Buses

Overall Trends

1 Introduction: Social Trends Affecting Buses

Since marketability and social issues go hand in hand with technological trends in buses, this article first surveys the conditions that affected buses over 2014.

1. 1. Buses and the Basic Act on Transport Policy

Buses, in essence, are vehicles that economically transport people. They trade the freedom of individual movement afforded by passenger vehicles for cost efficiency, and are subject to strict evaluation as production goods. Their assigned role of conveying people is a fundamental difference with trucks, another type of production goods. At the same time, as vehicles, they are expected to comply with the safety standards under the Road Trucking Vehicle Act, and the introduction of vehicles not provided for under that Act often faces significant hurdles. Since they also carry many lives, the social impact of a single accident is high, and buses are therefore subject to high-level safety requirements.

As production goods meant for the collective transport of people, buses do not enjoy a particularly large market scale, putting them in a special position in today's automobile industry, where mass production is a given. Their primary function of public transportation has seen some renewal with the establishment of the Basic Act on Transport Policy in November 2013.

This law places the onus for instituting policies that enable travel necessary for daily life or social activities on the national government, and can be said to represent the first official national recognition of the importance of public transportation. In Japan, public transportation has long been the purview of transport operators. Although this presented no problems while the number of users continued to rise, many regional transport operators are currently bemoaning the drop in the number of passengers carried, who constitute the backbone of their business operations. It is also clear that the population decline will continue. The contents of the legislation thus cover a definition and discussion of what form public transportation should take that has been long awaited by the industry.

As of 2014, concrete steps will be taken as part of the Basic Plan on Transport Policy, which sets advanced transport node functions such as ensuring public transportation punctuality and improving transit speed, guaranteeing comfort, and enabling smooth connections.

Vehicles used in public transportation include trains, trams and buses. In the U.S. and Europe, these modes are typically chosen based on transport capacity and cost, leading to active initiatives on the part of industries that treat public transportation institutions as a single entity. In Japan, by contrast, trains and automobiles, or travelers and cargo, for example, have a history of clearly being handled separately by the legislation, and the establishment of a basic policy on transport itself is a national first. Creating cross-functional policy proposals and system designs may take time. Even for the automobile industry, nothing other than buses comes to mind

Fig. 1 Will ultra-compact vehicles threaten buses some day?

in terms of a relationship with public transportation institutions. The need for efficient city building imposed on the transit of people itself as the declining birth rate and aging of the population become more pronounced, as well as coordination with the compact city and smart city urban development concepts that also address the protection of the environment represent some of the considerations that prompted the Basic Act on Transport Policy. Put another way, expanded public transportation will foster both the reduction of social costs and greater public convenience. In that sense, ultra-compact vehicles (Fig. 1), which are expected to ensure freedom of travel for the elderly, are very likely to play a role as a local means of transit despite being at the opposite end of the spectrum from buses in terms of both size and shape. Once the social cost efficiency axis of evaluation starts being applied to vehicles that transport people, closer attention will be given to the division of roles for those two types of transport. If, for example, ultra-compact vehicles come to be used for short-distance travel, such as hospital visits by the elderly, the considerable threat this would pose to local transit bus operators is easy to envision.

1. 2. New fare and pricing system for charter buses

A new system for charter bus fares and pricing was established in 2014

There have been regulations on charter bus fares and pricing in the past. However, separate time-based fares for cruising time or waiting time at visited locations added as separate fees to distance-based fare systems covering actual driving with passengers on board led to confusing calculation methods, and business was often conducted using prices based on experience. This naturally led to large price differences based on factors such as the influence or track record of the travel agency placing an order, creating a situation where the fares defined by the system were devoid of substance.

At the same time, since the supply-demand adjustment regulation was abolished in 2000 -- a form of deregulation -- the number of small-scale operators with few fixed costs has surged, and price competition has intensified. Given the nature of charter bus operation, the specifics of the work changing from one day to the next is par for the course, which means extensive experience is required of bus attendants. This was also part of operator know-how and strongly affected the trust relationship with travel agents. However, the price competition that followed the easing of regulations has driven profits down, leading to many cases of experienced charter bus operators closing their doors, and concerns over safety have been raised as low-cost small-scale operators stepping in to fill the vacuum have become prominent. The new system to ensure appropriate fares and pricing arose to address these circumstances.

As a result, it has become more common for charter bus fares paid by consumers to be equal to travel fares, and bus operator sales figures are on the rise. Operators have started to note that the new system makes it easier to plan vehicle purchases, a trend notable as the vehicles used for inbound tourism by the new small-scale operators are being gradually replaced. In terms of environmental protection and safety, the renewal of these vehicles is a welcome step.

Although there are expectations that the reasonable sales figures resulting from the new system will lead to greater safety and become reflected in labor costs indirectly producing a similar effect, the approach of leaving such investments up to operator intent remains unchanged from the previous system.

