

※Since 2010, private mini-vehicle trucks were excluded from the survey. 2010 revised

Fig. 2 Freight shipments by vehicle type.

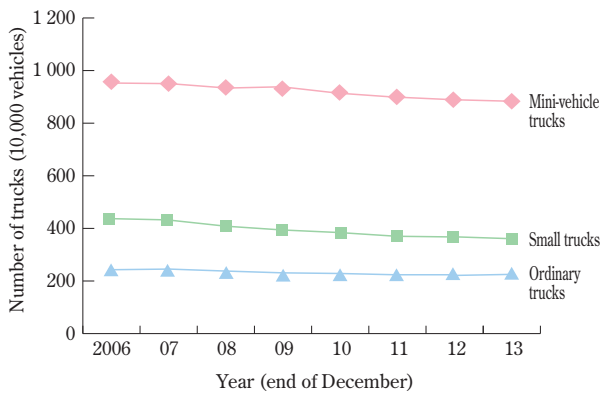


Fig. 3 Number of trucks in Japan according to vehicle type.

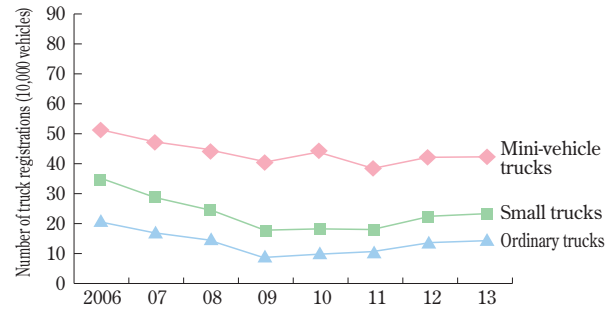
further broken down by the types of truck used, medium and Heavy duty trucks account for 77.0%, small trucks account for 1.9%, special-purpose trucks account for 20.9%, and mini-vehicle trucks account for 0.2%. Compared to the previous year, the number of medium and Heavy duty trucks in Japan decreased by 3.2%, while the number of special purpose trucks increased by 3.0% (Fig. 2).

## 2.2. Number of trucks in Japan

The number of trucks owned in Japan continues to decrease. At the end of 2013 the number of trucks was approximately 14.7 million vehicles, a decrease of 130,000 vehicles or 0.9% compared to the previous year for small and mini-vehicle trucks (Fig. 3).

## 2.3. Number of truck registrations in Japan

The number of new truck registrations in Japan in 2013 was approximately 800,000, an increase of 2.1% compared to the previous year. When this is broken down according to the different types of trucks, the number of medium and Heavy duty trucks increased by 5.1%, the number of small trucks increased by 3.8%, and the number of mini-vehicle trucks decreased by 0.3% compared



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

Fig. 4 Number of truck registrations in Japan according to truck type.

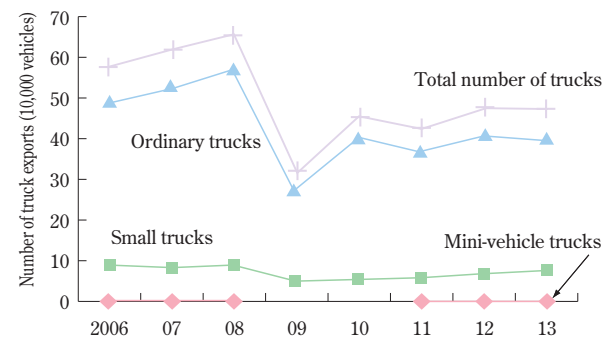


Fig. 5 Number of truck exports according to truck type.

to the previous year. Consequently, all types of trucks increased in 2013 (Fig. 4).

## 2.4. Exports

Approximately 470,000 trucks were exported, a decrease of approximately 5,000 or 1% compared to the previous year. When this is broken down according to the different types of trucks, the number of medium and Heavy duty trucks decreased by 3.0%, while the number of small trucks increased by 12.0% compared to the previous year. This shows a significant increase in small truck exports (Fig. 5).

