Foreword

In the 21st century, the progress of science and technology has driven the development of modern transport, leading to tremendous changes in the speed, efficiency, safety and comfort of transport. At present, China's transport industry is witnessing a transition from traditional to modern means, applying modern science, technology, and management to promote the development of a modern and comprehensive transportation system. Energy-saving and environment-friendly principles present higher expectations for high-speed growth of China's transport industry.

To realize ‘safe, efficient, green and harmonious’ development of the modern transport system, China's science and technology authority has formulated a series of policies to encourage technological innovation in relevant fields. An array of initiatives have been launched, such as ‘Major Special Project for Electric Vehicles’ and ‘Major Special Project for Energy-saving and New Energy Vehicles’, to strengthen research, development and innovation in energy-saving and environment-friendly automobiles. Relevant ministries have released The Joint Action Plan for Innovation of China High-Speed Rail to establish an efficient innovation system for high-speed rail. The national scientific and technological programs have played a leading role in facilitating innovative research into the intelligent transport, by developing The National Intelligent Transportation System Architecture and The Standard System of Intelligent Transportation System in China. After nearly 10 years of continuous innovation and development, China has made significant progress in modern transport technology, with innovative achievements in electric vehicles, high-speed trains, maglev trains, high-tech ships and other key means of transportation. A number of key infrastructure technologies have been mastered, e.g. bridge-building. Traditional industries such as automobiles and ships have been upgraded, while emerging industries like electric vehicles and high-speed rail have been encouraged.

As the transport industry embraces both opportunities and challenges, an innovative China will actively adapt to economic globalization, expand resource allocation, market development, technological innovation and customer service to other parts of the world, and accelerating the modernization of China's transport with an open mind and a broad perspective.
ENERGY-SAVING AND NEW ENERGY VEHICLES

Energy and environmental issues are long-term challenges for the international automobile industry. Facing the dual challenges to transform energy power systems and upgrade traditional auto technology, China is committed to vigorous development of new energy vehicles, and has cultivated new economic growth poles and emerging industries.

Since 2001, China has launched a number of research projects, such as the simultaneous development of hybrid vehicles, battery electric vehicles, and fuel cell vehicles, synchronous development of multi-energy powertrain control systems, engine technology and control systems, and battery technology and management systems. Further measures have been taken to support the needs of regional economic development:

1. pilot projects for new energy vehicles in several cities
2. application of research findings for new energy vehicles
3. full scale production of electric vehicles
4. formation of a new energy automotive industry chain
5. rapid development of machinery, materials, electronics, information, manufacturing equipment and other industries

All these measures lay a solid foundation for the emerging industry of new energy vehicles.
KEY TECHNOLOGY FOR HYBRID VEHICLES

Hybrid vehicle technology is believed to be a major solution to energy saving and environmental protection. China has conducted research into three key hybrid vehicle technologies: BSG micro hybrid, ISG mild hybrid, and dual motor full hybrid. The design and pilot production of hybrid vehicle prototypes have been completed, and a variety of successful hybrid vehicle products have emerged as a result.

CASE: Dual-motor hybrid system

The fuel consumption of the dual-motor hybrid system, developed by China First Automobile Group Corporation, is 5.3L/100km under the conditions of Euro III and Euro IV emission standards, saving more than 40% compared with traditional engines.
Case: Hybrid electric bus

The series or parallel hybrid electric buses developed by Wuzhoulong, CSR Times, Zhengzhou Yutong, FAW, and Dongfeng have achieved good performance. In 2013, the mean time between failures reached 10,000 km, and the first overhaul service of the main components reached 80,000 -100,000 kilometers. By the end of 2013, more than 10,000 hybrid electric buses had been put into trial operation.
**KEY TECHNOLOGY FOR BATTERY ELECTRIC VEHICLES**

The battery electric vehicles, characterized by zero emissions, high energy utilization, low cost, and a wide range of power sources, represent the future of the new energy automotive industry. Since 2001, China has been working on innovating technology in this field:

- lithium-ion batteries
- other advanced onboard energy system technology
- matching technology for power systems
- intelligent charging technology
- intelligent vehicle control interactive communication technologies
- other key technologies for battery electric vehicles

China has now established a complete power system technology platform for battery electric vehicles with proprietary IP, and set up vehicle production and demonstration bases for commercial battery electric vehicles in many cities. These include cars, buses, sanitation trucks, logistics vehicles and others. A small number of them are already being exported to the European and American markets.