1. 3. Responding to the rising number of foreign tourists

Figure 2 shows how the number of visitors to Japan has shifted since the launch of the Visit Japan Campaign in 2003. Despite decreases corresponding to the global financial crisis and the Great East Japan Earthquake, an overall upward trend can be observed and, helped by a lower exchange rate for the yen last year, the number of visitors in 2014 rose to 13.41 million (interim figure) from 5.21 million in 2003. In 2003, the top regions of origin were South Korea, Taiwan, the U.S., China, and Hong Kong, with the order changing to Taiwan, South Korea, China, Hong Kong and the U.S. in 2014. Assuming a 2003 baseline of 100, the increase in the number of visitors from China to 537 for 2014 stands out. While there are certainly individual visitors, a large number of tourists come in groups and make use of charter buses. This is leading charter bus operators who focus primarily on inbound tourists to augment their fleets. With the anticipated continued rise in the number of visitors as the 2020 Olympic Games approach, charter bus operators throughout the country are making plans to replace and add vehicles, pushing up bus production volumes.

1. 4. Electric bus commercialization is underway

The transit buses that handle urban public transporta-

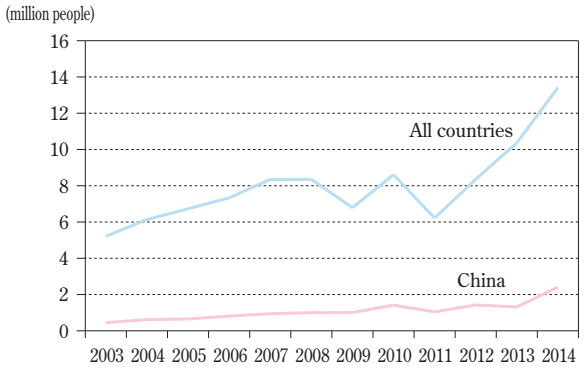


Fig. 2 Visitors to Japan

tion are intrinsically tied to environmental issues, while technological issues and courses of action are linked to administrative policies. In terms of resources and environmental protection, the U.S. and Europe have adopted a systematic approach where organizations in the public transportation industry as well as bus and component makers, are coordinating with administrative authorities and research institutions to deploy new technologies, and a course of action is gradually becoming clear. In that context, some makers have started making plans to eventually cease or drastically reduce the production of buses equipped with pure diesel engines. In Japan, current practice is limited to individual makers working with local authorities and research institutions to advance research and development. With the exception of a few CNG models and light-duty buses with gasoline engines, the overwhelming majority of vehicles are equipped with diesel engines, and in terms of number of units, diesel-electric vehicles cannot be regarded as mainstream.

Nevertheless, from the standpoint of community building that makes use of environmentally-friendly vehicles such as hybrid or electric vehicles, which have little impact on the environment, the Ministry of Land, Infrastructure Transport and Tourism is promoting a project for green regional transportation through electric vehicles. With the goal of reducing CO_2 emissions in mind, the project aims to make electric vehicles more widespread within specified regions given their low environmental impact. For buses, it also includes a framework to subsidize half of the costs of acquiring vehicles and setting up charging facilities.

In the spring of 2014, electric bus business operations benefiting from the 2013 budget got underway with five

Fig. 3 Heavy-duty electric bus made by South Korean HFG

Fig. 4 The charger for the South Korean HFG electric bus does not use CHAdeMO

Fig. 5 Mie Kotsu heavy-duty electric bus

vehicles on duty at four locations in Japan. All of the vehicles are equipped with a lithium-ion battery and perform rapid charging between trips. Four of them are heavy-duty vehicles, with three imported from South Korea (Fig. 3), and they represent the first vehicles designed exclusively for the mass production of electric buses. Charging stations (Fig. 4) are set at the bus depot and along the bus route. The remaining two vehicles, one heavy-duty bus (Fig. 5) and one medium-duty bus (Fig. 6) are newly manufactured Japanese diesel engine buses refitted as electric vehicles by makers specializing

Fig. 6 East Japan Railway Company medium-duty electric bus

in such conversions

The budget for this project extends to the 2014 and 2015 fiscal years, and the launch of more electric bus operations is also planned for the spring of 2015 and 2016.

