

Trends and Future Prospects Regarding Steering System Technology



Masahiko NOGUCHI*
Director

Koyo has a close relationship with the auto industry, and it is important to both the company's growth and its contribution to society to develop and supply environmentally friendly automotive products. Over the years, steering system needs have changed from comfort to safety and then to environmental friendliness.

Herein, technical trends regarding steering systems are reviewed and views concerning the future discussed briefly.

Key Words: power steering system, automobile, ITS, active control

1. Introduction

Koyo, whose steering business has expanded steadily with the progression of motorization, has overcome numerous difficulties over the years to achieve its present position, including PL laws, yen appreciation, and the shift abroad of Japanese production. Koyo has stood at the forefront of the development of advanced technology to meet diversifying customer needs and has striven tirelessly to provide products that balance quality, price, performance and other factors, enabling it to obtain the strong trust of many customers, expand its steering business significantly, and contribute to the improvement of automobile comfort, performance and safety.

People imagine that technological advances will bring improved convenience and easier lifestyles, and while this is generally true, there have been many cases in which these advances have unwittingly brought environmental destruction.

Technological development in the 21st century must take preservation of the environment fully into account if indeed such development is to bring about improved quality of life. In this regard, demands are increasing for steering systems not only with improved performance but also with greater levels of safety and environmental friendliness.

This paper takes a look at technological trends related to steering systems, including efforts until the present time and the outlook for the future.

2. Transition of Automobiles and Steering Systems

2.1 Century for Automobiles

The automobile was first introduced some 100 years ago, and its development has been ongoing since that time. Koyo has been developing steering systems in step with the advance of the automobile.

The mass production of automobiles began in earnest in 1911, and the growth of related technologies and technical

development during WWII further spurred the advance of automobile technology. Today, the auto industry plays a pivotal role in the economies of most of the world's countries.

In 1980, Japan temporarily surpassed the United States and became the world's leader in the area of passenger vehicle production. However, this growth had a detrimental side as it brought about air pollution and other negative social and environmental problems.

2.2 Automobile Production Volumes

A total of 38.66 million passenger vehicles were produced in the world in 1999, an increase of approximately 2.2% from 1998.

As shown in the by-country breakdown of **Fig. 1**, Japan produced 8.1 million units in 1999, an increase of 0.6%, and this growth is expected to continue in the future because of expanding markets in China and other Asian countries.

As automobile production quantities increase, demands from society and customers for steering systems with further improved levels of environmental friendliness, energy conservation and safety will also increase, and it is our responsibility to meet these demands.

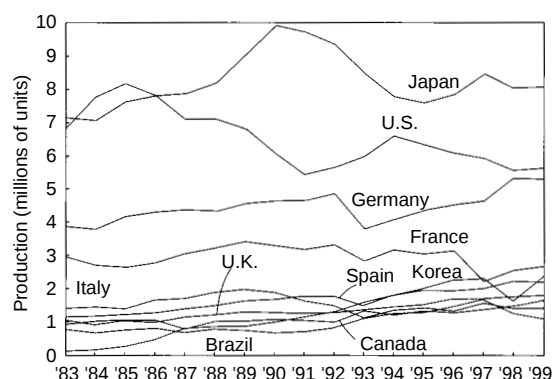


Fig. 1 Passenger vehicle production trends
(Study by Japan Automobile Manufacturers Association)

*Director, Steering Systems Engineering Center, Steering Systems Operations Headquarters

2. 3 Steering System Market Trends

Demands regarding steering products have changed along with the advance of motorization, and Koyo's steering products, which began with ball screw manual steering system, have likewise advanced to meet these demands. Although drivers initially desired only easier turning ability, they soon began to demand greater stability at high speeds and improved steering feeling and comfort. Koyo's products met each of these demands, and in 1983 we were the world's first to mass-produce an electronically controlled hydraulic power steering system (Fig. 2).

Demands for further improved safety and driving feeling were followed by demands for greater fuel efficiency-giving rise to the popularization of subcompact cars-and Koyo responded in 1988 by becoming the world's first to introduce electric power steering, a completely new type of power steering that meets the requirement of next-generation vehicles for environmental friendliness.

