BUSES

Overall Trends

1 Introduction: Needs Projected in Recent Bus Technologies

Buses are a familiar day-to-day means of conveyance for people, and the technology they contain strongly mirrors social concerns. Although they are less in demand and are fewer in operation than trucks, a similar type of production goods, the bus operators who use them typically have extensive experience and perform their own preventive maintenance. These elements make them distinctive as a vehicle where the needs of the operators are directly reflected in product development. The technological trends finding their way in buses are becoming increasingly diverse.

1.1. Environmental changes and transitions in bus technologies

After World War II, the first priority faced by emerging bus technologies was to achieve the mechanical durability and reliability essential to maintaining normal operation. In and after the late 1950s, exports of buses as completed vehicles, which were proactively initiated to obtain foreign currency, also achieved a high level of international product appeal.

The building of expressways in the 1960s fostered efforts to improve performance, ensure safety, and enhance the comfort of passengers riding for long periods of time. For urban route buses, factors such as the propagation of driver-only buses and the introduction of devices to make announcements or collect fares, which were driven by then need to increase operational efficiency, prompted the evolution of technological fields unique to buses.

In the 1970s, environmental protection concerns brought about the need for environmental performance to comply with noise and emissions regulations, with the subsequent gradual strengthening of those regulations turning compliance itself into a basic goal for automotive engineering.

More recently, the growing need to achieve labor savings, lighten driving fatigue, and improve safety in response to the changing conditions related to bus drivers (aging, shortage of drivers) is spurring various technological innovations including automatic gear shifting, enhanced support functions for safe driving, and GPS-based dynamic management.

In addition, the fact that buses carry many people means that every single accident draws a tremendous amount of attention, leading to strong calls for safety technologies that curtail the possibility of accidents. At the level of the vehicle, control technology that maintains stability while driving is becoming more common, and research and development on non-material elements such as driver monitoring, work schedules and management systems is being pursued vigorously in an effort to eliminate human factors leading to accidents.

Since regulations concerning sightseeing vehicles have been relaxed, operators seeking to differentiate their buses have been calling for functions adapted to diversifying passenger preferences.

1.2. New needs accompanying globalization

In a different vein from bus operator needs, the harmonization of international standards is having a strong impact on structure technologies. Aligning with the EC standards, which are becoming predominant worldwide, the main examples are the adoption of new ISO standards on wheels for heavy-duty trucks and buses and consecutive amendments to the standards for lighting devices as well as for the attachment of passenger seats and seatbelts. Body rigidity standards for light-duty buses are also gradually being reviewed.

The bus-related technologies formerly fully contained within the closed loop of manufacturers as provider and bus operator as user have, therefore, come to more strongly mirror social concerns and even factor in international elements. The key concepts involved are safety, which appeals to bus end users, as well as environmental

Fig. 1 Example of electric bus that started operating in 2015

protection in the context of an ever more global society.

Changes in the technologies for Japanese-made buses in 2015 also reflected internal and external needs while conforming to those key concepts.

1. 3. Strengthening safety

The installation of a collision damage mitigation braking system (AMB) made mandatory for heavy-duty sightseeing buses in 2014 has been followed up by the adoption of new lane departure warning system standards in August 2015. Current Japanese and imported vehicles subject to these requirements have all been made compliant. However, as vehicles remain in service for longer periods, those subject to compliance with the latest regulations represent only approximately 20% of the total number of vehicles owned. This is leading to growing interest in retrofitted following distance warning system as a means of enhancing the safety of aged vehicles. Collision mitigation braking systems (AMB) with capabilities equivalent to those in the latest models are also being installed in some newer models.

They also further enhance safety in conjunction with the installation of vehicle stability control systems that control the engine and provide independent braking for each wheel in situations involving a potential loss of vehicle stability due to excessive speed or slippage.

Furthermore, the aging of drivers in the bus industry has led to the development of systems aimed at preventing accidents caused by health conditions, such as sensors that monitor the driver's heart rate or systems that detect alertness based on eye movement.

In terms of ensuring the safety of passengers, seatbelt use in buses for school children is becoming more common, and the number of operators adopting three-point seatbelts is also rising. Although this reflects greater attention to safety on the part of end users, actual seatbelt use in sightseeing buses is low, and raising awareness remains an issue.

