Rolling Stock Market Environment and Initiatives of the Rolling Stock Company

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Introduction

Rolling Stock Company ("the Company") aims to contribute to society by providing people with vehicle products that support safe, secure, and comfortable travel as part of its vision to "become the industry's most trusted manufacturer of vehicle systems and provide dreams and excitement to customers worldwide through its outstanding teamwork and the highest level of technology and quality." The following describes the vehicle market environment in which the Company operates, its business development history, and its initiatives for the future.

1 Rolling stock market environment

Although the Japanese economy has been experiencing a modest recovery thanks to government-led economic measures, the falling number of passengers associated with the country's aging society and declining birth rate means that significant market growth cannot be expected. In recent years, demand has mainly been driven by the replacement of aging railcards, and since the total number of car orders has been on the decrease, railcar manufacturers continue to face fierce competition for orders.

At the same time, however, railcards have won recognition in countries and regions around the world for offering a more environmentally friendly means of mass transportation as they generate less CO_2 emissions than other transportation methods, such as automobiles and airplanes. In the United State and emerging countries such as India, Brazil, and Southeast Asian countries, many projects for the construction of high-speed railways and the expansion of urban transportation are planned for the purpose of stimulating the economy and generating employment. According to the Association of the European Rail Industry (UNIFE), the world rail market will grow at an annual average rate of 2.7% (NAFTA: 3.6%; Asia Pacific: 4.1%) until 2019, and continued market growth is expected.

The Company has been actively expanding its business overseas mainly in two markets: North America and Asia. In North America, in response to a growing population and as part of economic and employment measures, investment in social infrastructure is being proactively examined and demand for the addition and replacement of railcars has been generated for the Northeast Corridor, which is centered on New York. In Asia, against a backdrop of growing urbanization in emerging countries, investment in railway infrastructure has increased and there is strong demand for railcars in India and Southeast Asian countries. In addition, the Japanese government is taking a positive stance toward infrastructure exports as a priority for its growth strategy, including the provision of yen loans. Despite the strong overseas demand described above, we face fierce competition just like we do in Japan, as our competitors—the big three European manufacturers (Alstom, Bombardier, Siemens) and China Railway Rolling Stock Corporation (a Chinese state-owned manufacturer)—have a larger business scale than us.

2 Business development

In light of the above circumstances, the Company aims to achieve balanced, sustainable growth mainly in the three markets of Japan, North America, and Asia, with the world's highest technology and quality as its advantages. The following section describes the Company's business development and future initiatives, both in the Japanese and overseas markets.

(1) Development of the vehicle business in Japan

The Japanese market is the Company's most important market in terms of employment and regional economic promotion, as well as the enhancement of its mother factory functions in developing new technologies and products.

Having consistently remained at the forefront of cutting-edge technologies as Japan's top vehicle

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manufacturer since it began operations at the Hyogo Works in 1906, the Company has served as a driving force for railway development and modernization and provided society with a variety of vehicles, including electric trains, coaches, freight cars, electric locomotives, and diesel locomotives, as well as related systems and equipment and new transit systems. On the technology front, we have stayed ahead of our competitors in developing state-of-the-art vehicles, such as Shinkansen trains, all aluminum-alloy trains, guide-rail system electric cars with rubber tires, completely automated new transit systems, and low-floor, battery-powered light rail vehicles (LRVs). In addition to the above, with customer requirements for countermeasures to deal with issues such as noise and vibration having become increasingly sophisticated and diversified due to the speeding-up of vehicles, we have responded by gaining support from the Aerospace Company, the Corporate Technology Division, and other divisions. In recent years, the results of our efforts have come to fruition in the form of Shinkansen trains, such as the Hokuriku Shinkansen E7 Series/W7 Series (Fig. 1), and limited express trains and suburban commuter trains for conventional railway lines, such as the 8600 Series limited express trains for the Shikoku Railway Company.