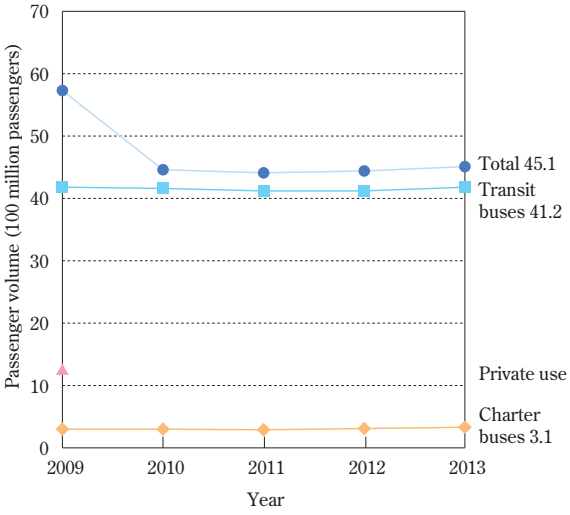
2 The Bus Industry in Statistics

2. 1. Passenger numbers

The number of transit bus passengers in 2013 was 4.176 billion, an increase of approximately 5.1 million, or 101.2%, over the previous year. Despite increasing for two consecutive years, the number of transit bus passengers has yet to return to 2009 levels. While the bus industry as a whole engages in initiatives to enhance the convenience of transit buses, the decline of the population is just one factor that requires continuing to keep a close watch on whether the increase in the number of passengers will take on a tangible form.

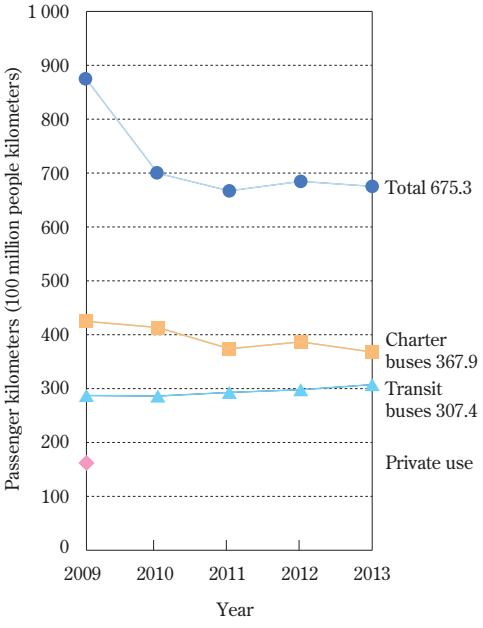
Similarly, the number of charter bus passengers rose smoothly in 2013, reaching 329 million, or 111% over the previous year. Along with the previously mentioned increase in the number of visitors to Japan, these figures provide a glimpse of the growing vigor of charter bus operations targeting inbound tourism. The latest figures on chartered vehicle ownership were not available at the time of writing, but based on the overall increase of around 1% in the number of vehicles from 2011 to 2012, an impressive rise in the individual vehicle operating rate can be surmised (Fig. 7).

Passenger kilometers (Fig. 8), which indicate the distance actually travelled by bus users directly reflects the rise in the number of passengers, and shorter distances traveled per passenger explain the overall decrease. Tying in with the new expressway bus system from the previous fiscal year, these shorter per passenger distances are attributed to the greater difficulty of organizing long-distance bus tours arising from the upper limit on the distance a single driver is permitted to drive in a day introduced to ensure the safety of charter buses.



＊Private use buses were excluded from the survey in 2010

Fig. 7 Passenger volume (number of passengers)



＊Private use buses were excluded from the survey in 2010

Fig. 8 Passenger volume (passenger kilometers)

2. 2. Market trends -- production and registration

As production goods restricted in application, buses enjoy a stable customer base while being free from major fluctuations in demand, but at the same time, barring a sudden increase in the number of passengers, the cannot expect a significant increase in production volume. Bus production and bus registrations in Japan are shown in Figs. 9 and 10, respectively. The industry is recover-

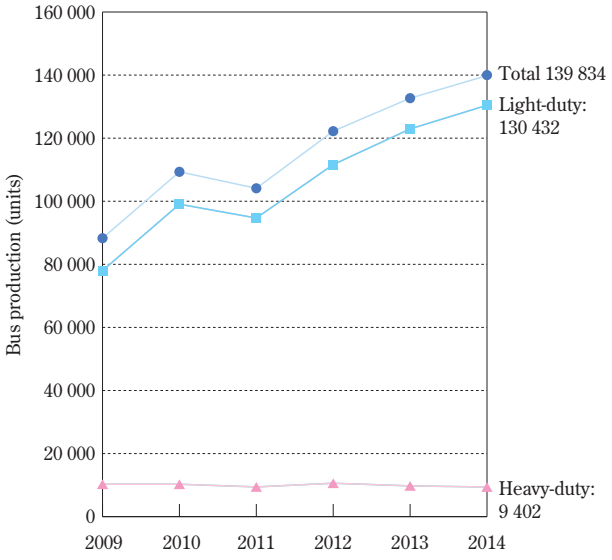
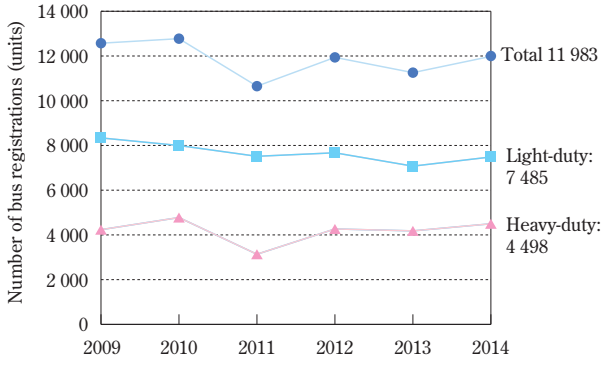