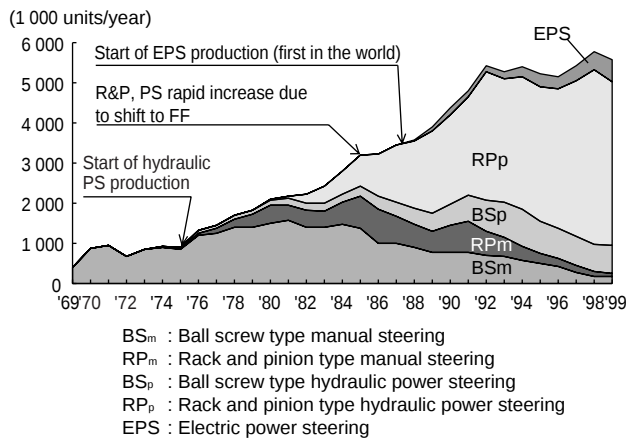


Fig. 2 Koyo steering system technical trends

2. 4 Future Market Demands

People are becoming increasingly aware of the problem of global warming, the harmful effect on humans of various discharged substances, the need to improve fuel efficiency, etc., and demands for products excelling in environmental friendliness and energy conservation are growing. Consequently, it is expected that the changeover to electric power steering system (EPS) and hydraulic power steering system with motor-driven pump (H-EPS) will proceed quickly in the future.

Figure 3 shows steering system demand trends by world region. Data indicates that the use of EPS and H-EPS will increase rapidly around the world and that by 2006 about 42% of all steering systems installed in new vehicles will be these energy-efficient types.

What deserves particular attention is the fact that the percentage of EPS and H-EPS in Europe will be about 55% by 2006, which is because of the keen awareness in Europe of environmental issues and the relative ease of installing EPS on compact cars, which are popular there.

It is therefore necessary to respond on a global basis to this worldwide shift to electric power steering with a simultaneous emphasis on performance, quality, and cost.

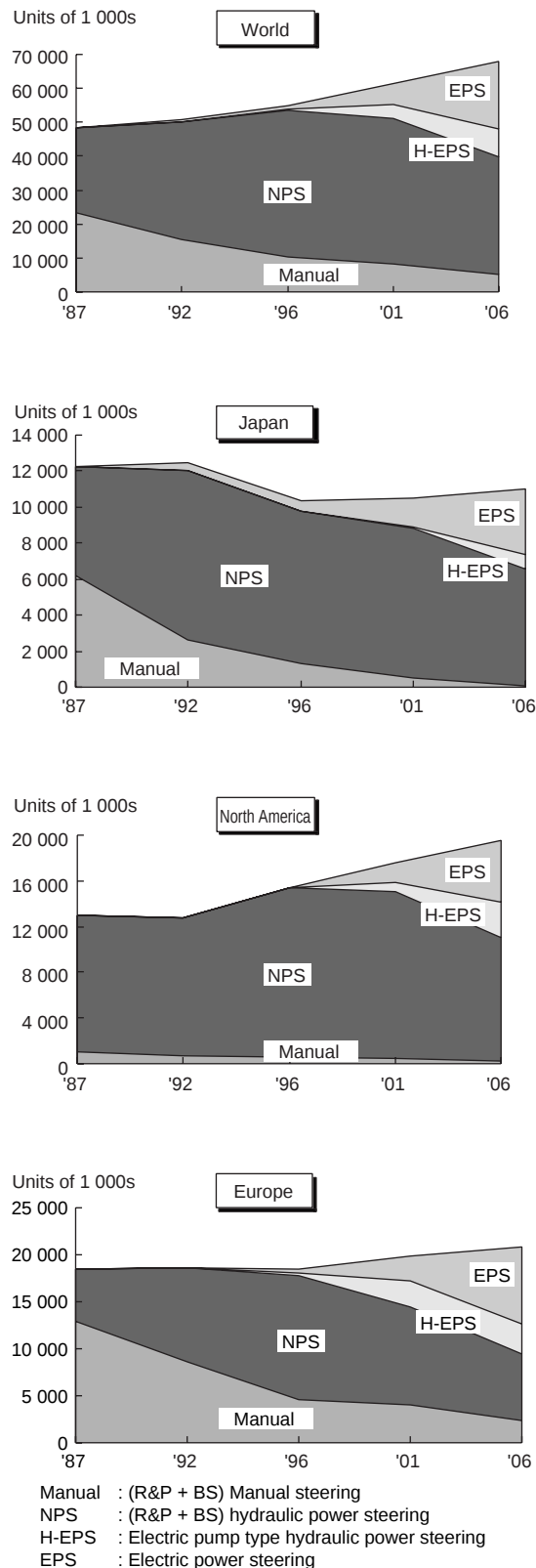


Fig. 3 Requirements for steering systems

3. Development of Steering System Technology for the 21st Century

3.1 Evolution of ITS Systems

Although the automobile has brought about tremendous convenience, our 21st century motorized world must deal with environmental and safety problems that have accompanied this convenience. ITS (Intelligent Transport Systems) technology is expected to play a significant role in resolving these problems. Although vehicles until recently have possessed only the basic functions of moving, stopping and turning, they will increasingly be equipped with electronics and information systems that serve as "brains" and "nervous systems", an early example of which has been car navigation systems. The entire vehicle will become part of an integrated system that is connected not only mechanically but electronically.