(2) Future initiatives in Japan

In the Japanese market, where order competition has recently become increasingly fierce, the Company will enhance its leading-edge technologies by taking full advantage of its outstanding quality and integrated management to differentiate itself from its competitors. Specifically, we will further develop not only leading-edge technologies that take advantage of synergies across our company segments, including the Aerospace Company and the Corporate Technology Division (efWING: environmentally friendly Weight-Saving Innovative New Generation Truck, high-speed railcars, etc.), but also standard commuter cars that meet the need for cost reductions and short delivery lead times (efACE: environmentally friendly Advanced Commuter & Express train).

In addition to the above, while maintaining high productivity in our high-mix, low-volume production, we are working on improving the Hyogo Works in order to respond to small- and medium-lot orders for vehicles with a complicated, highly sophisticated structure, such as limited express trains and event trains that offer originality, which have been increasing in number in recent years. We are also actively developing peripheral equipment for vehicles—including the bogie instability detection system and the track irregularity inspection system—to provide customers with value throughout the entire vehicle lifecycle. Furthermore, we are actively approaching new customers with the aim of providing our products to a broader range of customers. In FY2015, we received orders for new commuter trains from Seibu Railway Co., Ltd. for the first time, and orders for new limited express trains from Tobu Railway Co., Ltd. for the first time since 1946. In addition to existing customers, we will actively propose our products to new customers by making use of our high quality, state-of-the-art technological capabilities.

Fig. 1 Hokuriku Shinkansen E7 Series/W7 Series

(3) Development of the vehicle business overseas

The Company began exporting railcars in 1911 when Kawasaki Dockyard delivered four coaches to Qing, and we have delivered large numbers of railcars overseas ever since. The high quality, leading-edge technologies that the Company has nurtured in domestic projects have been well received, and more than half of the Company's consolidated net sales are now from overseas, mainly Asia and North America

In Asia, we have a proven sales track record, particularly in Singapore, Taiwan, and China. In Singapore, we received orders for urban transportation vehicle from the country's Land Transport Authority (LTA) for the first time in 1984, and have been providing railcars, including C151A subway cars (Fig. 2), for over 30 years. We now have the largest market share there with 64% of the market. In Taiwan, we have received orders for 34 high-speed trains (408 cars in total) from Taiwan High Speed Rail since 2000. In the field of mass rapid transit (MRT), we have delivered large numbers of railcars, such as the EMU for the Taiwan Taoyuan International Airport Access MRT System, since our first delivery of railcars to the City of Taipei in 1992. In China, we entered into a plant partnership with CSR Qingdao Sifang Co., Ltd. ("Sifang"), which is now a subsidiary of China Railway Rolling Stock Corporation but was under the umbrella of China's Ministry of Railways in 1985, and have built up a 30-year relationship of trust through our support for the planning of the company's vehicle plants, technical cooperation, and production cooperation.

In North America, following our export of tram cars for use by the Southeastern Pennsylvania Transportation Authority (SEPTA) in Philadelphia in 1980, we have delivered double-decker train coaches for the Long Island Rail Road, PA-5 cars for the Port Authority Trans-Hudson Corp. (PATH), and various other types of railcars for over 35 years. The total number of cars ordered amounts to approximately 4,500. In particular, for the New York City Transit Authority (NYCT), we have delivered more than 2,000 cars in total since our first delivery of subway cars in 1985, thereby gaining the leading market share there. In 1985, we established the current Kawasaki Rail Car, Inc. (KRC) (Fig. 3) as an affiliated company in North America, and launched operations at our Yonkers plant the following year. We also established a vehicle plant for Kawasaki Motors Manufacturing Corp., USA (KMM) (Fig. 4) in Lincoln, Nebraska, in 2002 to enhance our production system. The KMM vehicle plant has successfully introduced an integrated manufacturing process that covers all stages from body structure manufacturing to final assembly. By improving our productivity, reducing our transportation costs, and mitigating our foreign exchange risk through local production, we have satisfied the "Buy American" provision that requires companies to procure at least 60% of US-made parts. The Company, as a locally based vehicle manufacturer, is further striving to provide

Fig. 2 C151A subway cars for Singapore's Land Transport Authority

Fig. 3 Kawasaki Rail Car, Inc. (KRC)

Fig. 4 Kawasaki Motors Manufacturing Corp., USA (KMM)

low-cost, high-quality vehicles and improve customer satisfaction by responding quickly to problems and providing other services.

