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# China Automotive Steering System Industry Report, 2021

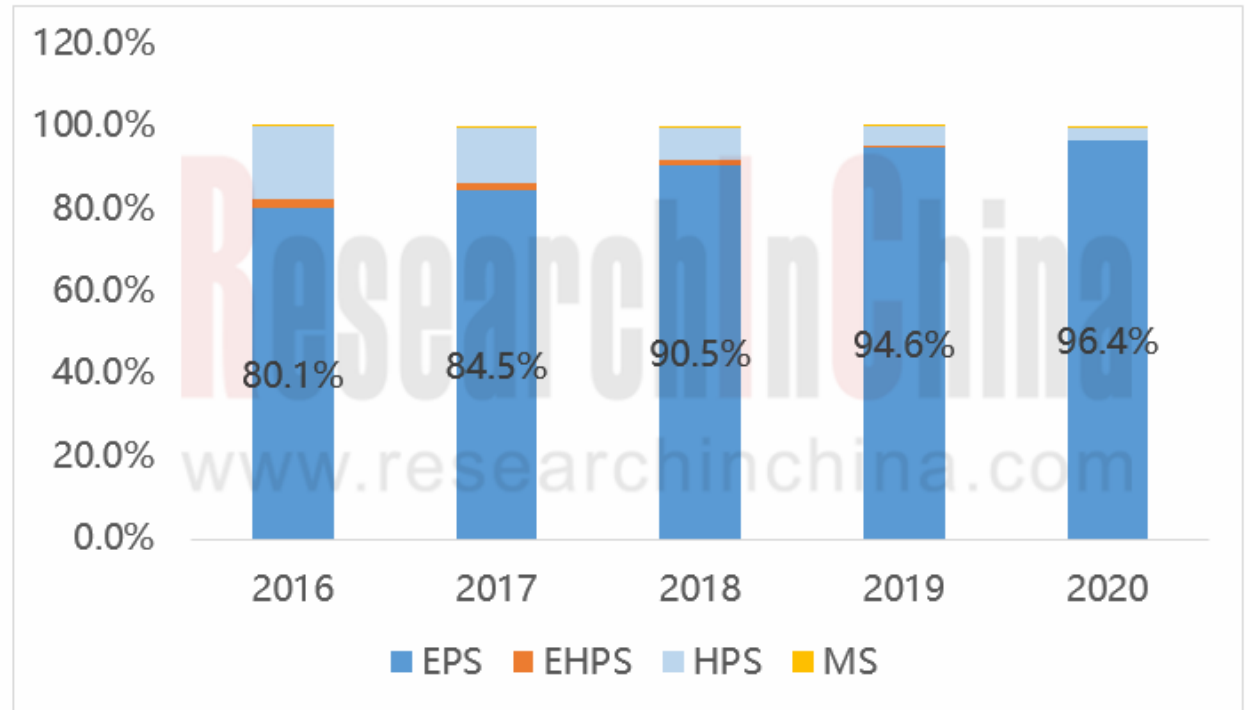
## Automotive steering system research: EPS dominates the market, SBW prepares for fully autonomous driving

After hundreds of years of development, automotive steering systems have derived HPS, EHPS, EPS, SBW and other types. At present, HPS (hydraulic power steering) and EHPS (electronic hydraulic power steering) have been widely used in commercial vehicles, while EPS (electric power steering) is mainly applied to passenger cars, and SBW (Steer-by-Wire) has the lowest penetration rate.

### *EPS occupies the passenger car market, while HPS and EHPS dominate the commercial vehicle market*

In Chinese passenger car steering system market, the share of EPS has increased from 80.1% in 2016 to 96.4% in 2020; only a small number of passenger cars adopt HPS and EHPS solutions. Relatively speaking, the higher the price of cars, the higher the proportion of EPS solutions applied.