Fig. 9 Bus production in Japan



Note 1: From 2003, statistics were collected based on the license plate number registration category rather than according to chassis (excluding mini-vehicles)

Fig. 10 Number of bus registrations in Japan

ing from the downturn caused by the Great East Japan Earthquake and is exhibiting a slight upward trend.

Although the market was quiet on the environmental regulations front in 2014, rush demand was triggered by the revision of the tax system (amendment of the consumption tax). Other initiatives include the grant of a national government subsidy package to Okinawa, where the non-step bus adoption rate lagged behind the national average, allowing the purchase of 40 non-step buses. This is part of the fiscal 2012 (with delivery and operation started in spring 2013) 5-year plan that calls for a total of 200 vehicles. The 317 vehicle increase over the previous year in the number of heavy-duty bus registrations in Japan for 2014 indicates that, for buses, such political measures have a not inconsiderable effect on statistics.

In addition, the growing numbers of visitors to Japan is also starting to affect the production volume of charter buses. Vehicle orders by operators targeting inbound tourists rose to the fore in the latter half of the fiscal year, and production lines are thriving. All of this is expected to be clearly reflected in the fiscal 2015 statistics.

2. 3. Imports and exports: no significant change, but...

Figures 11 and 12 show the number of exports and main export destinations. While international affairs and the exchange rate strongly affect bus exports, 2014 did not exhibit any major changes or new trends compared to previous years. Light-duty front engine buses lead exports, with Asia, Africa, and the Middle and Near East as the main markets. For many years, this class of buses was the exclusive province of Japanese manufacturing. Recently, however, lower cost Chinese- and South Korean-made models that use Japanese-made light-duty buses as a benchmark are emerging, and such models are expected to affect future exports. In addition, the latest light-duty bus needs of existing destination markets will have to be addressed.

Heavy-duty bus exports consist primarily of component kits. Although there have been attempts to export completed vehicles to right-hand drive regions, the strong demand among operators in the various destination countries for fully low-floor urban buses that are fully low-floor or articulated makes for markets that restrict the product appeal of Japanese-made buses.

There was a time when completed vehicle exports flourished and made inroads in markets outside Japan, the cost of exporting such vehicles was considered an impediment and exports shifted to local assembly. On a global scale, however, completed vehicle exports are still going strong, and few bus manufacturers target only their own domestic market.

In fact, a look at bus imports (Fig. 13) makes it clear that they have been rising incrementally every year since 2011. Articulated buses and heavy-duty electric buses, which Japanese manufacturers do not produce, are complementing steady imports of South Korean sightseeing buses. Given the declining range of product selection for Japanese-made buses, it is highly probable that bus imports, which also encompass vehicles unavailable in Japan such as double-decker buses, will continue to increase.