(4) Future challenges in overseas markets

In the same way as we do in the Japanese market, we aim to build up a relationship of trust with our overseas customers by taking full advantage of the overwhelmingly high-quality technological capabilities we have achieved through our integrated management and contract fulfillment capabilities, including the meeting of delivery times, and to continue winning orders by strengthening our non-price competitiveness without falling into a price competition with Chinese and Korean manufacturers.

To strengthen our competitiveness, we will first of all form flexible partnerships to implement projects with an optimal scheme. Having formed a consortium with Sifang, we are currently working on the MRT train project for Singapore's Land Transport Authority (LTA), in which we perform the project management, undertake the design work, and supply the bogies and the major equipment while Sifang develops the new train cars. This scheme combines our technological capabilities with Sifang's low-cost production capacity. We aim to flexibly seek optimum partnering opportunities in the future, as well. In emerging countries whose infrastructure has not been well developed in spite of the demand for transportation, orders are often placed for entire railway systems, not just for train cars. To capitalize on this demand, we have been working to strengthen our system integration capabilities. Specifically, we are currently working on the Taichung City Railway System project, for which we won the order in 2011. In India, which is a new market for us, a freight-dedicated electric locomotive project is planned, and active marketing activities have been carried out.

In North America, we have a large backlog of orders,

Fig. 5 7000 Series subway cars for the WMATA

including 7000 Series subway cars for the Washington Metropolitan Area Transit Authority (WMATA) (Fig. 5), R188 subway cars for the NYCT, and M9 railcars for the Long Island Rail Road (LIRR) and the Metro-North Railroad (MNR). We will continue building a relationship of trust with our customers and actively strive to win orders for new projects by steadily implementing these large-scale projects using our production systems in Japan (Hyogo Works and Harima Works) and the United States (KRC and KMM), while also improving our productivity through the promotion of the Kawasaki Production System (KPS) and further enhancement of our supply chain management.

3 Technology development in the pursuit of originality and innovation

Our technological developments have led to the creation of a variety of vehicles, including Shinkansen (bullet trains), overseas train cars, and new transit systems. Given the Japanese and overseas market environment and the business developments described above, it is necessary to develop leading-edge technologies in the pursuit of originality and innovation that is unique to our company in order to successfully differentiate ourselves from other companies through non-price competitiveness.

We have developed efWING, a new vehicle bogie that uses CFRP for its main frame structure. The railcars used for efWING are made from carbon fiber reinforced plastic, which is a material often used in the aerospace field. This material's characteristics help to reduce weight significantly and curb energy costs. Through various demonstration tests conducted in the United States, efWING has been proven to meet the vehicle operational safety requirements of the US Department of Transportation (USDOT). After the development process was completed, efWING was put into operation by the Kumamoto Electric Railway Co., Ltd. in March 2014. Since fiscal 2015, the Shikoku Railway Company, the Kyushu Railway Company, and the Nishi-Nippon Railroad Co., Ltd. have conducted a series of operational tests to confirm the operational stability and passenger comfort. We will further improve this technology with the aim of achieving fully fledged commercialization.

In recent years, other railcar manufacturers have advocated the platform concept and demonstrated cost and quality advantages of scale by presenting manufacturer standards, similarly to in the automobile industry. However, we are focusing on the development of a scheme to respond to mass customization, in which value can be improved while continuing to meet customer requirements. The scope of application for efACE, the Company's standard railcar concept, has been expanding year by year to the point where it now covers railcars ranging from the initial aluminum railcars through to stainless railcars. We are also working to develop a module concept for overseas markets (Fig. 6), in which standard modules for parts and equipment, such as driver's cabs and doors, are built and assembled according to standardized procedures with the aim of making this concept applicable to overseas manufacturing while also meeting customer requirements.