Chinese Passenger Car Steering System Market Structure, 2016-2020



Source: ResearchInChina

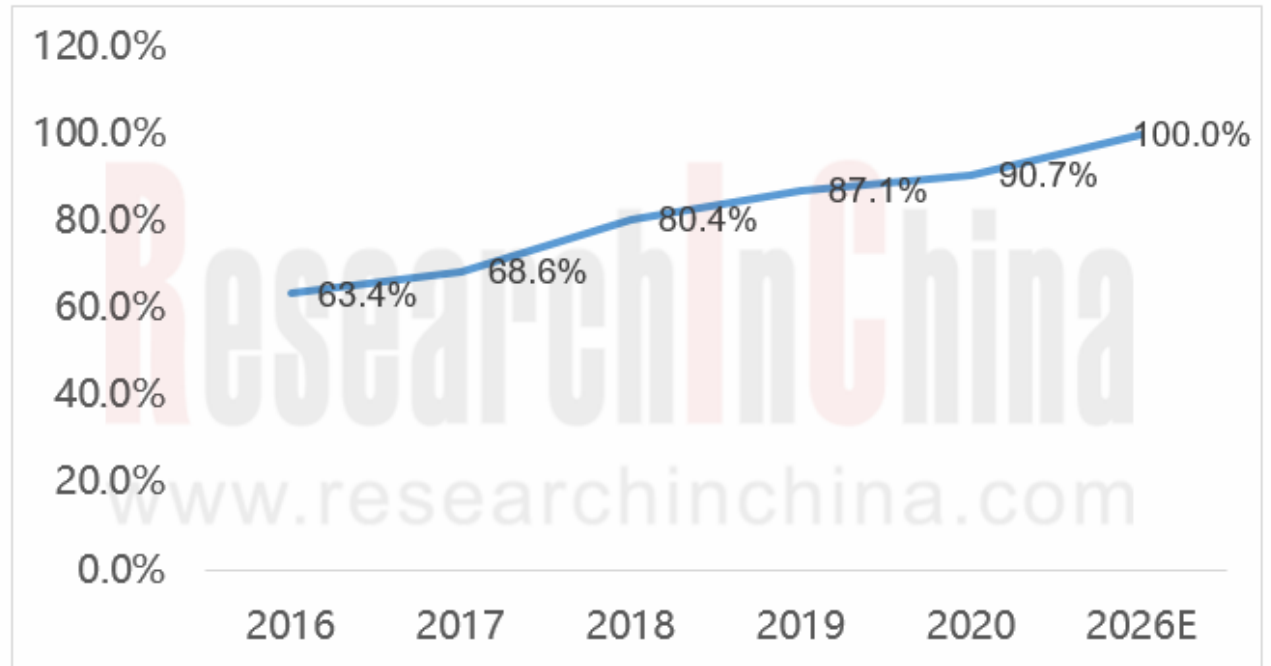
Due to its small size, low power consumption, light weight and flexibility, EPS is the first choice for new energy vehicles. EPS accounted for 99.91% of the new energy passenger car market in 2020, and this proportion is expected to reach 100% in the future.

HPS and EHPS are usually seen in most commercial vehicles, especially heavy-duty vehicles, thanks to their high power and low prices. In 2020, China's commercial vehicle steering systems were still dominated by HPS and EHPS, of which EHPS made up for 40.1%. However, the market shares of HPS and EHPS will gradually be grabbed by EPS in the future because they not only consume lots of power, but also cause hydraulic oil leakage, which do not meet environmental protection requirements.

***The EPS penetration rate of local passenger car brands is gradually increasing***

In the Chinese passenger car market, the EPS penetration rate of Chinese passenger car brands is much lower than that of foreign passenger car brands. In 2020, the former was 90.7%, while the latter hit as high as 100%. However, with the gradual tightening of environmental protection, local brands will gradually abandon the polluting steering systems such as HPS and EHPS. By 2026, the EPS penetration rate of Chinese passenger car brands is expected to reach 100%.