**Case: Battery electric buses served during the Brazil World Cup**

Electric buses manufactured by CSR Corporation Limited carried passengers into town from the airport during the 2014 World Cup. These vehicles employed a full range of relevant control technologies which are applied in the high-speed EMU, such as vehicle CAN bus control technology, motor vector control technology, IGBT variable frequency control technology and fault diagnosis technology. This made vehicle performance more accurate, stabler and safer, which was particularly important and appropriate for the conditions encountered in Brazil-complex and changeable lines and a dense population.
**Case:** Beijing's electric vehicle industry

Beijing has long been an enthusiastic advocate of battery electric vehicles. Over the last ten years, the city has steadily put in place a complete battery electric vehicle system, covering commercial and passenger vehicles, and built three battery electric vehicle industrial bases: the industrial base for the design and manufacturing of new energy vehicles in Changping District, the Daxing new energy vehicle technology industrial park, and the Fangshan high-end modern manufacturing industrial base. In April, 2014, Beijing hosted China's largest ever electric-only taxi delivery ceremony. 700 electric taxis have entered service in seven districts and counties - Yanqing, Fangshan, Miyun, Pinggu, Daxing, Changping and Huairou. The number of electric taxis on the roads of Beijing has now reached 750. In total, almost 1700 new energy automobiles are now operating in the fields of public transport, sanitation and taxi services.
CORE TECHNOLOGY FOR FUEL CELL VEHICLES

The fuel cell vehicle is key to the sustainable development of the future automotive industry due to its advantages of zero emissions, high efficiency, and diversified and renewable fuel resources. China now possesses a fuel cell vehicle power system platform with proprietary IP. It has mastered the core technologies, power system, and key components of the vehicle and has established full vehicle production capacity.

Case: Fuel cell vehicles served during the Beijing 2008 Olympic Games

Fuel cell vehicles based on the Passat car platform of Shanghai Volkswagen Automotive were issued with their production and road licenses on April 28, 2008. During the Beijing Olympics, 20 Passat fuel cell cars made more than 2,100 passenger trips and cumulatively traveled nearly 800 km, acting as guide cars for the marathon and completing many other tasks.
Case: Industrialization of traction battery and fuel cell engine

China has the capability to design and manufacture traction batteries and the relevant production equipment. By the end of 2009, the annual production capacities of nickel-metal hydride and lithium ion traction batteries exceeded 140 million Wh and 900 million Wh respectively. By the end of 2010, China had invested almost 8 billion RMB in this field, forming traction battery industrial cluster zones on the Pearl River Delta, the Yangtze River Delta and the Beijing-Tianjin axis.

Production of lithium manganese batteries for vehicles

Modern automobile lithium-ion traction battery manufacturer
China has mastered the R&D, manufacturing and testing technologies of fuel cell engines with a range of several hundred kilometers, established a national fuel cell, system platform and vehicle engineering technology center and test base, and developed electro catalysts with high activity and anti aggregation and carriers with high specific surface area and antioxidation. Screen printing membrane electrode technology has matured, and small volumes of CCM membrane electrode products are now being exported.

Relevant performance data:
- Dynamic driving cycle of one low-pressure fuel cell stack now has a capacity of more than 1,500 hours.
- The highest efficiency of fuel cell engines exceeds 61%.
- The maximum volumetric specific power reaches 1,000W / L.
- The efficient low-temperature storage and startup can be achieved at $-10^{\circ}C$.
COMPLETE SETS OF KEY TECHNOLOGY FOR ELECTRIC VEHICLE INFRASTRUCTURE

Infrastructure has a direct impact on the popularization of electric vehicles. China has established a good foundation through a number of relevant demonstration projects. By the end of 2012, China had set up 133 electric vehicle charging stations of various types, 27 battery swapping stations, 6,462 charging piles, two hydrogen refueling stations and two mobile hydrogen refueling stations.
Electric vehicle charging (hydrogen refueling) stations all over China
Case: Electric vehicle charging and battery swapping stations in the Olympic Central District

During the Beijing Olympics in 2008, in order to guarantee the energy supply for the operation of battery electric buses, a 5,000 m² electric vehicle charging station was built in the Olympic Center District. The charging station was equipped with automatic swapping facilities which can swap all battery boxes for a vehicle in eight minutes. The used batteries were then recharged separately from the vehicle, which helped with the centralized maintenance of the batteries and improved the utilization efficiency of vehicles.
ADVANCED AUTOMOTIVE TECHNOLOGY

