Feature The Role of the Semiconductor Industry in Society

How semiconductors support cars and people

The NEC Electronics Group engages in research, development, manufacture, and sale of semiconductor products and provides related services. Here, we take an automobile as an example, to give our stakeholders an idea of the important roles microcontrollers and other semiconductors play in our daily lives. In recent years, remarkable progress has been made in reducing fuel consumption and improving automotive safety. Let's take a look at how the relationship between cars and semiconductors evolved from the past to the present and what awaits in the future to learn about one of the many ways in which semiconductors are making a difference in our lives.

The Role of Semiconductors in the Future of Automobiles

Semiconductors are used in computers, mobile phones and many other objects that are part of our daily lives. Without semiconductors, we would lose the comforts and convenience we enjoy in our daily lives. Even global economic activities would not function properly without semiconductors. Semiconductors also play an important role in environmental protection, which is a serious global concern.

A good example is improved driving efficiency and reduced environmental impact made possible by computerization of automotive control systems such as engine controls. The ITS (Intelligent Transport Systems) technologies, which can be utilized to collect and transmit information to traffic management centers are very promising. For example, information on driving behavior such as jackrabbit starts, sudden braking and fuel consumption rates, can be compared to the behavior of other drivers on the road, and road conditions such as slopes, and used to help people drive more safely and efficiently to conserve fuel.

As a big fan of driving cars myself, I drive a hybrid car equipped with a navigation system; my gas mileage is constantly tracked on the display screen. I make it a habit to drive safely and in an environmentally responsible way. My navigation system computes the best route to my destination and takes me there with a map display and voice instructions, so I don't have to worry about getting lost and wasting gas, which ultimately means lower fuel consumption. I also feel that the ETC (Electronic Toll Collection system) lanes on toll roads are very effective in relieving traffic congestion and making driving less stressful.

When I think of all the things semiconductors have made possible so far and potential for even greater achievements, I look forward to the role they will play in the safe and pleasant motorized society in the future.

Saburo Kato
Chairman, Japan Association of Environment and Society for the 21st Century (JAES21)

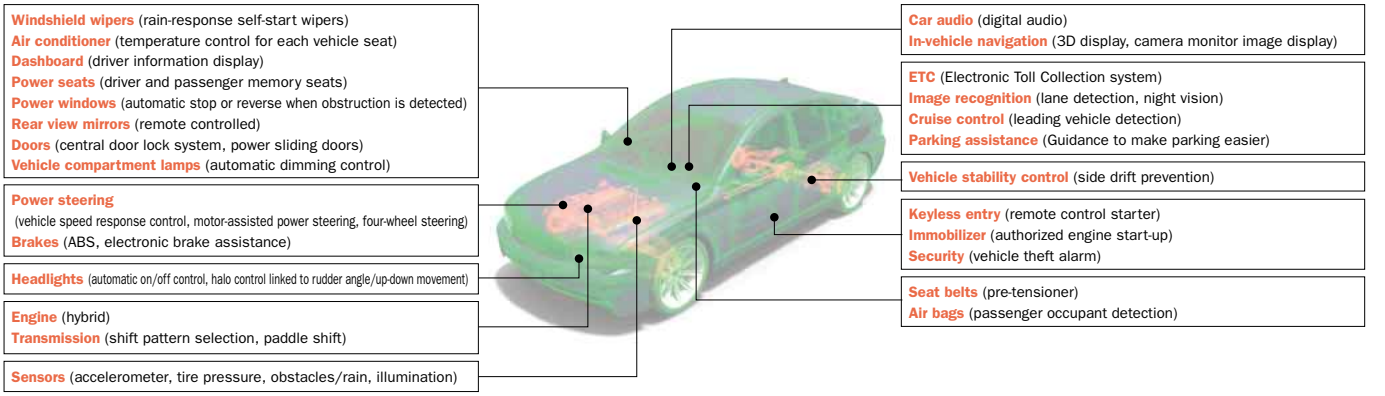
The transition from "drive", "turn", and "stop" to "environment", "safety", and "comfort"

The first semiconductors to be used in cars in the 1960s were the transistors in car radios. Now, half a century later, the semiconductor controls all of the basic functions of the car—driving, turning, and stopping—that formerly were mechanically operated. This is the result of demand for more precise control of the engine, transmission, power steering, and braking.