**EPS Penetration Rate of Local Passenger Car Brands in China, 2016-2026E**



Source: ResearchInChina

***Multinational companies dominate the market, while local companies strive to survive***

At present, the global automotive steering system market is mainly occupied by vendors such as JTEKT, Bosch, ZF, ThyssenKrupp, NSK, Mando, Hitachi Astemo. These multinational companies have deployed the Chinese market through sole proprietorship or joint ventures, firmly occupied the supply channels of luxury and joint venture brand automakers, and penetrated into the supply system of local automakers.

There are more than 100 local companies in China, but most of them are small companies targeting the aftermarket with weak competitiveness. Zhejiang Shibao, CAAS, Elite, Nexteer Automotive, etc. which have relatively strong competitiveness can compete with multinational giants. For example, Nexteer Automotive and Zhejiang Shibao have entered the supply systems of American, German and Japanese automakers by virtue of their robust strength, and have taken places in the siege of multinational companies.

**Layout of International Vendors in China**

|                     | Layout  | Nature                     |
|---------------------|---|----------------------------|
| <b>Bosch</b>        | Bosch Huayu Steering Systems (Wuhan) Co., Ltd.                | Sino-foreign joint venture |
|                     | Bosch Automotive Steering System Jincheng (Nanjing) Co., Ltd. | Sino-foreign joint venture |
| <b>ThyssenKrupp</b> | ThyssenKrupp Steering System (Changzhou) Co., Ltd.            | Wholly-owned               |
|                     | ThyssenKrupp Steering Gear & Auto Parts (Changzhou) Co., Ltd. | Wholly-owned               |
|                     | ThyssenKrupp Presta Fawer (Changchun) Co. Ltd.                | Sino-foreign joint venture |
| <b>JTEKT</b>        | JTEKT Automotive (Tianjin) Co., Ltd.                          | Foreign joint venture      |
|                     | Yubei Koyo Steering System Co., Ltd.                          | Sino-foreign joint venture |
|                     | Shye Fu Koyo (Xiamen) Mechanical Industry Co.,Ltd. (SF-Koyo)  | Foreign joint venture      |
|                     | KOYO JOINT (XIAMEN) CO., LTD.                                 | Foreign joint venture      |
|                     | JTEKT Steering Systems (Xiamen) Co., Ltd.                     | Foreign joint venture      |
| <b>Seiko</b>        | NSK Steering Systems Dongguan Co., Ltd.                       | Wholly-owned               |
|                     | NSK Hangzhou Automotive Components Co., Ltd.                  | Sino-foreign joint venture |

Source: ResearchInChina



## ***Major vendors and automakers have deployed SBW which will be promising in the future***

The biggest difference between SBW and EPS is that the former removes the mechanical connection between the steering wheel and the rack and uses ECU to transmit commands instead. SBW features fast response, flexible installation, lighter weight, and improved collision safety.

SBW technology was proposed as early as 1950. After decades of development, it has now been mass-produced on Infiniti's several models. Although SBW still has problems such as high cost, immature technology, limited user acceptance, low penetration rate, etc., some automotive steering vendors and automakers are very optimistic about SBW technology and are making efforts herein. There will be a number of production models using SBW.