Fig. 2 Fuel cell bus field test conducted in Tokyo in July

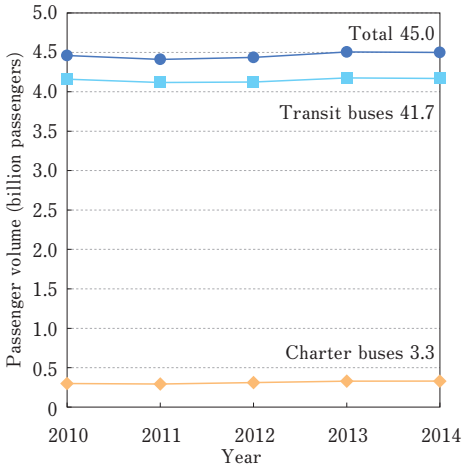
1. 4. Working toward environmental preservation

All new Japanese buses currently manufactured are compliant with the latest noise and emissions regulations (2009 and 2010 post-new long-term regulations), and bus engines are already featuring smaller displacements, supercharging, and precise control of fuel injection. In urban buses, the desire to reduce fuel consumption is leading to the optimization of gear patterns and the introduction of automatic gear shifting.

After Mitsubishi Fuso Truck and Bus Corporation made an automatic transmission (AT) with a torque converter standard equipment on buses used on urban routes in 2010, Isuzu Motors Limited and Hino Motors, Ltd. followed suit in 2015, adopting a two-pedal system in their own urban route buses through the use of an AT with a torque converter or of an automated manual transmission (AMT, an electronically controlled mechanical transmission). Automatic shifting has leapt forward. This is clearly a radical change in Japanese-made buses, where manual shifting has been predominant for years. The reform of driving operations was prompted by environmental performance requirements.

While diesel engines are set to remain dominant in Japan for the foreseeable future, other countries are trying various systems, including electric hybrid and pure electric vehicles, gas-powered engines, and even fuel cells. While efforts started in Japan last year to commercialize electric and plug-in hybrid buses are still being pursued, there are still few vehicles and their operation is limited in scope (Fig. 1).

Field tests of fuel cell buses targeting popularization sometime around 2020 are also being conducted. One such test conducted under more realistic driving conditions involved an active metropolitan bus driver operating the bus on a selected Tokyo metropolitan bus route in the intense late July heat (Fig. 2).



*Domestic buses were excluded from the survey in 2010.

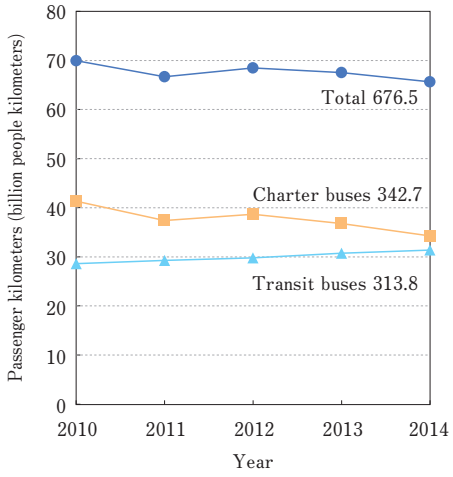
Fig. 3 Passenger volume (number of passengers)

1. 5. Changes due to the use environment

After exceeding the ten million mark for the first time in 2013, the number of visitors to Japan reached new records of 13,410,000 in 2014 and 19,737,400 in 2015, which represents a considerable increase of 47.1% over the previous year. Increasing the number of visitors is also part of the policy for the 2020 Tokyo Olympic and Paralympic Games and is expected to continue to rise unless factors such as the political situation, the exchange rate, or natural disasters trigger dramatic changes. The recent strong demand for charter buses stems from this rise in the number of visitors.

Consequently, there is a booming interest in additional or replacement sightseeing buses. However, due in part to the consolidation of bus manufacturing plants in the last few years, there are limitations on significant increases in production capacity and it currently takes ten months or longer to receive a vehicle after ordering it.

At the same time, plans to increase bus transport capacity in event locations and Tokyo by 2020 are underway. The introduction of 20 or so high transport capacity articulated buses is being examined, and there are plans to manufacture such buses, whose acquisition had depended on imports, in Japan. The turntable that makes the pivoting joint of articulated buses possible is only available from a limited number of manufacturers, and attention is turning to how the technology will be introduced within the constraints of development time and costs.



*Domestic buses were excluded from the survey in 2010.

Fig. 4 Passenger volume (passenger kilometers)

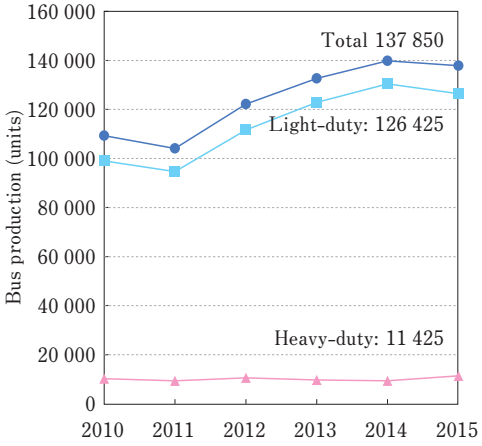


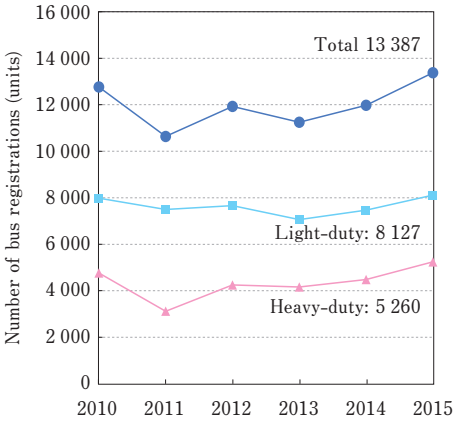
Fig. 5 Bus production in Japan.