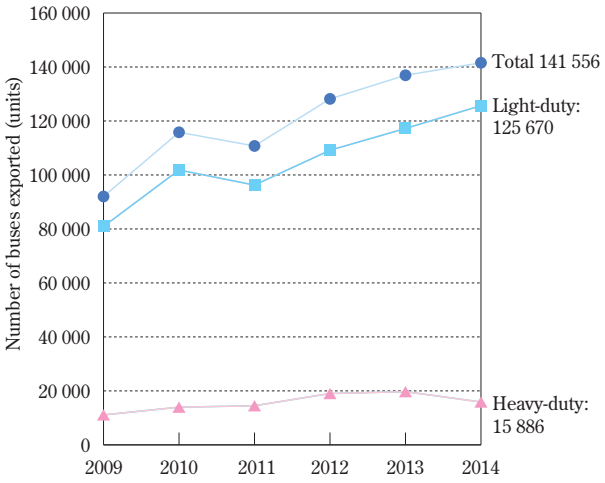


Fig. 11 Bus exports

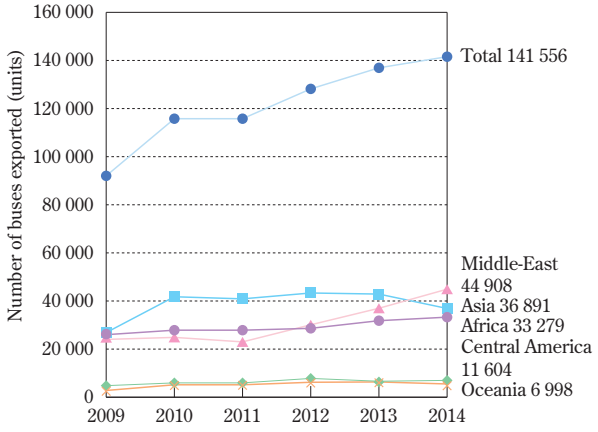


Fig. 12 Main export destinations

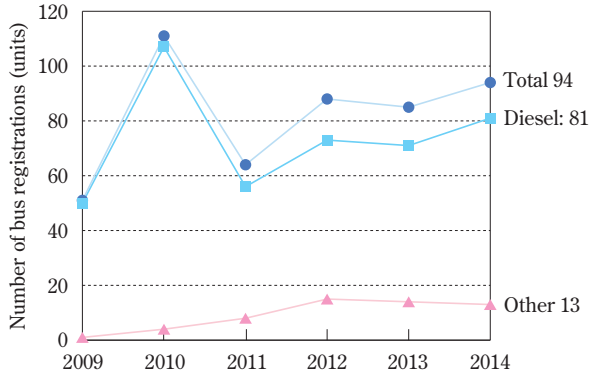


Fig. 13 Number of imported bus registrations

3 Regulatory Trends

The new standards for collision damage mitigation braking systems came into effect in November 2014. Also, the new standards on lane departure warning systems that will be applied starting in August 2015 also cover Japanese-made buses, and compliant vehicles were gradually launched in 2014. They will be introduced in the section on new vehicles.

Fig. 14 Hino S'elega QRG vehicle

New vehicles meeting the heavy-duty vehicle fuel economy standards +10% incentive introduced as part of fuel-efficient car tax reduction measures have been launched, making them eligible for the vehicle acquisition and motor vehicle weight tax exemptions for new vehicle purchases. Considering their high vehicle price, the tax exemption amount strongly increases the appeal of buses.

Stricter seat safety requirements based on harmonization with the EC have been incorporated not only in standard products by makers, but also in seats built to original specifications whose development costs were borne by the operators, and there are already buses equipped with such seats in operation.

4 New Buses

4. 1. Light-duty buses

There were no new light-duty bus models in 2014.

4. 2. Heavy-duty buses

Several new heavy-duty bus models were introduced, and are presented below in chronological order.

In March, enhanced control in the E13C engine improved the fuel efficiency of the Hino S'elega and Isuzu Gala. Combined with the vehicles equipped with the A09C engine that had already met the 2015 fuel economy standards + 10% level, this means all vehicles have now achieved that value (Fig. 14). These vehicles also feature a new function to avoid collisions with other vehicles in congested traffic or other low speed conditions in addition to a collision damage mitigation braking system. Lane departure warning systems and driver monitoring systems that monitor the driver's gaze and help prevent

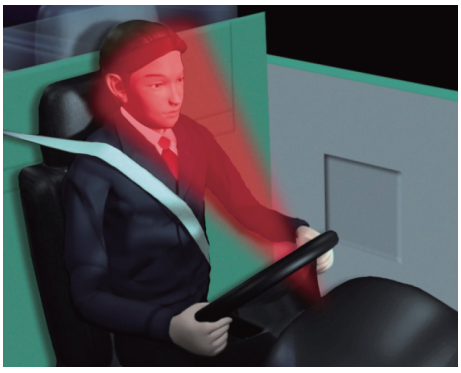


Fig. 15 Driver monitor used by Hino

Fig. 16 Hino Blue Ribbon Hybrid undergoing monitor driving in preparation for market launch

Fig. 17 Mitsubishi Fuso Truck and Bus Corporation Aero Star

Fig. 18 Mitsubishi Fuso Truck and Bus Corporation Aero Ace QRG vehicle

driver drowsiness (Fig. 15) have also become standard equipment. These safety systems have also been added to the S'elega and Gala models with an overall length of 9 m, as well as to the S'elega Hybrid.

April saw the unveiling of a prototype Hino Blue Ribbon City Hybrid that combines a new hybrid system with an electronically controlled automatic transmission (ATM). Monitor operations have begun. The new system changes the order of the clutch – motor – engine arrangement to motor – clutch – engine. At take-off, the clutch can be disengaged and the motor driven, and while accelerating, they can run in parallel. Monitor operations schedule for one year have begun at the Transportation Bureau of the Tokyo Metropolitan Government and Tokyu Bus Corporation. The model is a modified LNG-HU8JLGP (Fig. 16).

In June, Mitsubishi Fuso Truck and Bus Corporation launched a new Aero Star model. This is the first Japanese-made urban bus to feature discharge headlamps. It adopts a plastic fuel tank, extends the non-step floor ahead of the middle door, and offers the forward-facing priority seats that operators had been clamoring for. A folding ramp to assist boarding by wheelchair users has become a standard feature (Fig. 17).