Automotive technology, which combines manufacturing, equipment, electronics, information, and energy, makes an important contribution to the nation's industrial strength. In the fields of automotive design and manufacturing, China has realized the full process from concept to design of the chassis. Then automobile power systems nationwide have been upgraded, and the transition from MPI (multi port injection) to gasoline direct injection (GDI) and pressurization for the gasoline engine has been achieved, accompanied by the transition from traditional mechanical pump development to high-pressure common rail electronic control and pressurization for the diesel engine. All of these improvements have increased fuel efficiency and reduced emissions. China is now engaged in high-performance high-quality chassis tuning and design, upgrading of traditional chassis toward platformization and modularization, as well as industrialization of vehicle integration technology, powertrain technology and key generic technologies.
VEHICLE INTEGRATION TECHNOLOGY

To ensure energy saving, environmental protection, safety and comfort of vehicles, actions have been taken for body design, vehicle integrated development, power system matching and performance optimization, chassis tuning and matching optimization, forming the mass production capability of relevant products.

Case: Export cars developed by Changan Company

To meet export demand and comply with the regulatory requirements of export destinations, the Changan Automobile Company has conducted a rigorous product definition and development, formed a set of processes for Changan car chassis matching and performance optimization with proprietary IP, chassis structure safety technology for frontal, side and rear collision, optimization design and matching of occupant restraint system and pedestrian protection and child restraint systems as well as integrated EPS/ESP/chassis control strategies with proprietary IP. It has also developed cars with NVH performance levels reaching the international standards.

Changan Benben Love right-hand drive car is a model specially developed for overseas markets, e.g. South Africa and Malaysia.
POWERTRAIN TECHNOLOGY

In terms of powertrain, China has mastered and industrialized GDI gasoline engine technology, car diesel technology, heavy-duty diesel engine technology and technologies for developing dual-clutch automatic transmission, high torque mechanical automatic transmission, multi-gear automatic transmission and stepless automatic transmission products.

**Case: Gasoline direct injection engine loading**

China First Automobile Group Corporation has developed a 1.5L turbocharged direct injection petrol engine and adopted ordinary three-way catalysis (TWC) to enable the GDI to achieve national IV emission standards. A simultaneous PFI (port fuel injection) and GDI (gasoline direct injection) combustion system achieves the shared platform of PFI, homogeneous theoretical mixing ratio GDI and stratified lean mixture ratio GDI. Two kinds of cylinder cover can be manufactured on the same production line. In service, this engine can reduce fuel consumption by more than 15% and provide a dynamic increase of 15% compared with an intake port injection gasoline engine of the same power level. In formal testing, the noise level within one meter of the engine can be reduced by 5 ~ 6 Db (A) compared with a naturally aspirated engine with the same power.

![Engine Image](image-url)
Case: 6-speed dual clutch (DCT) automatic transmission

Zhejiang Geely Holding Group has developed a 6-speed DCT automatic transmission system, mastered optimum shift control and intelligent electronic control, DCT and integrated control of vehicle power transmission, high-precision & stable signal generators, and other key technologies and formed a complete technology development platform. Geely Vision cars with 6-speed DCT automatic transmissions have good shift performance, quick response and small shift shock. The time from start to 100kph is lowered by 12.5% compared with the same gear MT and by 12.2% compared with the same gear AT, and the oil consumption decreases by 5.7% compared with the same gear MT and by 16.3% compared with the same gear AT.
The intelligent transportation system (ITS) is an important part of modern traffic science and technology. Over the past 10 years, China has been committed to promoting the development of intelligent transportation technology, and has achieved notable results.
COMPREHENSIVE INTELLIGENT TRAFFIC MANAGEMENT AND SERVICE SYSTEM FOR THE BEIJING OLYMPICS

The Pilot Project for ITS in Beijing "High-tech Olympics" included Olympic traffic planning, a comprehensive information platform, intelligent traffic management, parking guidance, and an advanced transport system. Both the capacity and the efficiency of the whole road network in Beijing were improved, reducing the total travel time, energy consumption, and automobile exhaust emissions, improving the safety and reliability of road traffic, and gaining tremendous social benefits as a result.