In addition to this basic equipment, features are constantly being added to automobiles to create a more pleasant driving environment: air conditioners, power windows, windshield wipers, rear-view mirrors, door modules, and air bags to protect passengers from accident-induced injuries. They are all made possible by semiconductors.

Automobiles have evolved dramatically by incorporating of a broad range of electronics technologies accompanied by increasingly advanced development concepts that now focus on environment, safety, and comfort.

Microcontroller-operated automotive equipment and systems



Environment Contributing to environmental-friendly vehicle performance

Microcontrollers and engine control

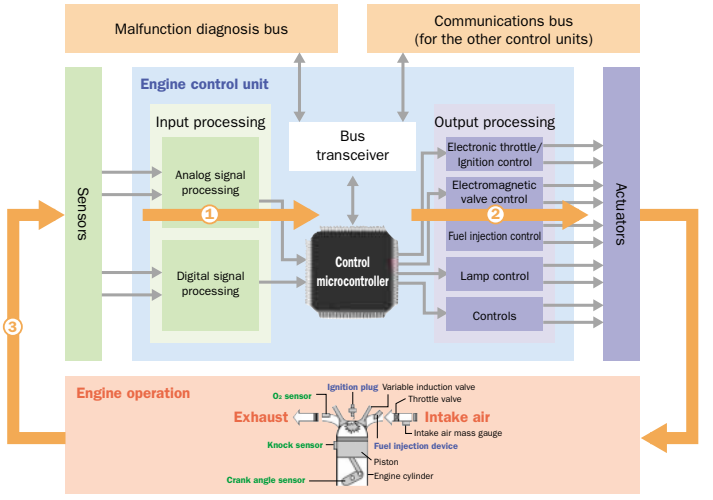
The phrase, "Environmentally responsible vehicle performance" immediately brings to mind the keywords such as fuel consumption and exhaust gas—in other words, engine performance.

Microcontrollers were first used in engine control thirty years ago, in the 1970s. In Japan, this was a period of rapid economic growth. It was also the time when the world experienced the oil crisis, or the "oil shock," which triggered global efforts in conserving energy.

Facing the world energy crisis, regulations concerning vehicle fuel consumption and exhaust emissions were tightened in the effort to suppress and prevent air pollution. To meet the requirements imposed by the regulations, automotive manufacturers began using microcontrollers to operate the engine electronically, so that fuel could be burned more efficiently.

The first 8-bit microcontrollers produced for car engines were used for optimum control of fuel injection and ignition timing. As regulations became increasingly stringent, 8-bit microcontrollers were replaced by higher-performance, more sophisticated 16-bit and, eventually, 32-bit microcontrollers to improve engine performance in effort to lessen environmental impact by reducing fuel consumption and exhaust emissions.

Mechanism for engine control by microcontrollers



① Sensors monitor factors such as the engine's crank angles, the air intake mass, how far the throttle valves are open, and the amount of oxygen in exhaust gas, and send to the microcontroller.
② To reduce fuel consumption and exhaust emissions, the CPU in the microcontroller calculates and determines the optimum amount of fuel injected into the cylinders and ignition timing in relation to the air intake mass, and then sends this control information to the actuators.
③ The condition of the exhaust gas and other information is constantly fed back to the microcontroller, which in turn controls the amount of fuel injected into the cylinders and the timing of ignition.

Emergence of 32-bit microcontrollers for hybrid cars

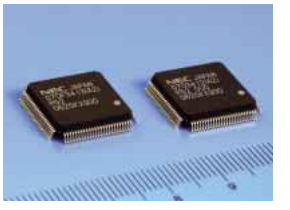
In the 1990s, the need to curb CO_2 emissions became serious issue concerning global warming. Due to strict regulations against exhaust emissions, mainly in North America, people began to demand clean-energy vehicles. Electric cars appeared to be a promising solution, but there still remain several obstacles for widespread adoption. For example, batteries in electric cars are large and heavy, and it takes a long time to recharge; even when the batteries are fully charged, the cars are only able to drive a short distance before they need to be recharged, not to mention the lack of battery charging facilities.

The limitations of electric vehicle technology led to the development of hybrid cars, which have both the gasoline engines and electric motors. Hybrid cars can be refueled at conventional gas stations, making additional infrastructure construction unnecessary. Hybrids also solve the problems of recharging time and driving distance.