2 The Bus Industry in Statistics

2. 1. Passenger numbers

The number of transit bus passengers in 2014 was approximately 4.17 billion, which is about the same level as in 2013 (Fig. 3) Although there are signs of recovery in the vicinity of major cities, the demand in the regions remains on its downward trend. Since a concentrated population is essential to the viable operation of public transportation, the ongoing depopulation in the regions is undermining the profitability of regional bus operators. Such operators are limited in the number of new vehicles they can introduce, and the approach involving replacing vehicles with used vehicles from major cities remains essentially unchanged.

The number of passengers on inter-city route buses, a growing sector for transit buses, was 190 million, representing 2 to 3% of all transit bus passengers. The num-



Note: Starting in 2003 the classification criteria were changed from the vehicle chassis to license plate number (mini-vehicles are excluded).

Fig. 6 Number of bus registrations in Japan.

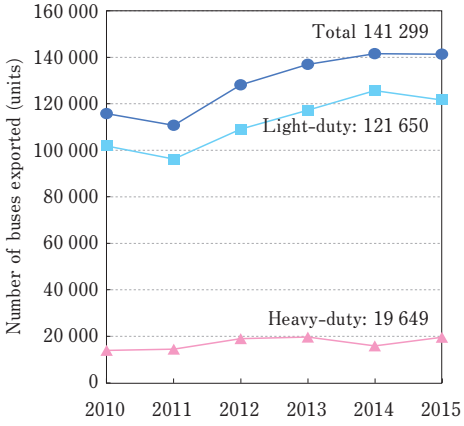


Fig. 7 Bus exports.

ber of passengers increased by approximately 5 million over the previous year in 2015 and, based on the figure of over 4 million passengers per year for expressway tour buses (charter transportation) in the period just before the transition to the new expressway route buses, this represents a steady shift of passengers since that transition. Following the transition to the new expressway route buses, the number of operators entering the market dropped, and there was some reorganization between operators as well as a return to the market by others, but none of this caused a significant change in the number of buses in operation.

Short-distance daytime bus routes have always represented a large proportion of the number of passengers on inter-city expressway route buses. For overnight driving, the need to have two drivers is leading to the cancellation of some routes due to a shortage of drivers, but this has little effect on the number of passengers on overnight long-distance routes.

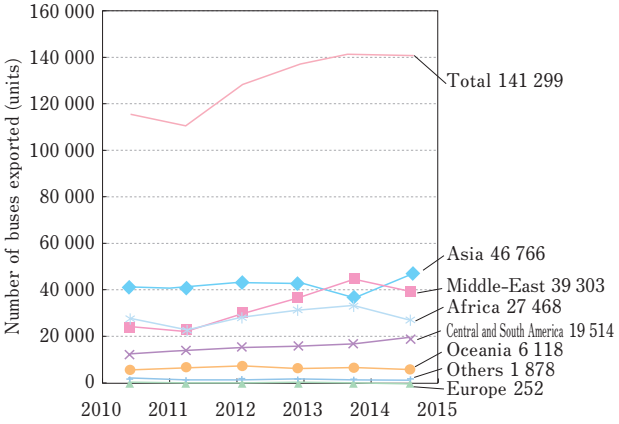


Fig. 8 Main export destinations.

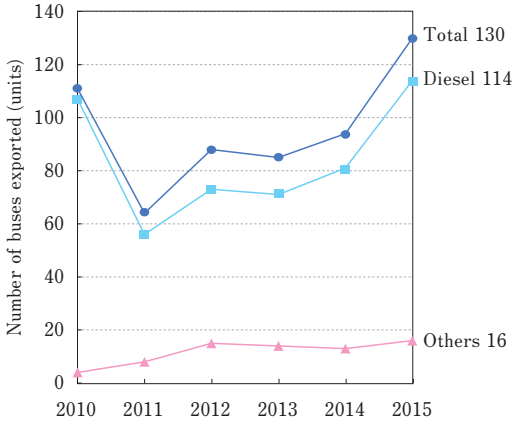


Fig. 9 Number of imported bus registrations.

The number of passengers using charter transportation was also essentially the same as in 2014. The system for charter bus fares and pricing introduced in 2014 has improved profitability for operators, spurring momentum for switching to new vehicles, but dissatisfaction at the higher economic burden has also started to make consumers forgo bus trips. As a counterbalance, demand is brought up by the operation of charter buses catering to inbound transportation, namely visitors to Japan. However, under circumstances where no significant increase in the number of vehicles can be expected, that counterbalance is not large enough to be reflected in statistical figures.