**Case**

The comprehensive intelligent traffic management and service system for the 2008 Beijing Olympics achieved high quality and efficient transport services for the Olympic games, including:

- journey times not exceeding 30 minutes from the athletes' residential quarters to the competition venues;
- monitoring at least 5,000 vehicles;
- detection and response to traffic accidents within three minutes and an accuracy rate of more than 90%;
- a traffic data system capable of acquiring the location data of no fewer than 10,000 cars;
- dynamic traffic state data processing capability of no more than 5 minutes;
- 80% coverage of the traffic guidance system of expressways and trunk roads.

**Comprehensive traffic management and service system for the Beijing Olympics**
INTEGRATED ITS AT THE SHANGHAI WORLD EXPO

The Shanghai Expo intelligent transportation system included a broad range of technologies and services:
• traffic information collection system for the elevated roads and relevant expressways, and fast ground-level roads;
• analysis, identification and prediction system for traffic conditions;
• traffic information publication system;
• Shanghai Traffic Information Center;
• a complete metropolitan freeway traffic management system;
• real-time collection of traffic flow data and quick response to traffic accidents;
• traffic information exchange and sharing agreement;
• technology and management modes for collaborative operations among different departments.

Case

The Shanghai World Expo ITS covered the Yan'an elevated road and 20.7 kilometers of outer ring roads and the expressway from the Bund in the east to Huqingping Freeway in the west. The traffic strategy provided a comprehensive regional traffic service platform, integrating the information from six sectors: urban rapid road, ground-level road, rail, public transport, airport, and waterways. This system expanded the functions of the urban transport hub and provided public-oriented information services, industry-oriented technical services, expo-oriented traffic management services and government-oriented decision support services.

Comprehensive traffic information service platform for Shanghai World Expo integrates the traffic resources
ITS INFORMATION PLATFORM FOR THE GUANGZHOU ASIAN GAMES

The Guangzhou ITS mainly involved the development of traffic information platform and public-oriented traffic information services. Through the formulation of related standards and specifications, fusion of the related technologies and integration of related products, an integrated ITS common information platform provided ITS planning, management and control, and business support.

Case

During the 2010 Guangzhou Asian Games, the aggregation time of the approaching traffic flows for the opening and closing ceremonies took less than 90 minutes, and the traffic evacuation times took less than 60 minutes. There were no traffic delays, missing games, delayed games, or traffic accidents.

Intelligent traffic management system can provide real-time road information

Guangzhou Asian Games Traffic Command Center
In terms of electrical toll collection, China has developed a full operating system including:
- ETC and MTC mixed lane controller;
- ETC roadside control unit;
- an interconnected regional electronic non-stop toll collection system with security key technology;
- software for an inter-provincial ETC interconnected toll collection and settlement center;
- regional interconnected non-stop toll collection operation management architecture;
- safe and reliable technology for a regional interconnected electronic non-stop state highway toll collection system;
- technical specifications for an interconnected electronic non-stop toll collection system.

**Case: Inter-provincial highway ETC**

Beijing-Tianjin-Hebei region and the Yangtze River Delta region have created inter-provincial connection of highway ETC, which not only can improve the traffic flow and accelerate the transmission of information and resources among cities, but also can promote the development of low-carbon transportation.
HIGH-SPEED RAIL TECHNOLOGY

High-speed rail has become a trend in railway development and a symbol of a modernized country, for it boasts advantages such as large capacity, safety and comfort, all-weather reliability, environment friendly and sustainability. As the core of the high-speed rail system, high-speed trains reflect a country’s high technology, manufacturing capacity, innovation capability, and core competitiveness in rail.

High speed rail infrastructure and high-speed train technology have been advancing rapidly in China by systematically introducing and absorbing advanced foreign technology and upgrading it through innovation, forming a nationwide cross-industry chain.
HIGH-SPEED RAILWAY CONSTRUCTION

At high running speed, and in conditions featuring high-speed and heavy-density train crossing, China's high-speed railway has achieved tunnel transit, double-heading, and double arch current collection at a speed of 350kph.

Case: Beijing-Shanghai high-speed rail

Beijing-Shanghai high-speed rail was brought into service in 2011. At the time it was the longest high-speed railway, built and operating to the highest technical standards. Since 2011, 786 8-carriage high-speed trains have entered service in China.
MANUFACTURING TECHNOLOGY OF HIGH-SPEED TRAINS

Total power of the traction drive system of the new-generation high-speed trains exceeds 20,000 kW. Energy consumption per capita is less than 5.2 kWh/100 kilometers, and the energy consumption per capita for the whole journey from Beijing to Shanghai is less than 70 kWh. The brake system adopts the composite electric-pneumatic braking principle. The energy recovery rate of the regenerative braking system is nearly 95%. The product technology is stable, with reliable performance. Production capacity has reached 8 to 10 16-carriage high-speed trains per month, and debugging capability is in place and reliable.