When a hybrid car decelerates, kinetic energy is recovered by the batteries as electricity; when the car stops or decelerates the engine shuts off, making it possible to eliminate the fuel consumed by idling. However, parallel use of the gasoline engine and the electric motor requires extremely sophisticated processing. These complicated operations are processed by microcontrollers.

NEC Electronics has been quick to commercialize automotive microcontrollers. In August 2006, we developed the V850E/PG2, a 32-bit Microcontroller for electric motor control. The V850E/PG2 performs high-precision measurement of sensor data, and has a variety of embedded functions that enable highly accurate motor control, achieving the high efficiency and reliability demanded for the hybrid cars.

The semiconductor products we provide to automotive manufacturers play an important part in improving vehicle performance to reduce environmental impact, and they make a significant contribution to fuel consumption and CO_2 emission reduction measures to prevent global warming.



The V850E/PG2

Safety Comfort Making a difference in automotive safety and comfort

IMAPCAR®, our quest for safety

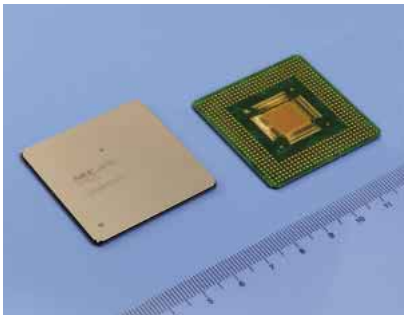
Improving automotive safety is one of today's most important issues. Realization of cars that don't collide with objects or cause accidents would be an immense contribution to society.

If a driver were able to recognize all solid objects on both sides and in front and back of the car, most accidents could probably be prevented. Although automotive manufacturers have long been working to achieve this goal by equipping vehicles with sensing capabilities, such as radar and cameras, there were limitations in aspects of flexibility, cost, and performance.

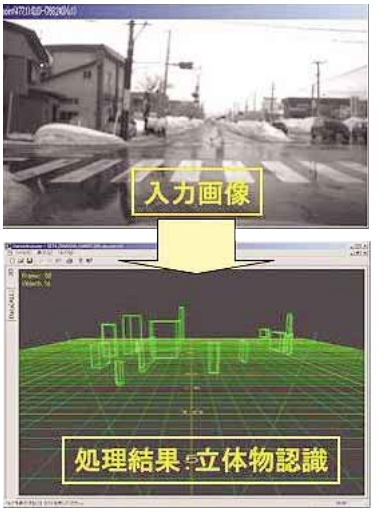
To offer a solution to these challenging issues, NEC Electronics joined forces with NEC Laboratories on research and development of IMAPCAR®, a sophisticated parallel processor*. IMAPCAR® with its world-leading high-speed performance, enables real-time detection of three-dimensional objects including pedestrians, a feature which was difficult to achieve until today. The product will contribute to improvement in safety for both drivers and pedestrians.

IMAPCAR®, jointly developed by NEC Electronics, Toyota Motor Corporation, and Denso Corporation, will be embedded in the pre-crash safety developed by Toyota Motor Corporation, which is featured in Toyota's Lexus LS460, scheduled to be available in September 2006.

*The new sophisticated parallel processor integrates 128 processing elements, enabling highly efficient simultaneous processing of multiple tasks.



IMAPCAR®
IMAPCAR® is a registered trademark of NEC Electronics in Japan



IMAPCAR® image processing to detect pedestrians

Making future automobiles more pleasant

What constitutes a pleasant driving environment? A smooth, enjoyable drive to your destination? An entertaining in-vehicle environment that prevents boredom? The ideal comforts we seek are diverse and limitless.

More than ten years have passed since the appearance of in-vehicle navigation systems in Japan that fulfill the dream of getting to one's destination smoothly without getting lost. The pursuit of comforts in driving has resulted in evolving navigation systems that not only serve navigational needs, but also are able to handle a variety of other data.

Steady progress is being made on the new ITS program in Japan to solve the inescapable issues of car-dependent society —traffic accidents and traffic congestion.

We foresee the arrival of a motorized society where in-vehicle navigation systems work together with a network of ITS services. We also envision that an ideal car of the future will possess functions just like a robot that integrates all control systems and acts as a man-machine interface to support drivers under any kind of driving conditions.