When the distance actually travelled by bus users is factored in the passenger volume (Fig. 4), transit buses exhibit a small increase, while charter buses show a tendency to decrease. This can be attributed to larger numbers of users in cities and the contribution of inter-city travel by expressway bus for transit buses, and by the effect of shorter per day driving distances due to the upper limit on imposed on a single driver for charter buses.

Fig. 10 Mitsubishi Rosa 4WD

Fig. 11 Isuzu Erga

Fig. 12 Hino Blue Ribbon

2. 2. Market trends -- production and registration

The number of buses produced in Japan in 2015 was 137,850, a decrease of a little less than 2,000 compared to the previous year as a result of a 4% decrease for light-duty buses. Medium and heavy-duty bus production was 11,425 vehicles, a 21.5% increase over the previous year and the highest number in the past five years. Medium and heavy-duty buses, which are typically in transition in substitute markets, exhibited a surge in demand unseen in recent years (Fig. 5).

In the past, it was common for operators to specify the body manufacturer for Japanese-made buses, and there were plants capable of building complete heavy-duty buses throughout Japan, but since 2010, grouping with engine manufacturers has brought the number of such plants down to three, owned by two companies. Despite recent steadily growing demand in the sightseeing sector, production capacity is limited, and that demand is being addressed by adding work shifts and hiring more workers.

Reflecting increased production, the number of vehicle registrations has also risen. Light-duty bus registrations have also increased (Fig. 6)

Figures 7 and 8 show the state of bus exports. Economic conditions at export destinations come to mind first to explain the already noted decline in light-duty bus exports, but changing needs concerning such buses must also be considered. For many years, light-duty buses were the main models exported by Japan. They sustained a strong product appeal as quality, durable, reliable and affordable front engine production vehicles. Recently, however, lower cost South Korean- and Chinese-made light-duty buses that use Japanese-made models as a benchmark have been selling in greater numbers.

In countries like Turkey, where a large market is ensured for light-duty route buses, sales of vehicles with high added value such as non-step light-duty buses are rising, and the emergence of markets to which the mass produced, single model grade Japanese light-duty buses are not adapted cannot be overlooked.

Heavy-duty buses counted as exports are not completed vehicles, but rather component kits whose body is remodeled at the destination. Countries in Asia, the Middle-East, and Africa are the main destinations for exports of Japanese buses which are suited to those markets. However, emissions regulations are being strengthened in those countries as well, with more and more of them adopting Euro regulations. Taking the various old and new regulations at export destinations is an issued faced by vehicle manufacturers worldwide. Needs concerning low-floor buses or the articulated buses that underpin bus rapid transit (BRT) systems are also becoming more sophisticated in those countries, where the expansion of Chinese-made buses assembled from selected components, including the engine, stands out.

In contrast, excluding a slice of the sightseeing market occupied by South Korean-made buses, the only real bus imports are articulated buses that cannot be purchased in Japan (Fig. 9). The halt in the production of Japanese double-decker buses, once the main type of imported bus, has led to preparations to once again procure them via imports.

Fig. 13 Hino Blue Ribbon Hybrid

Fig. 14 Scania-Volgren introduced in the city of Niigata

Fig. 15 BYD-made electric bus operated by Kyotokyukou Bus

3 Regulatory Trends

As noted earlier, the installation of a collision damage mitigation braking system (AMB) on heavy-duty sightseeing vehicles became mandatory in 2014, and compliance with the new standards for lane departure warning systems (namely, permanent activation) was made mandatory in August 2015. Three Japanese models and the South Korean-made Hyundai Universe have been made compliant and launched in 2015.

In addition, new vehicles with a gross vehicle weight (GVW) over 7.5 tons will have to be adapted to the 2016 next-phase emissions regulations as of October 1, 2016. Manufacturers also need to prepare for the pending standards concerning the body rigidity of light-duty buses.

4 New Buses

4. 1. Light-duty buses

In January, the engine used in the Toyota Coaster and the same company's Hino Liesse II OEM model was enhanced, improving fuel economy on some models. The vehicle was launched with three-point seatbelts as standard equipment on all seats and rear double doors as an option.

November saw the return of the Mitsubishi Rosa 4WD, whose production had been stopped due to factors such as the integration of various models. The vehicle is adapted to the wishes of operators looking for a replacement vehicle, and it is currently the only light-duty 4WD bus on the market. Differences from the previous model include a different engine, a dual-clutch transmission, and adaptation to a urea selective catalyst reduction system, and the underbody layout has been revamped (Fig. 10).