**Layout of Relevant Companies in the SBW Field**

| Classification                     | Companies          | Layout   |
|------------------------------------|--------------------|--|
| <b>Automotive steering vendors</b> | Bosch              | In 2018, Bosch Huayu brought the demo car with SBW system to show customers the wire control technology. The SBW is expected to be mass-produced in 2024   |
|                                    | JTEKT              | For autonomous driving above L3, JTEKT has developed SBW technology. In 2018, JTEKT demonstrated its SBW.  |
|                                    | ZF TRW             | In October 2020, ZF released AKC 2.0. SBW rear axle steering improves agility of longer electric vehicles. Volume production began in full-size luxury cars in December 2020   |
|                                    | Nexteer Automotive | Nexteer Automotive has launched SBW technology, and unveiled Steering on Demand™ System and Quiet Wheel™ Steering based on SBW.  |
|                                    | Mando              | Mando's SBW is expected to be mass-produced for the first time in North America in 2021. Mando has contracted with Canoo for SBW.  |
|                                    | Schaeffler         | Space Drive – originally developed by Paravan GmbH which was acquired by Schaeffler to provide mobility solutions for the disabled – features "steer-by-wire" functionality, which enables safe and reliable vehicle steering by purely electronic means. At the 2019 Shanghai Auto Show, Schaeffler demonstrated its Schaeffler Mover, an urban concept car that uses SBW. In the same year, it signed an investment cooperation agreement with the Hunan Xiangjiang New Area Management Committee to bring Space Drive technology to China and put it on the market in 2021. |
|                                    | Hubei Henglong     | In June 2021, China Automotive Systems, Inc. (CAAS) announced that Hubei Henglong Automotive Systems Group Co. Ltd., a unit of the company, had bought 40% stake in Sentient AB, a Swedish automotive technology company. Sentient has patents in the field of wire control.   |
|                                    | NASN               | On June 5, 2021, Shanghai NASN Automotive Electronics Co., Ltd. released three new chassis-by-wire products, including SBW system solutions that support L3-L4 autonomous driving. 6 redundancy features ensure the normal operation of the steering system.   |
| <b>Automakers</b>                  | Tesla              | In 2020, Tesla planned to establish a new team in Austin, Texas, USA, responsible for motors, transmission systems and chassis technologies. In the recruitment, Tesla required candidates to have work experience in "SBW and brake/motor integration". In the future, Tesla may be the first that applied SBW technology to Cybertruck battery-electric pickups.   |
|                                    | Great Wall         | In June 2021, Great Wall Motors launched Coffee Smart 2.0, equipped with an electronic mechanical SBW system which is the first domestic SBW technology supporting L4+ autonomous driving. From the power supply to sensors, controllers and actuators, it adopts a triple backup design with the ASIL D safety level. It is expected to be officially put into commercial application in 2023.  |
|                                    | Subaru             | Subaru announced that it will use SBW technology on Solterra, which will be launched in 2022.  |
|                                    | Dongfeng Trucks    | In 2020, Dongfeng Trucks and Inceptio Technology cooperated to verify L3 heavy-duty truck prototype A. In conjunction with Knorr-Bremse, they comprehensively demonstrated and repeatedly adjusted and optimized technical solutions, performance parameters, time schedules, development costs, etc., and completed the L3 brake-by-wire and steering redundancy solutions. By the end of 2021, L3 autonomous trucks will be mass-produced and landed on arterial expressways.  |

Source: ResearchInChina

Comparison of Main SBW Products/Technologies

| Main products/technologies | Main features   | Mass production  |
|----------------------------|---|--|
| ZF AKC 2.0                 | <ul style="list-style-type: none"> <li>• 10-degree rear steering angle. IM L7 adopts AKC 2.0, which can realize bidirectional 12-degree steering</li> <li>• Central actuator: 11KN (the previous generation: 8KN)</li> </ul>  | Mass production for full-size luxury cars in December 2020   |
| Infiniti DAS               | <ul style="list-style-type: none"> <li>• 3 parallel ECUs play different roles (from left to right: the left front wheel, the steering wheel, the right front wheel) and monitor each other at the same time.</li> <li>• Two 90-degree auxiliary motors are installed at each side of the frame, with a steering force sensor. The steering sensor reports the steering angle required by the driver to the auxiliary motors through the control module.</li> </ul>  | It has been applied to Infiniti Q50/Q50L/Q60/QX50  |
| Schaeffler Space Drive     | <ul style="list-style-type: none"> <li>• The Space Drive operating system, which consists of a three-stage multi-redundant motor-driver and control system for all common electric motors (60 A/DC 12–24 V), is suitable for use in applications with the highest safety requirements. The system's processor unit (ECU) meets the most demanding requirements in accordance with the ISO 26262 ASIL D safety standards.</li> <li>• the Space Drive system is road-approved for the international vehicle types M1, M2, M3, N1, N2, and N3.</li> <li>• The 90-degree intelligent SBW module can help the vehicle achieve a 90-degree steering angle.</li> </ul> | Space Drive is currently installed on Olli driverless minibuses, Audi R8 LMS GT3, Mercedes-AMG and BMW M6 GT3. It will be mass-produced in China in 2021 |