Mitsubishi Fuso Truck and Bus Corporation made safety systems such as collision damage mitigation brakes and the MDAS-III driver alertness monitor, as well functions to enhance comfort such as a plasma cluster ion generator, standard equipment on the Aero Ace short body type MM in August.

In September, Mitsubishi Fuso Truck and Bus Corporation replaced the VG turbo in the 6R10 engine mounted in the Aero Queen and Aero Ace models with an asymmetric turbocharger. This improves reliability by applying the same modification as in the company's heavy-duty trucks. In addition, an electronic variable-flow water pump enhances cooling efficiency and reduces drivetrain loss. As with the above-mentioned MM, a plasma cluster ion generator has become standard equipment. Product appeal has been boosted through the adoption of LED for interior, side marker, and other lights.

1 Buses manufactured in Japan

There were no new designs in Japanese buses over the last two years, with the sole exception of the facelift given to the Mitsubishi Fuso Truck and Bus Corporation Aero Star.

Making it first urban bus to be equipped with discharge headlamps, which have been standard on sightseeing buses that often drive on expressways, provided the impetus to revamp its front face design. The light-duty truck headlamp unit was chosen in light of mass production efficiency considerations, and, despite being subject to many restrictions, its design embodies the corporate identity while achieving a distinctive freshness (Fig. 1). At the same time, the outstanding improvement in nighttime visibility is highly appreciated by urban bus drivers. Preparations for retrofitting to existing vehicles have been completed. Moreover, standard headlamps are about to become LED-based, a welcome move in terms of enhancing the safety and reducing the fatigue of urban bus drivers during nighttime driving.

Fig. 1 Mitsubishi Fuso Truck and Bus Corporation Aero Star

The Aero Star has now also features a folding ramp to assist boarding by wheelchair users as standard equipment. Folding ramps started coming into widespread use in Europe over 10 years ago, but in Japan, powered or removable ramps are more common. Both wheelchair uses and the drivers who operate it will welcome the ramp's greater ease of use (Fig. 2).

Fig. 2 Folding lamp on the Aero Star

2 Design of Buses Manufactured outside Japan

Various specialized bus exhibitions are held worldwide, and bus manufacturers from all over the world present new models at each of those important markets. The large number of manufacturers means many types of new models were released, and this section presents the designs that stood out among the new urban buses unveiled in 2014.

2. 1. Solaris Urbino

The new Urbino model by Solaris drew attention as the vehicle with the most radical design. Founded in 2001, Solaris Bus & Coach S.A. is a bus manufacturer that originated as a Polish plant building Neoplan buses under license. In a short time, it has acquired a large market share not only in its own country, but also in various cities throughout Europe. Both its flexibility with regard to components trusted by customers and its original design have contributed to its success. The asymmetric front styling tailored to left-hand drive vehicles is characteristic of the company.

Premiering at the 2014 IAA, the new Urbino model -- an ordinary urban bus -- caused a stir with a styling that makes it look as though it had come out of a movie where robots transform into vehicles. It could be described as the design sketch itself coming to life. Other designers around the world are probably also drawing such sketches, but typically, the premise of creating a commercial product leads to incorporating the opinions of people in various positions, resulting in a final design that strikes a happy medium and errs on the side of caution. Solaris management appears to realize such stylish buses driving around the city, will turn the heads of children walking along the road, who in turn will pester

Fig. 3 Solaris Urbino

Fig. 4 Anadolu Isuzu Citiport

their parents to let them ride those buses. Some people might attribute this to the company being up and coming. Nevertheless, this kind of impact in urban buses is a welcome breath of fresh air (Fig. 3).

2. 2. Anadolu Isuzu Citiport

The Turkish automaker Anadolu Isuzu, as its name implies, is a joint venture between Isuzu Motors Ltd. and Anadolu Group. The buses it manufactures use Isuzu medium- and light-duty truck engines, and the company forte has been light-duty buses, which represent a large market in Turkey. With European manufacturers recently establishing plants in Turkey, Anadolu Isuzu developed a full-size urban bus with an eye to bringing Turkish buses to the European market. As the three-door specification suggests, the engine and auxiliary devices are offset to the left in the direction of movement in a stacked layout, enabling the low floor to extend all the way to the rear of the interior. A Cummins engine was chosen since Isuzu does not manufacture Euro VI compliant engines large enough for urban buses. Design-wise, it follows the trend that calls for switching to window graphics (Fig. 4).

2. 3. New Routemaster operated by London Buses

The most famous bus in the world is probably the red double-decker, a dominant and intrinsic London icon.