4. 2. Medium-duty buses (hybrid vehicles)

Medium-duty bus choices are limited to three models in two series for urban route buses, and two models in one series for sightseeing buses, including those for private use. There were no new developments for diesel vehicles, but Hino added as plug-in hybrid to its Melpha series. It is a region- and purpose-focused commercial vehicle based on the concept model exhibited at the 2013 Tokyo Motor Show. Combining a diesel engine with a maximum output of 169 kW and a 175 kW motor-generator, this bus can drive from 15 to 20 km on a single charge in electric mode on a flat road. It can supply power to shelters in the event of a major disaster, and is envisioned as a shuttle for use by local authorities.

4. 3. Heavy-duty buses (diesel vehicles)

In April, the Hino Sélega sightseeing bus and the Isuzu Gala bus featuring a 9-liter engine changed their emissions designation after exceeding the 2015 heavy-duty vehicle fuel economy standards by 10%.

In July, Mitsubishi Fuso improved the fuel economy of its Aero Queen and Aero Ace sightseeing buses by making the engine cooling system more efficient and enhancing the air conditioner compressor. The lane departure warning system was also made standard equipment and updated to be permanently active.

August saw completely redesigned Isuzu Erga and Hino Blue Ribbon City models launched, respectively, as the Isuzu Erga and the Hino Blue Ribbon (Figs. 11 and 12). This marks the first complete redesign in 16 years for the Erga, and in 17 years for the Blue Ribbon City when counted from the introduction of the first non-step

Source: Shiga Central Sightseeing Bus

Fig. 16 Amphibious bus scheduled to enter service at Lake Biwa

Fig. 17 Fuel cell bus exhibited at the Tokyo Motor Show

version.

Isuzu was primarily responsible for the development of this heavy-duty bus also supplied to Hino, which represents the first model integrated from the development stage since the two companies started collaborating on bus production. There is only one variation of the diesel model.

The main characteristics include eliminating the one-step model in favor of a unified non-step structure, the adoption of a plastic fuel tank and the expansion of the non-step floor achieved by switching to a long wheelbase and positioning the priority seat in front of the middle door to face forward. A new package was achieved through features such as a taller cabin behind the middle door. Another distinguishing characteristic is the increased the steering angle obtained by shortening the front overhang, which provides mobility on par with that of one-step vehicles.

The engine is an Isuzu 4-cylinder that uses a 2-stage turbocharger for supercharging with a 5.2 L displacement that drives heavy-duty bus with a GVW of 14 tons. An Isuzu 6-speed AMT has completely replaced the previous manual transmission (MT). Along with the option to choose an AT with a torque converter, this provides a two-pedal layout and automatic shifting on all models. Taking a cue from the Mitsubishi Fuso Aero Star

Fig. 18 Color and white LED destination signs

launched in 2014, it uses discharge headlamps and LED for interior lighting, and includes a folding ramp as standard equipment. In addition, it offers features easy to use in real-world situations such as the installation of fixtures to hold wheelchairs on the body side of raised section behind the middle door.

The two-step model for private use or general sightseeing, available under the Isuzu Erga and Hino Blue Ribbon II names, keeps the 6-cylinder engine and body of the previous model.

4. 4. Heavy-duty buses (hybrid vehicles)

The parallel hybrid Isuzu Erga launched in August 2012 was updated in January and became a late 2014 series (14.5 series) model. This update based on real-world feedback includes the addition of a power mode to the 6-speed AMT and space for one more passenger in the rearmost row of seats achieved by making the systems lighter. In April, the emissions designation for the fuel-efficient vehicle tax reduction was changed from QQG − to QSG − . The body is inherited from the previous generation of the Erga non-step model.

In contrast, Hino Motors, Ltd. launched the Hino Blue Ribbon Hybrid with revamped version of its in-house hybrid system in December (Fig. 13). The base model was mounted on the body of the Blue Ribbon City in March 2014 and put into preliminary operation by some operators. This model, built on a new body, represents the official launch of the vehicle.

The new hybrid system includes clutches between the engine and the motors, making it possible to disengage the engine and drive using only the battery. The hybrid model is equipped with a Hino 4-cylinder engine, combined with a 6-speed AMT also made in-house.

4. 5. Imported vehicles

4. 5. 1. Scania–Volgren articulated bus

The city of Niigata chose an articulated bus with a body made by Australian manufacturer Volgren for the BRT system it is introducing to alleviate traffic conges-

Fig. 19 The Umikaze regular sightseeing bus in the city of Sasebo

Source: Tateyama Kurobe Kanko Co., Ltd.

Fig. 20 Glass roof bus on the Tateyama Kurobe Alpine Route

Fig. 21 Seat grades used in the Hakata Go

tion in the city center. The base chassis is made by Scania, and this will be the first bus made by that company to drive in Japan. Operations will start in September, and currently scheduled to use four buses. Compared to the Mercedes-Benz Citaro G articulated bus imported in the last few years, the fact that it was originally manufactured in Australia, a left-hand traffic country, both its vehicle body width and axial weight are equivalent to those in Japanese vehicle safety regulations (Fig. 14). Other operators are scheduled to introduce this bus, and it is expected to become one of the main articulated buses used in Japan.