Source: ResearchInChina

China Automotive Engineering Research Institute Co., Ltd. (CAERI) has worked with Huawei, Baidu, Schaeffler and many other companies to jointly compile SBW and Brake System Communication Protocol Requirements and Test Specifications, which is conducive to promoting the development of SBW technology and its application in intelligent vehicles. At present, the penetration rate of SBW in China is extremely low, and was estimated at 0.1% in 2020. In the next few years, the penetration rate will jump rapidly, and it is expected to reach 15% by 2026. Meanwhile, the market scale will gradually expand to RMB12.16 billion, with lucrative development prospects.

***EPS is the key to ADAS functions, while SBW is one of the key technologies for fully autonomous driving***

The automotive steering system is closely related to the development of autonomous driving. At present, EPS is the key to ADAS functions, serving different levels of autonomous driving with typical ADAS functions like APA, LDW&LKA and DSR. However, in essence, the steering signal of EPS still comes from the driver, while the steering signal of SBW stems from the algorithm. Therefore, SBW can be completely separated from the driver to control steering as one of the key technologies for fully automatic driving in the future.

At present, some automotive steering system companies have begun to deploy autonomous driving.

## Layout of Automotive Steering Companies in Autonomous Driving

| Companies                | Layout   |
|--------------------------|--|
| Nexteer Automotive       | Nexteer Automotive can cover L1-L5 autonomous driving through its EPS, high-availability EPS, SBW and other product portfolios. 32% of EPS orders signed by the company are involved with L3-L5 ADAS/AD functions. The ADAS-related patents accounted for 22.7% of the company's total in 2020.  |
| NSK                      | The new generation of steering control software developed by NSK can be applied to various products such as EPS, and can be highly compatible with ADAS and autonomous driving.  |
| Bosch                    | Bosch's steering control unit supports all driver assistance functions and autonomous driving. Servoelectric electric power steering system provides the possibility of highly automated driving.  |
| JTEKT                    | In terms of autonomous driving and advanced driving assistance, JTEKT develops and produces EPS that meets the national standard ISO26262 for automotive functional safety. By dual-systemizing the torque sensor that monitors the driver's operation and the motor drive that provides the steering assist torque, the sustainability of EPS is improved. In addition, JTEKT has developed SBW technology for autonomous driving above L3. |
| China Automotive Systems | In June 2021, China Automotive Systems purchased a 40% interest in Sentient AB to enter the autonomous driving space. Sentient AB is a Swedish automotive technology company specializing in software development and hardware design for advanced steering functions, vehicle motion control and autonomous driving.  |

Source: ResearchInChina

# Table of Content (1)

## 1. Introduction to Automotive Steering System

- 1.1 Definition
- 1.2 Classification
- 1.3 HPS
- 1.4 EHPS
- 1.5 EPS
  - 1.5.1 EPS Classification
- 1.6 SBW System
  - 1.6.1 Structure of SBW System
  - 1.6.2 Road Sense Feedback Control Strategy of SBW System
  - 1.6.3 Steering Execution Control Strategy of SBW System
  - 1.6.4 Redundant Design of SBW System
  - 1.6.5 Classification of SBW System
- 1.7 Industry Chain

## 2. Automotive Steering System Market

- 2.1 Development History
- 2.2 Application of Various Products
- 2.3 Market Size
- 2.4 Market Structure
  - 2.4.1 Passenger Cars
  - 2.4.2 New Energy Vehicles
  - 2.4.3 Commercial Vehicles
- 2.5 Major Market Players
  - 2.5.1 Global
  - 2.5.2 China
- 2.6 Competitive Landscape
- 2.7 Trends of Automotive Steering Application
- 2.8 Trends of Automotive Steering Technology
  - 2.8.1 Autonomous Driving and Automotive Steering System
  - 2.8.1 Autonomous Driving and Automotive Steering System --- SBW is the inevitable Development Direction of Autonomous Driving