Specific efforts in the area of ITS can be divided into the following five categories:

① Car intelligence

② Car multimedia

③ Facilities

④ Logistics

⑤ Transport

This diagram illustrates a vehicle steering system equipped with a torque sensor. The main view shows a car with labels for the **Control unit**, **Battery**, **Steering gear**, **Motor, clutch**, **Reduction gear**, **Torque sensor**, and **Vehicle speed sensor (inside instrument)**. An inset provides a detailed view of the steering assembly, showing the **Torsion bar**, **Input shaft**, **Output shaft**, and points **A** and **B** where the torque sensor is integrated into the shaft assembly.

(Advanced Cruise-Assist Highway System Research Association)

3. 2 Efforts toward Vehicle Integrated Control

Based on the above, Koyo is working to develop integrated-control systems that optimize vehicle steering. These EPS-based systems also possess active safety features and are compatible with future automatic operating systems.

① Active torque control system

For the purpose of enabling danger avoidance during vehicle operation, Koyo is developing a steering system whereby the vehicle sends a warning to the driver when an object becomes too close and increases torque (turning resistance) to keep the driver from turning into the object. This system includes lane maintenance function, overturning prevention function, crosswind compensation function, etc. and can detect emergency driving and in such cases override the turning-prevention function.

② System integrated with brakes

This system (see Fig. 6) controls vehicle movement and enables vehicle stability on low-friction roads by the harmonious control of steering and braking systems. A steer-by-wire steering system is used, wherein there is no mechanical link between the input end (steering column) and output end (steering actuator), preventing the upward thrust of the steering column during collisions. Input signals, in addition to those from the conventional angle sensor, torque sensor and vehicle-speed sensor, are received from the vehicle's yaw rate sensor and lateral acceleration sensor, enabling active control (see Fig. 7).

③ Steering system for automatic driving

Koyo is conducting R&D to improve the precision of automatic steering by developing steering angle control technology, external disturbance compensation technology, and driver input identification technology.

The benefits obtained from the development of these advanced integrated vehicle control technologies are not only applicable to future systems but also to the design of conventional steering products, particularly in the area of obtaining improved center rigidity and return.

In order to respond to the market demand for integrated control encompassing the entire vehicle, we must grow from being merely a steering supplier to being a systems supplier and raise the added value of the steering system from the viewpoint of the entire vehicle.

3. 3 Modularization

The current trend among the world's automakers is to award concentrated orders to parts makers capable of supplying entire modules instead of merely ordering individual parts, and Koyo is moving in the direction of supplying modules centered on the steering system that incorporate such systems as the brake and suspension systems.

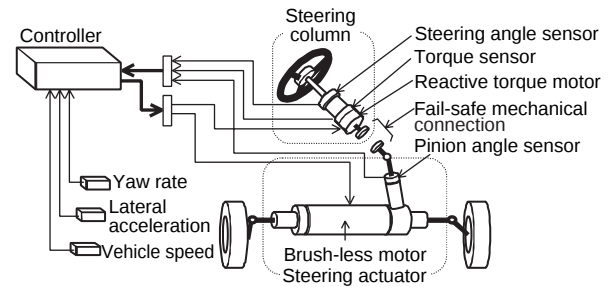


Fig. 6 Example of Koyo steering for ITS

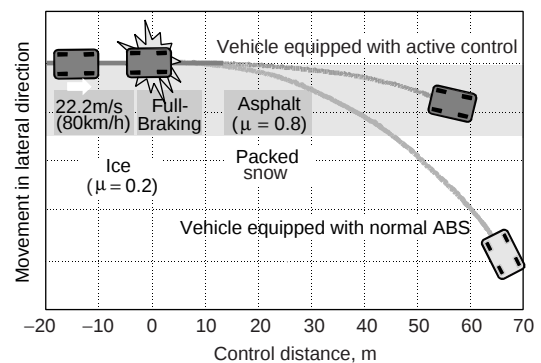


Fig. 7 Example of active control implementation

3. 4 Global Expansion

Koyo has steering manufacturing bases in Europe, North America, South America and various Asian countries in addition to its domestic bases (Fig. 8) and is actively expanding its steering business on a global basis.

1) Technology

Koyo has technical centers in three main world regions that carry out steering-related R&D; its R&D Center in Nara is the Koyo Group's main technical center and coordinates work at the European Technical Center in Lyon, France, and at the North American Technical Center in Detroit, Michigan. Koyo aims to strengthen these bases in the future in order to expand its capabilities in the areas of design, development, and customer technical service.