4. 5. 2. BYD electric bus (China)

Using the 2014 budget allocated to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) project for green regional transportation through the use of electric vehicles, the local Kyotokyukou Bus started to

Fig. 22 Isuzu Erga/Hino Blue Ribbon

Fig. 23 Light-duty bus limiting passenger capacity in the pursuit of comfort

operate five vehicles in Kyoto in February (Fig. 15). The maker, BYD, is a Chinese company that began as battery manufacturer and developed a heavy-duty electric bus in 2010. Equipped with BYD's in-house lithium iron phosphate battery, it achieves a cruising range of 250 km on a single charge and has been selling well in China, of course, as well as in Europe and the United States.

4. 5. 3. Amphibious buses

The amphibious buses first seen in Japan in 2004 were initially U.S.-made buses, but they subsequently came to be produced in Japan as well. In 2015, a new amphibious bus was imported and operation at and around Lake Biwa was announced, but actual operation has yet to begin. The bus is reported to be made by a manufacturer form the Republic of Malta (Fig. 16).

4. 6. Buses exhibited at the Tokyo Motor Show

A total of three buses, two from Hino Motors, Ltd. and one from Isuzu Motors Limited, were exhibited at the November 2015 Tokyo Motor Show. The Hino exhibits consisted of the Sélega heavy-duty sightseeing bus (a commercial vehicle), which is equipped with a lane departure warning system and a driver monitoring system that monitors the driver's gaze to prevent driver drowsiness, and of a fuel cell bus jointly developed with Toyota.

The fuel cell bus (Fig. 17), presented a barrier-free cabin with color specifications hinting at designer proposals. End user interest was drawn to commercialization that

builds upon the exhibited model.

Technology exhibits included the presentation of systems that detect sudden changes in driver health conditions that make driving impossible and monitor the surroundings to stop the vehicle in a safe place. Such systems combine driver monitoring and automated driving and high expectations are set on their commercialization given the current situation where accidents caused by driver health conditions are actually occurring.

4. 7. New technologies for accessories and devices unique to buses

As stated earlier, there is a constant stream of new unique accessories and devices adapted to the use environment in buses. Some of those introduced in 2015 are described below.

Destination indications are an important information tool for urban buses and are typically film-based or digital destination signs. However, monochromatic signs are also said to lower the level of service, and newly launched destination signs that use color and white LEDs are popular for their high legibility and the amount of information they provide. Color LEDs were first proposed for public transportation in the U.S. in the early 2000s, but they were initially expensive. Similarly, LED lamps have come onto the market as replacement parts for hexagonal halogen headlamps. Driver appreciation of their outstanding nighttime visibility and light distribution has led to their widespread use.

The prevalence of smartphones and other portable devices has increased the need for the ability to recharge those devices, and the installation of USB ports in the seats of inter-city expressway buses and sightseeing has become notable. Efforts to provide Wi Fi access in buses are also moving forward.

In a different vein, the occurrence of accidents caused by driver health conditions has prompted growing interest in wearable sensors that monitor heart rate and other parameters, some operators have already started to use such sensors.

Design Trends

1 Buses manufactured in Japan

1. 1. Vehicles introduced by operators

There are examples of bus operators introducing new vehicles to respond to diversifying customer needs as well as to differentiate themselves. In all cases, the scope is limited to modifying commercial vehicles, and the following sections introduce a few of the vehicles introduced in 2015 that embody new market needs.

As a one-time vehicle, the city of Sasebo has introduced dedicated sightseeing bus following a regular route within the city. It is a remodeled aged vehicle, and the designers brought out their talent to produce a vehicle brimming with originality that makes the bus evoke a cruise ship (Fig. 19).

A bus with a glass roof in a raised portion of the ceiling has been manufactured for the Tateyama Kurobe Alpine Route, popular in the spring with tourists for its 20 m high snow walls formed by snow removal operations (Fig. 20).

The Hakata Go night bus between Tokyo and Fukuoka, known as Japan's longest route, has introduced a new vehicle featuring three grades of seats, including private booths with four seats (Fig. 21).

1. 2. Mass production vehicles

As stated earlier, a unified Isuzu and Hino urban route bus model has been fully redesigned.

Since the two companies combined hold over 60% of the Japanese heavy-duty urban market for new vehicles, the design changes have a considerable impact. As with development, design was the responsibility of Isuzu. This is the first full redesign of the previous model in 16 years. Enlarging the non-step area while retaining the mobility of a one-step bus resulted in unique proportions involving a long wheelbase and a short overhang (Fig. 22).