- 2.8.2 Layout of Companies in the Field of Autonomous Driving
- 2.8.3 Status Quo of China's Autonomous Driving --- Autonomous Passenger Car Sales Volume
- 2.8.3 Status Quo of China's Autonomous Driving --- ADAS Assembly Rate of Passenger Cars
- 2.8.3 Status Quo of China's Autonomous Driving --- ADAS Assembly Rate of Passenger Cars (by Price)
- 2.8.3 Status Quo of China's Autonomous Driving --- LDW
- 2.8.3 Status Quo of China's Autonomous Driving --- LKS
- 2.8.3 Status Quo of China's Autonomous Driving --- APA

## 3. Automotive Steering System Market Segments

- 3.1 EPS
  - 3.1.1 Market Size
  - 3.1.2 Penetration Rate
  - 3.1.3 Market Structure
  - 3.1.4 EPS SWOT Analysis
- 3.2 HPS
- 3.3 SBW
  - 3.3.1 SBW and Chassis-by-Wire
  - 3.3.2 Layout of Vendors in the SBW Field
  - 3.3.3 Layout of Automakers in the SBW Field
  - 3.3.4 Layout of Automakers --- Infiniti's SBW System
  - 3.3.4 Layout of Automakers --- Electronic Mechanical SBW system of Great Wall
  - 3.3.5 Comparison of Main SBW Products/Technologies
  - 3.3.6 SBW Patent Application
  - 3.3.7 SBW-related standards
  - 3.3.8 Difficulties in SBW Development
  - 3.3.9 SBW SWOT Analysis
  - 3.3.10 Prediction for SBW Market Size

## 4. Domestic Automotive Steering System Companies

- 4.1 Nexteer Automotive
  - 4.1.1 Product Portfolio



# Table of Content (2)

|   |  |
|---|--|
| 4.1.2 Operation   | 4.6.1 Capability   |
| 4.1.3 Orders  | 4.6.2 Main Customers   |
| 4.1.4 Products Launched in 2020                                 | 4.6.3 C-EPS  |
| 4.1.5 Automotive Steering Business                              | 4.6.4 P-EPS  |
| 4.1.6 SBW Technology  | 4.6.5 DP-EPS   |
| 4.1.7 Development History of SBW Technology                     | 4.6.6 R-EPS & S-EPS  |
| 4.1.8 ADAS and Autonomous Driving Technology                    | 4.6.7 ECU  |
| 4.2 Zhejiang Shibao   | 4.6.8 Steering Machines  |
| 4.2.1 Operation   | 4.7 Zhejiang Wanda   |
| 4.2.2 Output and Sales Volume                                   | 4.7.1 Main Customers   |
| 4.2.3 Main Automotive Steering Systems                          | 4.7.2 Main Products  |
| 4.2.4 Main Automotive Steering Gears                            | 4.7.3 Main Subsidiaries  |
| 4.2.5 Main Customers  | 4.8 Jiangmen Xingjiang   |
| 4.3 Fuxin Dare Automotive                                       | 4.8.1 Main Customers   |
| 4.3.1 Development History                                       | 4.8.2 Main Products --- Recirculating Ball GX&ZJ Series  |
| 4.3.2 Operation   | 4.8.2 Main Products --- Electrically Controlled Hydraulic DY Series & Angle Steering Gear JZX series |
| 4.3.3 Automotive Steering Systems                               | 4.8.2 Main Products --- Electric ZX Series   |
| 4.3.3 Automotive Steering Systems --- Steering Motors           | 4.9 Yubei Steering System  |
| 4.3.4 Fundraising Projects with Non-public Offering of A Shares | 4.9.1 Development History  |
| 4.4 China Automotive Systems (CAAS)                             | 4.9.2 Main Products --- Recirculating Ball-type Power Steering Gears                                 |
| 4.4.1 Main Production Bases                                     | 4.9.2 Main Products --- Rack and Pinion Hydraulic Steering Gears &EPS                                |
| 4.4.2 Capacity  | 4.9.3 Main Customers   |
| 4.4.3 Operation   | 4.10 Jiangsu Golden Transmission Co., Ltd.   |
| 4.4.4 Main Products --- EPS                                     | 4.10.1 Development History   |
| 4.4.4 Main Products --- Steering Gears                          | 4.10.2 Main Products --- Steering Columns  |
| 4.5 FAWER Automotive Parts                                      | 4.10.2 Main Products --- Transmission Shafts   |
| 4.5.1 Operation   | 4.10.2 Main Products --- Angle Steering Gears  |
| 4.5.2 Automotive Steering Systems                               | 4.10.2 Main Products --- EPS   |
| 4.5.3 Output and Sales Volume of Automotive Steering Systems    | 4.11 VIE Pump  |
| 4.5.4 Main Customers  | 4.12 Shandong Xianhe Yuexin Electromechanical Co., Ltd.  |
| 4.5.5 Main Automotive Steering System Subsidiaries              | 4.13 Nanjing Donghua Intelligent Steering System Co., Ltd.   |
| 4.6 Elite   | 4.14 Jiangsu Gangyang Co., Ltd.  |