Fig. 5 Next-generation bus in London

Fig. 6 Van Hool EX

While single-decker buses can also be seen recently, the AEC Routemaster is the bus that has enjoyed absolute local trust. Although, as might be expected, mass production vehicles by various makers have been used in the almost half a century since it went out of production, a next-generation model that would become the symbol of London some 20 to 30 years down the road was planned. The first model debuted in May 2010 after a competition calling for a future-oriented style that would not become obsolete. The U.K. approach is to take ample time to move from prototype to mass production. In 2014, over 300 vehicles entered service and are starting to make their presence felt in London. The bus, manufactured by Wrightbus, is a hybrid diesel-electric bus with a Cummins engine (Fig. 5).

2. 4. Interior and equipment

Multi-displays with color LCD screens that provide information on vehicle and driving conditions are commonly installed around the driver's seat in urban buses. Vehicles with many doors, such as the those used in BRT systems, also show images from cameras set to ensure safety near the door when passengers get on or off at stops, and that screen blacks out when the vehicle is

in motion to allow the driver to concentrate on driving. In BRT vehicles with a large passenger capacity, one significant difference compared to Japanese buses is the general isolation of the driver's seat from the passenger area, which frees the driver from having to deal directly with customers. In the sightseeing bus segment, the Van Hool EX (Fig. 6) which features a simple design and whose development was prompted by the establishment of a new factory in Macedonia to maintain competitiveness in low-cost markets is a new entry, but beyond that, changes are limited to the installation of skylights over the aisle in some high-grade sightseeing buses. Intended to bring novelty to long distance bus trips, the skylights share similarities with the popularity of open top buses in Japan, but overall, this segment does not offer as many new topics as the urban bus segment.

Bus Body Structures

1 New Buses

Moving away from the new buses by chassis manufacturers discussed under general trends, this section covers vehicles adopted by local operators.

1. 1. Electric buses

In March 2014, the operation of heavy-duty electric buses mentioned earlier got underway in Kitakyushu (two vehicles) and Satsumasendai (one vehicle). The buses are completed vehicles by Hankuk Fiber (HFG), a South Korean manufacturer (pictured earlier) introduced in Japan for the first time, and are operated by the Kitakyushu Transportation Bureau and Nangoku Kotsu, respectively. The style reminiscent of a peanut shell seen when this model was first announced in South Korea has been changed to a more commonplace style for the vehicles brought to Japan, and the body itself is characterized by its extensive use of carbon fiber. The Japanese company Toray Industries is said to have provided technical cooperation. Among so-called plastic-base buses, the Neoplan Carbonliner commercialized in the 1990s is still in people's minds. It was touted as a light, durable and highly repairable heavy-duty urban bus. HFG chose to use plastic to make the vehicle lighter, and achieved a weight reduction of over two tons compared to vehicles made with steel. The difference is allocated to the mounted battery.

Raising the capacity of the mounted battery guarantees a certain cruising distance on a single charge. The vehicle is equipped with a 90 kWh capacity Mitsubishi Heavy Industries lithium-ion battery and can drive approximately 80 km (40 km if the air conditioner or heater is used) on a single charge. The operators are recharging the vehicles slightly more often to match their schedules, and estimate that the cruising distance is roughly 50 to 60 km. Although they required some modifications to adapt to the Japanese driver-only approach, these buses have underscored the need to reduce body weight in Japanese-made buses. Even for diesel-powered vehicles, lighter bodies bring significant advantages.

Fig. 1 Osaka Bus high-deck open-top bus

Fig. 2 Joint Scania - Volgren articulated bus

In contrast, Mie Kotsu introduced a vehicle based on the Isuzu LV heavy-duty urban bus remodeled by Flat Field. The engine was removed and a Toshiba battery (66 kWh capacity) was installed. The vehicle is motor driven and has a cruising distance of approximately 50 km per charge. Issues that such modifications have to solve include the need for creative approaches to mounting the battery pack into a body structure designed for a diesel engine, and the limit on battery capacity imposed by vehicle weight constraints.

On a similar note, the East Japan Railway Company started operating a medium-duty electric bus based on the Isuzu LR, which was remodeled by Tokyo R&D. The bus was fitted with a Mitsubishi Heavy Industries 65.12 kWh lithium-ion battery, and rapid charging is performed after every run (22 km).

Despite expectations of innovation in electric bus designs due to the fact that no engine or cooling system is needed, the extra space is typically allocated to expanding the passenger compartment and even on a global scale, styling unique to electric buses is nowhere to be seen.

1. 2. Open-top buses

In 2013, a Japanese-made double-decker bus remodeled as an open-top bus drew attention and its popularity with users led the West JR Bus Company to launch double-decker open-top buses in Hiroshima in 2014. Osaka Bus also introduced a high-deck open-top sightseeing bus (Fig. 1). Unlike double-decker buses, it is not limited in terms of roads it can use and is bargaining on that versatility to spread its popularity. The number of vehicle body makers with open-top conversion experience is also increasing.