At the same time, creative manufacturing elements such as the sense of flushness between the body and the window glass produce results not found in pas Japanese-made buses and contribute to the new package. In contrast, highly-rated aspects of the previous model, such as the handling of headlamps as character lines, the destination sign, and the rear window balance stand out as concepts carried over from the previous generation. The headlamps that used to make it possible to tell the Isuzu and the Hino apart no longer differ. The sliding middle doors that affect the effective width on the cabin were retained, but new proposals that also respect the trust

Fig. 24 Irizar i8

Fig. 26 VDL Futura FDD2

Fig. 25 Neoplan Skyliner

Fig. 27 Ayats double-decker bus

placed in that type of door by bus operators are also expected to be presented in the future. Based on the model, the previous generation Erga body is also produced in parallel, but the bodies are expected to eventually be unified.

The number of vehicles is currently minimal, but there is a new trend of setting up light-duty buses that are mainly intended for inbound tourists and reduce passenger capacity in favor of greater comfort (Fig. 23).

2 Design of Buses Manufactured outside Japan

This section presents a few of the buses that made their debut at specialized bus exhibitions in 2015.

2. 1. Irizar i8

Irizar, who designed the body of the Scania flagship PB sightseeing bus whose bold body style drew attention, independently developed a new bus with an integral structure. A super high decker with a total vehicle height of 3.8 m, its styling design emphasizing pragmatism is powerful but does not have quite as much impact as the debut of the PB did. Nevertheless, elements such as the edge of the door wrapping over the outer panel, and the craftsmanship that completely conceals the mechanical functional components illustrate the lavish attention paid to the smallest details (Fig. 24).

Fig. 28 Van Hool double-decker bus

2. 2. Designs seen in double-decker buses for touring

Buses essentially have the proportions of a box, and the securing of aerodynamic characteristics and cabin capacity determines their exterior design. In addition, bus have a much longer model life cycle than passenger cars, and are produced in overwhelming lower numbers. Under such conditions, especially for assets of the scope of a sightseeing vehicle, diligently acquiring market share based on vehicle attractiveness is achieved through the product appeal imparted by styling. Within that category, double-decker buses, although few in number, are flagship products into which the manufacturers who supply them pour considerable energy.

The Neoplan Skyliner, whose allure lies in its dynamic styling, markets itself based on the elegance of that styling rather than cabin capacity and its unique window

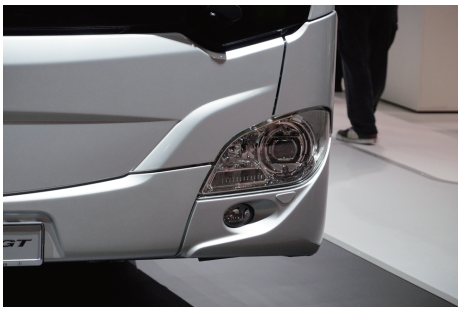


Fig. 29 Mercedes-Benz Citaro

Fig. 30 External appearance of Businova

Fig. 31 Interior appearance of Businova

graphics express the majesty of double-decker buses (Fig. 25).

The VDL Futura FDD2 is the successor to the company's Synergy. Touting its high seating capacity as a selling point, the Futura emphasizes its identity through its boxy body and the design applied around its headlamps. The flush body and glass are beautiful, and the design of the various sections, as well as the craftsmanship, are also highlights of the model (Fig. 26).

Although it has no connection to Japan, the Spanish Ayats, one of the few double-decker bus manufacturers in Europe, also makes use of window graphics to make the second level passenger cabin appealing, but they somewhat tend to the commonplace (Fig. 27).

Van Hool of Belgium also boasts an impressive double-decker bus track record. It has already finished the

Fig. 32 BYD double-decker bus for London

Fig. 33 Example of light-duty sightseeing bus

change of generations from the T9 to the TX (T10) series, with double-decker buses also becoming part of the TX series. Their design remains rather conservative (Fig. 28).

Since the easing of length restrictions in Europe, 12 m vehicles are in the minority, with lengths of about 12.3 m for two-axle buses or about 14 m for three axle buses dominating the market.

2. 3. Mercedes-Benz Citaro

A cumulative total of well over 40,000 units have been produced for this best-selling urban bus since its launch in 1997. It has maintained the same package while accumulating improvements to the components as it underwent facelifts of its frontal area. In the 2015 model, the headlight parts have been changed to give a sharper impression (Fig. 29). Expressing character through a solid form is another trend in European urban buses.

2. 4. Businova

This prototype French urban bus has a unique auxiliary three axle layout that compensates for the increased weight of the hybrid components behind the rear wheels. Although it has a non-step structure, the high floor low entry structure on the rear side of the middle doors provides a separate space from the front of the vehicle where a glass ceiling creates an interesting pergola-like cabin (Figs. 30 and 31).