Environment-responsive automotive performance and safety together with comfortable driving environments—car manufacturers are at work on these tasks in the effort to fulfill their corporate social responsibility in achieving a sustainable motorized society. We at NEC Electronics share this vision with car manufacturers for the future automobile society, and pledge to play our part in making it a reality by providing semiconductors that bring automotive performance to the highest level possible.

Expanding the automotive semiconductor business globally

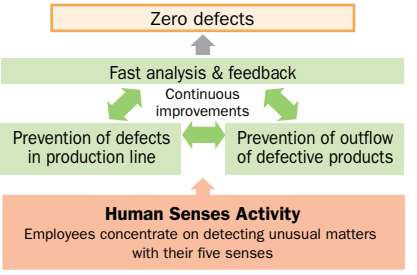
Quality management at NEC Kyushu

55 percent of the microcontrollers shipped by the NEC Electronics Group are used in automotive applications; many of these are manufactured at NEC Kyushu.

Malfunctions of microcontrollers in cars can potentially threaten lives of the drivers and many other people as well, so even one defective part is unacceptable. To ensure the high quality demanded of automotive microcontrollers, NEC Kyushu has developed a unique quality management activity called the Human Senses Activity, to achieve zero defects and maintain the highest quality by pairing proficient skills by hands—in other words, human proficiency—with the highly reliable digital technologies of semiconductor manufacturing equipment. This activity enabled NEC Kyushu to reduce defective products at factory shipment by 90 percent.

We are also reinforcing the manufacturing lines at the Roseville plant in the United States to implement global production of automotive microcontrollers. We are creating systems to develop the quality management practices at NEC Kyushu to our other manufacturing subsidiaries in the effort to provide automotive manufacturers with products of the highest quality.

The Human Senses Activity at NEC Kyushu



Design globally

To meet the varying needs of automotive manufacturers around the world, it is important to work closely with the customers in developing and designing products.

To this end, NEC Electronics has established design centers in Europe and North America to advance product designing tailored to particular requirements of automotive manufacturers in every region of the world. The centers cooperate with our design teams at company headquarters in Japan in adopting the latest design methods to improve design quality.

At NEC Electronics, we are continuously working to improve product quality by establishing a group-wide system from design to manufacturing in our aim to capture the world's No. 1 share of the automotive microcontroller market.

Customers' Voice

Provision of the best solutions for advanced safety technologies

Takashi Ogawa

General Manager
Electronic Engineering Div. II
Vehicle Engineering Group
Toyota Motor Corporation

IMAPCAR®, which was developed in collaboration with NEC Electronics, makes a great contribution to the camera sensor in Toyota's enhanced pre-crash safety. NEC Electronics not only developed the semiconductors, they also cooperated in many other ways; for example, by providing us with development tools and working on software development. This all-around support enabled us to smoothly complete all of the processes from development to product commercialization smoothly. We are very grateful for NEC Electronics' effort.

Toyota is working to achieve the ultimate goal of a motorized society—zero deaths from traffic accidents. We will persevere in increased efforts to develop advanced safety technologies. We hope to form a solid partnership with NEC Electronics and anticipate for their continual efforts to provide optimum semiconductor solutions.

Partnership with NEC Electronics

Matthias Ludwig

Purchasing Director
Automotive Electronics Division
Bosch Corporation

My name is Matthias Ludwig and I am Purchasing Director for Electronic Components at Automotive Electronics Division within the Bosch Group. First of all let me thank you for the close and open partnership. We appreciate the long and successful business relationship between our companies.

Bosch as number one worldwide automotive system supplier with a total turnover of 40 billion euro is delivering high quality and high innovative solutions to the entire car industry. To achieve our targets, we need strong partners which are strictly committed to those goals. We appreciate NEC Electronics supporting Bosch successfully, for example, in the electronic power steering applications with 32-bit MCU and PMF (PowerMOSFET) with above the average quality.

As an international acting supplier the support of our global activities all around the world is very important for us. NEC Electronics has recognized these necessities. They increased, for example, the support to Bosch after identifying new ramping up projects in Australia.

The challenges of the automotive industry for the coming years are based on the capability to realize a zero defect culture and to improve competitiveness. I personally ask NEC Electronics to help us to achieve these goals.

I hope we can both strengthen our close business partnership and be successful in the market with our high quality, innovative, competitive and excellent solutions.