December 3, 2010 – CRH new-generation high-speed train makes its first journey
Case: CRH high-speed train

In April 2010, the first CRH380A high-speed trains came off the assembly line. The continuous operation speed of the CRH380A is 350kph, with a maximum operating speed of 380kph. The vehicle design features ten innovation highlights: low-resistance flow head type, excellent body vibration modes, high airtight strength and airtight body, large-bearing high-security bogie, advanced sound insulation and damping technology, strong power green traction system, technology for active control of low airflow disturbance double arch current collection, high-security low-wear compound braking, humane, diversified and personalized service facilities, and intelligent control, diagnosis and monitoring. All these contribute to low resistance, light weight, regenerative braking and zero emissions.

On December 23, 2010, a new-generation CRH380AL high-speed train with proprietary IP set an operating speed record of 486.1kph on the Beijing-Shanghai line pilot section. All of the performance indexes of the train met the design specifications.
MAGLEV TRANSPORTATION TECHNOLOGY

The Maglev system is a revolutionary innovation in transportation technology, integrating advanced technologies in the fields of civil engineering, materials, machinery, power electronics and information control. Compared with a traditional high-speed railway, maglev can reduce infrastructure investment, cut operating energy consumption, and provide more efficient services.

China has supported the development of maglev transportation technology, and through technological innovation and demonstration has successfully developed the complete technology for a high-speed EMS maglev transportation long stator rail system. A production line with the annual capacity of 100,000 long stator iron cores has been built, reaching 100% domestic production in terms of track engineering. China has established a research and development platform for high-speed maglev vehicles, and created a standardized system for the design, manufacturing and testing of high-speed maglev vehicles, and a safety evaluation system. By the end of May 2011, vehicle prototypes have completed 15,000km of empty trial runs on Shanghai’s maglev demonstration lines, and 30,000km of trial runs carrying passengers.
**Case:** High-speed maglev track beam system on Shanghai’s demonstration lines

Shanghai’s maglev demonstration line is the startup project for high-speed maglev technology and is the engineering carrier for comprehensive collection and absorption of advanced overseas technologies. This line starts from Longyang Road Station, a metro hub in Shanghai Pudong New Area in the west, to Pudong International Airport in the east. The overall length of the main line is 30 kilometers, with 3.5 km of auxiliary lines; both lines run up and down and double back. The line is provided with two stations, two traction substations, one operation control center (located in Longyang Road Station) and one maintenance center. Three underbodies have been configured initially, and the designed maximum operating speed is 430kph. The one-way travel time is about eight minutes and the departure interval is 10 minutes. Construction of the demonstration line was started in March 2001, and the first public run was made on December 31, 2012. The maximum operating speed of 430kph was achieved.

A Chinese-built high-speed maglev track beam system achieved a maximum speed of 501 km/h on the Shanghai Demonstration Line
A Chinese-built vehicle carrying passengers on the Shanghai Demonstration Line at a speed of 430km/h
SHIP TECHNOLOGY

China currently possesses a relatively complete shipbuilding science and technology research and development system. Research areas include ship design, overall performance testing, ship support electromechanical equipment, marine materials, shipbuilding technology and other core competences. China has the design and construction capabilities for full range of mainstream ships, has made a significant breakthrough in the development of high-tech marine products, and has made progress in the development of key ancillary equipment.
MAINSTREAM SHIP TECHNOLOGY

China's shipbuilding industry has carried out optimization and upgrading work for three main ship types: bulk-cargo, crude carrier, and container ship. It has focused on the development of large and ultra-large ships and formed a relatively complete series of vessels. Development efforts have generated practical benefits.

Case: Ultra large ore carrier

China State Shipbuilding Corporation has developed a series of ultra-large ore carriers targeting the international market. Bulk orders are being accepted for the 230,000t large ore carriers developed by Institute 604. Orders have been signed for the independently-developed 400,000t ore carriers, and China Shipping Group has placed 8 orders for the 300,000t large ore carriers developed by Institute 708.