For high-speed railcars, our proprietary flow analysis software was applied to resolve the aerodynamic noise being generated by pantographs and the lower parts of the carbody, and a large-scale analysis was performed using the K computer in Kobe city to clarify the cause of such

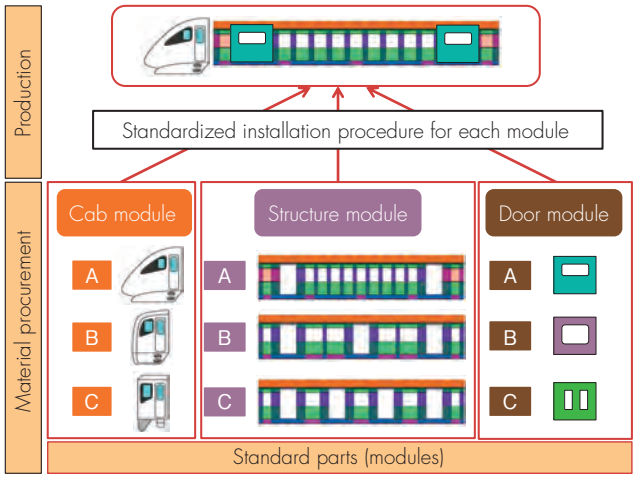

Fig. 6 Module concept

noise.

In overseas vehicle markets, we have succeeded in meeting strict technical and quality requirements, especially in our capacity as a pioneer in the North America market. For the latest 7000 Series subway cars for the WMATA, we have developed a thin corrugated floor structure to secure an additional underfloor outfitting space by reducing the floor thickness, while ensuring its rigidity, fire resistance, and heat and sound insulation. For the crash structure design, we have verified our analysis results by performing crash tests for the energy absorbing elements and then reflected the verification results in the design. These verifications have been front-loaded by intensively investing resources in the initial design process, and this has delivered significant results, such as the start of commercial operations as scheduled without any delays.

Meanwhile, as the Internet of Things (IoT) has attracted a great deal of attention, we have been working to develop the Bogie Instability Detection System (BIDS) as an underlying IoT-related technology. BIDS allows the information obtained to be continuously monitored, which contributes greatly to failure prediction diagnosis. We have also developed and started the mass production of a track irregularity inspection system that automatically detects irregularities in rail fastening parts and splice plates for commercially operated trains using image recognition technologies. This has contributed to cost reductions by improving the efficiency of track maintenance work.

4 Initiatives to improve customer satisfaction levels

Vehicle is effectively the face of the railway operators that make up our customer base. Reducing vehicle's environmental impact and life cycle costs, which is required more than ever recently, and providing rolling stock with improved designs helps to improve the corporate brands of railway operators. To improve customer satisfaction levels, we are working to increase passenger comfort through air conditioning and noise control. I would also like to describe the use of affective engineering and virtual reality, which have been studied in collaboration with Head Office's Corporate Technology Division.

Affective engineering is a technology that is used to objectively identify human feelings, so it can serve as an effective tool in creating design images based on the customer's design concept. Once design images have been created, they are converted into three-dimensional data, after which multiple designs created by our designers are verified scientifically based on affective engineering and developed into a concrete design. Finally, virtual reality (VR) using three-dimensional data allows the customer to check the three-dimensional design in advance for pre-verification. These initiatives to improve customer satisfaction levels have led to the acquisition of new customers.

In addition, since the Great East Japan Earthquake, there has been an urgent need for railway operators to address power outages and shortages. The solution is to secure infrastructure equipment in the event of an emergency. To this end, we have been focusing on enhancing the battery power system (BPS) by using Kawasaki's proprietary high-capacity nickel-metal hydride GIGACELL batteries, and we have delivered the world's first BPS for use in emergency train runs to Tokyo Monorail Co., Ltd. During normal rail operations, the BPS also stores regenerative electric power recovered from electric train cars, which allows railway operators to reduce their running costs by preventing regenerative invalidation.

Conclusion

Kawasaki Heavy Industries Rolling Stock Company has an operating history that stretches back over 100 years. During the past 15 years, the Company has achieved steady development, almost doubling its consolidated net sales, mainly due to an increase in overseas projects. We would like to thank our stakeholders for their continued support. Going forward, we would like to contribute to society by providing products that support safe, secure, and comfortable travel. To achieve that, we will continue to constantly strive to improve our outstanding quality and leading-edge technologies by making use of our integrated management to achieve further development.