2) Quality

Throughout its history, Koyo has followed the principle of "quality first" and has pursued reliability as a matter of top priority as a supplier of safety-critical parts. It aims to provide the same level of high quality from all its manufacturing bases around the world through a quality management system that adheres to QS-9000, ISO 9001 and other internationally recognized standards.

3) Price

As it continues its global expansion, Koyo will aim to provide steering systems at optimal prices through the continual review and improvement of manufacturing costs.

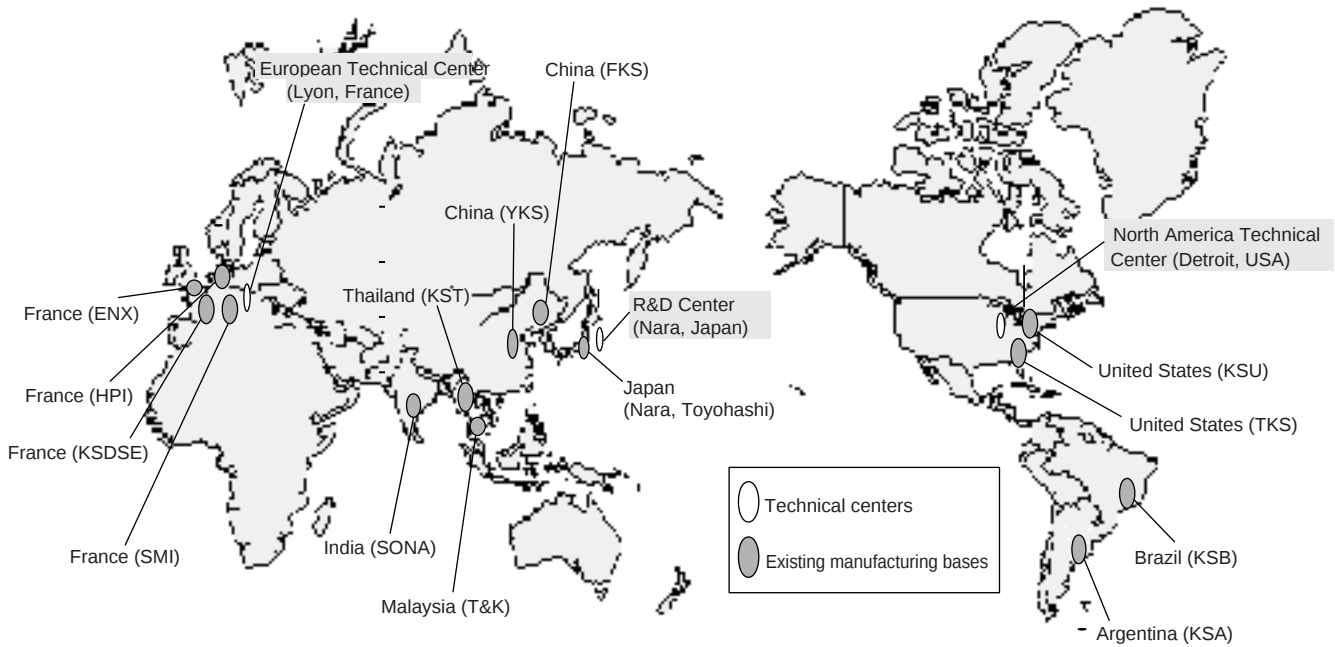


Fig. 8 Globalization of Koyo steering system operations

4. Summary

The 21st century will be a period of realizing unlimited potential, and the topic of how the world should be in this century is being debated around the globe. Koyo, which is in the process of expanding its operations globally, celebrated its 80th anniversary in January 2001 and took the opportunity to gain a clearer long-term vision of what it wanted to accomplish in this century. It is vital that Koyo foresee changes in market situations and respond quickly in order to continue growing as a world leader in the field of steering systems.

As we continue to strengthen the technological base we have built up over the years as a maker of manual steering, hydraulic power steering, and then integrated steering systems, we will work to gain the further trust of customers as a supplier of systems, centered on environmentally friendly EPS systems, that conform to integrated vehicle requirements.

However, regardless of what changes this new century brings, our adherence to a policy of quality first and our goal of providing products on a global basis that balance performance and price will remain unchanged.

As the IT revolution progresses, information regarding movements and changes around the globe will be communicated instantaneously, and technology suited to these changes must be created with greater speed. Accordingly, Koyo has adopted the motto "Speed & Change" and will continue its mission of providing products and technology that meet the ever-changing needs of the times with great speed, with a firm conviction that such efforts will result in becoming the world's leading supplier of steering systems.