China's home-made giant ore carrier
**Case: Very large container ship**

A number of 8530 TEU ultra-large container ships have now been designed and completed by China Shipping (Group) Corporation. The ship is the largest container ship designed and built by and in China. China is also the fourth country to have entered the ultra-large container ship building market following Denmark, Japan, and the Republic of Korea. China now has a series of container ships that can essentially cover the full spectrum of market demand. These range from small container ships of 1,000-containers or below, through 1,700 TEU, 1,800, 2800, 3500, 4200, 4250, 4600, 5100, 5668, and 6800, up to 8530 containers. Most of these have already been built.

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**Case: Very large crude carrier (VLCC)**

Two types of very large crude carriers - 297,000t and 318,000t have been developed by the Shanghai Waigaoqiao Shipbuilding Company. They offer good economy and high safety, meet the requirements of environmental protection, and are practically designed; furthermore, they meet standard specifications and PSPC requirements.
8530TEU container ship “New Asia”
HIGH-TECH SHIPS AND SHIP ENGINEERING TECHNOLOGY

Through years of continuous technological support, China’s shipbuilding industry has incorporated and absorbed imported technologies, engaged in innovation in the field of high-tech ships, and made breakthroughs in the key design and construction processes for large LNG ships and a large number of other high-tech ships, enhancing the competitiveness of China’s shipbuilding industry in the international market.

Case: Large liquefied natural gas (LNG) ships

Large liquefied natural gas (LNG) ships are internationally recognized as complex high-tech, and high value-added vessels. Up to December 2009, five China-built LNG ships representing a total capacity of 147,000 m³ were in service. Based on this, China State Shipbuilding Corporation has launched its own 160,000 m³, 172,000 m³, 175,000 m³ and 220,000 m³ LNG ships.

Case: Ro-ro passenger ships

China has mastered the design and construction technologies for ro-ro passenger ships. On December 28, 2010, the No. 1 ro-ro passenger ship ‘Longxing Island’, a 1,400-seat vessel with 2,000 linear meters of vehicle capacity was delivered. Guangzhou Shipyard International took orders for four such ships from the Zhonghai Gangian Shipping Company; the fourth of these was launched on December 28, 2011.
Case: Large semi-submersible transport ship

To respond to the needs of marine oil and gas exploration and extraction, China has developed ultra large-scale hoisting/pipe-laying ships and large semi-submersible transport ships, and mastered electric propulsion, digital manipulation, and other key technologies and design methods for 2×8,000t hoisting/pipe-laying ships and 50,000t semi-submersible transport ships. China now possesses core technologies with proprietary IP.

Case: Floating production storage and offloading vessel

The floating production storage and offloading vessel (FPSO) is a critical component of offshore oil and gas production. To meet the needs of China National Offshore Oil Corporation for a 150,000t class FPSO, 'Nanhai Endeavor' was completed and delivered on July 24, 2002, and officially entered service on the Wenchang Oilfield in the South China Sea, enhancing the competitiveness of China's shipbuilding industry in the international marine engineering market.
SUPPORTING SHIPBUILDING TECHNOLOGY

Over the past 10 years, China's scientific research in ancillary products of ships has increased dramatically, which has strongly promoted the shipbuilding industry. The domestic manufacturing of key products, serialized and lot sizing production, and the localization rate of components and parts have been significantly improved.

**Case:** Intelligent low-speed marine diesel engines

China has basically mastered the technology for manufacturing intelligent low-speed marine diesel engines and electronic control technology, and completed the manufacturing and shipment of 6X80ME-C intelligent diesel engines. The products have achieved IMO Tier I emission requirements, passed the inspection of the GL Ship Classification Society, and entered service. Localization rate of components and parts of the main engine has reached 80% or above, and a production line for this model has been set up.

**Case:** Engine room automation

As the heart of a ship, the engine room contains the main equipment of the ship. With increasing complexity of the ship's equipment and the increasing functionality come higher requirements for the reliability and stability of the ship's control systems. China has completed the research and development of main engine remote control systems, whole ship monitoring and alarm systems, valve remote control systems, integrated platform management systems and other related products. These systems have passed the inspection of the ship classification society and are now in widespread use.
BRIDGE TECHNOLOGY