# Table of Content (3)

- 4.14.1 Automotive Steering System Business
- 4.14.2 Main Automotive Steering Products --- Recirculating Ball Steering Gears
- 4.14.2 Main Automotive Steering Products --- C-EPS
- 4.14.3 Main Partners
- 4.15 Jiangsu Nanyang Nisemo Auto Parts Co., Ltd.
- 4.16 Defu Steering
- 4.16.1 Automotive Steering Business
- 4.16.2 Main Customers
- 4.17 Hubei Tri-Ring Group
- 4.17.1 Competitive Strength
- 4.18 Ningbo Tuopu Group
- 4.18.1 Automotive Steering Business

## 5. Foreign Automotive Steering System Companies

- 5.1 JTEKT
  - 5.1.1 Development History
  - 5.1.2 Operation
  - 5.1.3 Automotive Steering System Business
  - 5.1.4 EPS
  - 5.1.5 Hydraulic Steering Gears and Other Components
  - 5.1.6 SBW Technology
  - 5.1.7 Concept Cars Based on SBW
  - 5.1.8 Distribution of Production Bases
  - 5.1.9 Development in China
- 5.2 Bosch
  - 5.2.1 Operation
  - 5.2.2 Automotive Steering System Business
  - 5.2.3 Main EPS
  - 5.2.4 Steering Control Units
  - 5.2.5 Servoelectric? Fail-operational
  - 5.2.6 SBW
  - 5.2.7 Development in China

- 5.3 NSK
  - 5.3.1 Operation
  - 5.3.2 Automotive Business
  - 5.3.3 Automotive Steering Business
  - 5.3.4 Automotive Steering Products
  - 5.3.5 SBW Technology (FFA·RWA)
  - 5.3.6 Development in China
- 5.4 Hitachi Astemo
  - 5.4.1 Global Layout
  - 5.4.2 Main Customers
  - 5.4.3 Operation
  - 5.4.4 Automotive Steering Business
- 5.5 Mando
  - 5.5.1 Global Layout
  - 5.5.2 Operation
  - 5.5.3 Automotive Steering Business
  - 5.5.4 Freedom in Mobility
  - 5.5.5 Development in China
- 5.6 ThyssenKrupp
  - 5.6.1 Operation
  - 5.6.2 Global Automotive Business Layout
  - 5.6.3 Automotive Steering Business
  - 5.6.4 Development in China
- 5.7 KYB
- 5.8 ZF
  - 5.8.1 Business Performance
  - 5.8.2 See-Think-Act Development Strategy
  - 5.8.3 Automotive Steering Business
  - 5.8.4 AKC (Active Kinematics Control) Active Rear Axle Steering
  - 5.8.5 AKC 2.0
  - 5.8.6 Development in China



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