 1950s, when household air conditioners were a luxury item, DENSO was investigating the possibility of affordable vehicle heating and air-conditioning units. DENSO's first auto-heating unit was launched in 1952, followed by its first air conditioner in 1957. An aggressive product development strategy yielded many important advances, and an air-conditioning system that automatically controlled cabin temperature with manual switches launched in



An electric compressor, a key component of electric air conditioners for HEVs

1971 was one of the most advanced systems of its class at that time. Today, car air conditioners are DENSO's largest business category, and these products continue to hold the largest share of the world market.

In 2003, DENSO completed commercial development of an electric air conditioner for HEVs, which uses a newly developed electric compressor. This technology keeps the air-conditioning system running even during "idle" stops, when the engine shuts down to save fuel and lessen emissions.

DENSO will continue to seek the ultimate in cabin comfort. Future development concepts include a cabin comfort level measurement system based on the use of sensor technology to monitor biological data, including the body temperatures and pulse rates of passengers. Another goal is the development of individual air-conditioning and air-quality control systems to ensure optimal comfort for each individual passenger.

Improving Convenience

DENSO views vehicle-based convenience as a combination of communications, information and mobility. It continues to develop a variety of technologies in this area. DENSO recognized early on that communication systems for cars were going to grow as an important way to maintain contact with the home or office while driving or to obtain information about the destination or traffic conditions. That is why DENSO launched its first car transceiver in 1973. In the 1980s, we were among the first in the industry to begin developing car navigation systems.

Car navigation systems have become an increasingly important category of vehicle equipment. DENSO has contributed to advances in this area on three levels by developing navigation systems as information and communications terminals capable of linking with external systems, by integrating navigation systems with audiovisual equipment to provide enhanced in-vehicle entertainment, and by linking navigation systems with vehicle control equipment to improve safety and security.

In 2002, DENSO established a joint venture with Robert Bosch GmbH of Germany to develop large-scale integrated circuits and other core components for car navigation and multimedia systems. In 2003, we began to supply the Electronics Multi-vision Board, which uses Bluetooth technology to wirelessly connect car navigation systems and cell phones. This technology allows the user to make telephone calls using the touch screen on the car navigation system, and the navigation system's microphone and speaker system is then used for those calls. This product is typical of DENSO's efforts to develop systems that meet user needs by combining safety and enhanced convenience.

Another development concept that anticipates user needs is windshield display technology. This advanced concept combines display technology, sensing technology and HMI (human-machine interface) technology. Basically, all the information drivers need will be visible on the windshield directly in front of them. The data displayed includes vehicle speed, navigation information and virtual images of nearby objects or people. By displaying information that would not otherwise be readily visible to the driver, this system will significantly enhance not only convenience but also safety.



Car navigation system, the center of driving information and communication