Fig. 34 Example of light-duty urban bus

Fig. 35 Karsan Jest

2. 5. Double-decker electric buses

Standard recent red London double-decker buses are hybrid vehicles, but new electric buses have come onto the scene, and a plan for their full-scale introduction has been announced. The model unveiled in autumn 2015 uses BYD-made components, and the body was conceived by the reputed U.K. manufacturer Alexander Dennis. It has an orthodox design without any visible mark to highlight the fact that it is an electric bus (Fig. 32).

2. 6. Ideas for light-duty buses

Japanese-made light-duty buses are box-like despite having a front-mounted engine, and their silhouette parallels that of heavy-duty buses. As already noted, South Korean and Chinese light-duty buses follow the same proportions as Japanese buses, while in Europe, the approach of remodeling bus bodies and setting them on semi cabover multi-purpose commercial vehicle chassis with a hood predominates. Based on the existence of numerous body remodeling contractors, buses cover a broad range of specifications and prices, including vehicles for tours in small groups and urban buses in low-demand areas, providing important markets for those contractors. Chassis manufacturers have also started to establish dedicated subsidiaries to incorporate the work of the remodeling contractors.

A light-duty bus for touring made distinct by the complex curved window graphics drawn by a designer (Fig. 33) and a light-duty urban bus with similarly bold window graphics (Fig. 34) are presented as examples of products by independent remodeling contractors. Both are built on a Mercedes-Benz chassis.

In Turkey, where a large proportion of buses are light- or medium-duty buses, the Karsan Jest, built to drive on the narrower secondary roads leading to the main roads, is selling strongly. It has an orthodox front engine layout, and likely drew inspiration from the functionality of compact vehicles. In 2015, Karsan succeeded at obtain orders from the U.S. for buses that will apparently be used for services such as transporting elderly people living in suburban areas to and from the hospital. This vehicle was first exhibited at international bus shows in 2013, and promotions at such events has clearly led to business opportunities (Fig. 35).

3 Regulatory Trends

While the impact on design is indirect, efforts to make thinner vehicles in the wake of Western European nations-led modernization of buses are being carried out in Eastern European countries, countries around Russia, the Middle East, China, Africa and other regions. Despite considerable variation in emissions regulations for engines, formerly mainstream older high-floor urban buses are being replaced by non-step buses where the floor remains level all the way to the back of the bus. Consequently, not a few countries treat modern urban buses as a symbol of a developed city. This has been supported by the fact that the approach of procuring existing advanced components and assembling modern buses in a short time at a low cost has become commonplace.

It must also be remembered that, for many years, those countries and regions served as the main export destinations for Japanese-made buses. In Japanese urban buses, not only the engine, but also components such as the transmission and axles are, for all intents and purposes, built in-house, and situations where the support of bus operators have established low-entry buses with drum brakes as a standard specification are already a rarity at the international level. As an example, even in Taiwan, where Japanese-made buses have maintained a large market share, non-step buses consisting of a Chinese-made body remodeled to fit a European-made chassis with European-designed components are rapidly gaining market share, highlighting how conditions are

changing.

4 Conclusion

The Japanese bus industry currently seems unable to find the flexibility to open up long-term technological prospects as it cannot expect the number of transit bus passengers to rise and is struggling with the immediate issue of coping with the vigorous demand for charter buses. With the approach of the 2020 Olympic and Paralympic Games, the industry also faces government expectations that it will actively attract inbound tourists and contribute to the economy. In that context, the public transportation sector is making efforts to provide information in multiple languages via information terminals, but there are concerns over delays in preparing the necessary infrastructure. Unlike lodging facilities, traffic issues cannot be resolved simply by increasing capacity. Although a single event qualifies a crisis, there should be value in assessing these issues as part of a long term social plan. The early establishment of the Basic Act on Transport Policy has not been followed up with concrete actions.

In contrast, for local authorities faced with depopulation and the aging of their population, public transportation is becoming an increasingly important policy issue. For buses, public operation, which is considered a high cost approach, is being privatized, and in 2015, the cities of Kumamoto and Komatsushima discontinued their public bus operations. However, given the role of buses as a tool for daily life makes them a public service, it is difficult to make individual bus operators responsible for tasks such evaluations of environmental burden This is another reason that underscores the need for clear government policies on the status of buses.

On a different front, the U.S. and Europe are studying next-generation energies as well as evaluating the role of public transportation as part of urban planning, and those assessments are taken into consideration during technological development by bus and component manufacturers. Will the new energy urban buses by hybrid vehicles? Electric vehicles? Fuel cell vehicles? Will urban infrastructure build a new hydrogen society in counterpoint to the currently prevalent electricity? The choice will prove extremely strategic.

Thinking in terms of the globalization of automotive technology and competitiveness in international markets, the need to determine the when, what, and which time frame of necessary technologies, and establishing a process to do so, is undoubtedly a major issue separate from the need to cope with immediate demand.