To adapt to the rapid economic growth, China has launched a large-scale program of highway infrastructure construction. As modern bridge technology continues to progress with the support of science and technology, engineering complexity is increasing, and the technical level of bridge construction is also in constant development. By the end of 2011, China had built 4,100,000 kilometers of highway, of which expressways represented 85,000 kilometers. There had been a total of 689,400 highway bridges, and the number is increasing at a rate of about 30,000 every year. Among these are 2,051 super large bridges, and more than ten bridges with a span of over 1,000m. With the resolution of a series of complex bridge construction problems, Chinese enterprises are not only building all the bridges in China, but also beginning to export its technologies.
KEY TECHNOLOGY FOR THE CONSTRUCTION OF KILOMETER-SCALE CABLE-STAYED BRIDGES

The cable-stayed bridge, a modern bridge type with the main girder supported on a cable support tower through the stayed-cables, has spanning capability, solid structural rigidity, low cost and wide adaptability. Continuous extension of the span is the constant development theme of cable-stayed bridges, and the concentrated expression of engineering technical difficulty. With the rapid growth in transportation demands and the gradual construction of long span bridges that cross rivers and bays and that connect islands and continents at home and abroad, complex and extreme construction conditions and high navigation standards demand more from the spans of cable-stayed bridges.

Case: Suzhou-Nantong Bridge

The Suzhou-Nantong Bridge spans 1,088 meters. The design and construction process had to address such problems as poor weather conditions, complex hydrological conditions, bedrock buried deep and high navigation requirements, etc. China now possesses the complete manufacturing and erection technologies for super long stayed-cables, having developed galvanized steel wire for 1,770MPa stayed-cables and now being in a position to export its products, significantly enhancing the international competitiveness of the country's bridge technologies.

The Suzhou-Nantong Bridge is a landmark across the Yangtze River
Hangzhou Bay Cross-Sea Bridge with a total length of 36 km
KEY TECHNOLOGY FOR THE CONSTRUCTION OF SUPER LONG-SPAN SUSPENSION BRIDGES

The suspension bridge has become the preferred bridge type for spanning large rivers, straits and harbors and other traffic barriers due to its good mechanical performance, large span capacity, beautiful appearance, good seismic performance, and safe and efficient construction. Compared with other forms of long-span bridges, the suspension bridge has obvious spanning capabilities and high aesthetic value, is known as “the Queen of Bridges” and is very suitable for long-span requirements.

Case: Xihoumen Bridge

In 2005, China completed the Xihoumen Bridge, a steel box girder suspension bridge, which represented an advance in a number of key technologies, including survey and design, wind resistance, cable materials, manufacturing, installation and control in a marine environment, structural monitoring, maintenance management, and others, significantly enhancing the international competitiveness of our bridge technologies.
KEY TECHNOLOGY FOR THE CONSTRUCTION OF CROSS-SEA TUNNEL-ISLAND-BRIDGE PROJECTS

A cross-sea cluster project covers road, bridge, tunnel, island and a number of projects. Its construction conditions are complex and the technical difficulty is high. It is the integration of multi-disciplinary, multi-profession and multi-level technologies. The Hong Kong-Zhuhai-Macao link is a good example - the project bestrides the Lingding Sea at the Pearl River Estuary, connecting Hong Kong, Zhuhai, and Macao and consists of immersed undersea tunnels, artificial islands and cross-sea long-span bridges.

Case: Hong Kong-Zhuhai-Macao Bridge

The structure of Hong Kong-Zhuhai-Macao Bridge is lodged in a deep soft stratum which has large differences in distribution. The bridge has high seismic fortification standards and rigorous whole-line water blocking rate requirements. passes through a Chinese White Dolphin protection area with high environmental protection requirements, and is located in the busiest shipping section of the Pearl River with high navigation safety requirements. The undersea tunnel in the seabed is 5,990m long and located in open seas. The difficulties presented in its construction are higher than that of similar international projects. Two artificial islands in the sea are located in an offshore environment and the entire island body is located in the deep soft foundation. In addition to guaranteeing the stability and the settlement control of the island structure itself, it is also necessary to create a successful link between bridge and tunnel; it is the largest artificial island project with the highest construction difficulty ever built in the open sea. Steel box beams are used for the upper structure on a large scale, and the steel requirement is 400,000 tons. In order to meet the strict water blocking requirements, the non-navigational bridge has used the buried bed prefabricated foundation for the first time. The design service life of the Hong Kong-Zhuhai-Macao Bridge is 120 years, and the standard is higher than that of any existing domestic project. Durability technology is the key to ensuring the construction quality of this project.