1. 3. Articulated buses

In 2014, Gifu Bus procured two additional articulated buses which, like other recently imported articulated buses, are Mercedes-Benz Citaro Gs. Moreover, articulated buses compliant with the latest emissions regulations (Euro VI) and featuring a width of 2.5 m or less and a rear wheel (3rd axle) weight of 10 t or less, which combine a Scania chassis with a body made by Australian manufacturer Volgren, will be acquired by Niigata City, which is introducing a BRT system to improve the traffic situation in the city center. A picture of the bus has been released (Fig. 2). Operations are scheduled to start in August 2015. The range of options for Japanese operators planning to introduce articulated buses is broadening.

1. 4. Other vehicles

Overnight buses where pictures drawn on the ceiling in fluorescent paint are made visible by shining black light on them have emerged from projects undertaken by operators. Such projects strive to achieve product differentiation amidst the cutthroat competition of the intercity overnight bus routes business (Fig. 3). Although unrelated to body structure, another point of interest is the Isuzu Motors use of a next-generation biofuel (a light oil containing 1% oils and fats extracted from the euglena algae) in its company medium-duty shuttle bus.

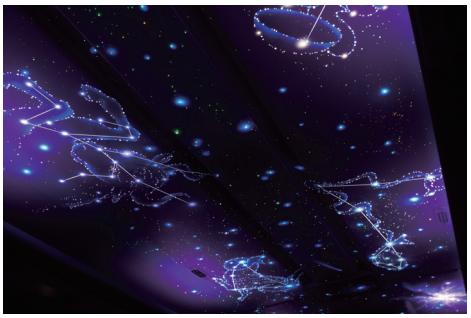


Fig. 3 Differentiation in the interior of overnight expressway buses: Keisei Bus

2 Trends outside Japan

Having realized the effectiveness of environmentally-friendly buses such as natural gas, hybrid, trolley, or electric buses at expanding public transportation services as well as reducing environmental protection and social costs early, the U.S. and Europe have actively been pursuing initiatives to introduce such buses. In Europe, the EU and the International Association of Public Transport (UITP) have initiated projects such as the European Bus System of the Future (EBSF) and the Zero Emission Urban Bus System (ZeEUS) to test what technologies should be used in near-future European urban buses, and various cities are introducing different new technologies and conducting pilot trials. Major bus and component manufacturers, research institutes, and government authorities are participating in these projects in search of optimal solutions, and with the unique transport situation in each city, as well as the various technological approaches taken by the manufacturers carrying out development, holding the pilot trials in parallel is both effective and fair. The existence of diverse technological approaches is a given, and these initiatives bear watching in terms of the concentration of research and development efficiency and costs.

The shift from diesel to electricity stands out as an emerging trend, and there is a strong sense that in cities, buses powered only by diesel are being increasingly relegated to the fringes. Even as bus manufacturers respond to such trends by designing vehicles adapted to various power sources, component makers, who play a central role in the building of buses, are establishing a firm foundation through measures such as expanding their horizons to cover electric buses as well as hybrid

vehicles and developing adaptable products.

The spread of BRT systems is also providing momentum for buses to become more prominent. In Japan, this spread is due to a long-time misunderstanding that articulated buses and BRT systems are the same thing starting to give way to recognition that, in areas with the potential for sufficient demand, setting up a BRT system by enhancing the functionality of existing buses proves much more cost-effective than introducing a tram-like LRT. Introducing railway systems involves considerable management and maintenance expenses in addition to the initial setup costs. As the population declines, everything rests on the tradeoff between cost and transport capability.

3 Conclusion

For many years, Japanese buses have been developed and designed with the needs of Japanese customers in mind, a situation exemplified by recent heavy duty vehicles whose market strategy makes no allowance for export markets. In such a situation, after ascertaining that purchaser needs have been met, it is essential to verify, in real time, whether user or, put another way, social needs are also met. In that respect, issues faced by production goods differ from those of passenger vehicles.

In Japan, although the transition of urban buses to automatic transmissions in advancing rapidly, the same cannot be said of the disc brakes that have become mainstream in the U.S. and Europe. A situation where only specialized bus technologies stand out within the automobile technology in a single country is anything but desirable. If reflections are to be made, isn't it important to conduct studies based on a course of actions for systems and technology that focus on the social role of buses, which can be describe as the true customer of buses. The necessity of exchanging information on an international level may grow. If diesel buses, with over 50 years of history behind them, give way to electric buses, considerations such as whether the resources necessary to produce electricity are abundant enough will undoubtedly call for international coordination.

One thing is certain: in a society facing a mountain of issues including awareness of global warming as a problem and the concentration of the population in cities, the expectations placed on buses, which have been made into an economical means of transporting people through the refinement of technology, will grow greater than ever.