When the number of truck exports is analyzed according to destination, there was an increase in exports to the Middle-East, Africa, North America, and Europe. However, truck exports to Southeast Asia, Central and South America, and Oceania decreased. In Southeast Asia, which had featured remarkable growth since 2009, exports decreased 6% compared to the previous year. This probably reflects the slowdown of economic growth in Southeast Asia and the effects of political instability in Thailand (Fig. 6).



### 3 The topics of 2013 Model Year

#### 3.1. Domestic models for Japan

Although some mini truck manufacturers made full model changes, none made model changes to Heavy duty or medium duty trucks. Instead, efforts were made to improve reported fuel economy values and to expand the range of trucks that can qualify for the preferential tax scheme for environmentally friendly vehicles.

A new initiative involving electric vehicle validity trials on public road began for small trucks.

##### 3.1.1. Heavy duty trucks

Since last year, there were no major model changes from any manufacturer and the available vehicles are roughly equal in terms of safety equipment and qualification for the preferential tax scheme for environmentally friendly vehicles.

The bi-yearly Tokyo Truck Show and Tokyo Motor Show were held in 2013. At the October Tokyo Truck

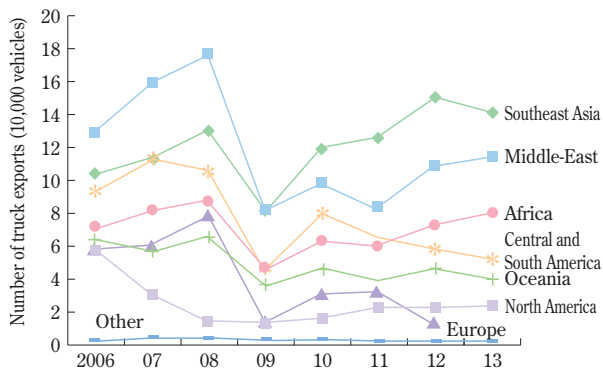


Fig. 6 Number of truck exports according to destination.

Show, Hino Motors, Ltd. exhibited its “Cool Hybrid” refrigerated van truck, which is equipped with a special purpose hybrid system used to provide electric power to the refrigerator rather than for driving (Fig. 7).

At the November Tokyo Motor Show, UD Trucks Corporation presented the Quon Fuel Demonstrator (Fig. 8), which aims for an all-encompassing approach to decreasing fuel consumption by supplementing its improved aerodynamic design with road profile prediction based on GPS and map data. Mitsubishi Fuso Truck and Bus Corporation, for its part, introduced its Super Great Fuel Efficient Truck (Fig. 9) which strives to reduce fuel consumption by managing electrical power through a combination of optimum aerodynamic technology, PWM alternators, and solar batteries. The show highlighted consideration for the increasingly difficult economic situation of users through aggressive initiatives such as 10% improvements in the fuel economy of current models.

##### 3.1.2. Midium duty trucks

There also were no major model changes from any manufacturer for medium duty trucks, nor did any particular initiatives stand out over the course of the year.

##### 3.1.3. Light duty trucks



Fig. 8 UD Trucks Quon Fuel Demonstrator.



Fig. 7 Hino Profia Cool Hybrid.

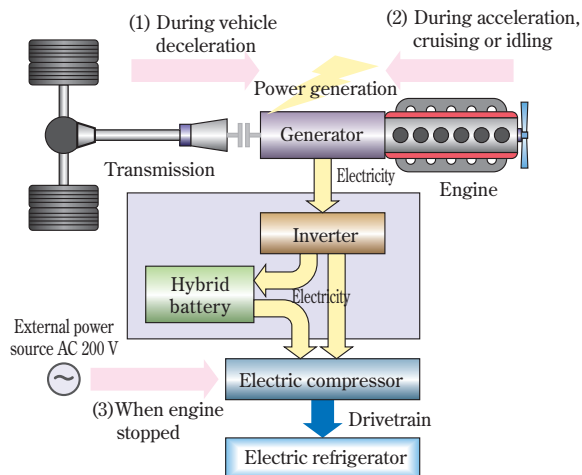




Fig. 9 Mitsubishi Fuso Fuel Efficient Truck.



Fig. 12 Suzuki Carry.



Fig. 10 Hino Dutro EV.

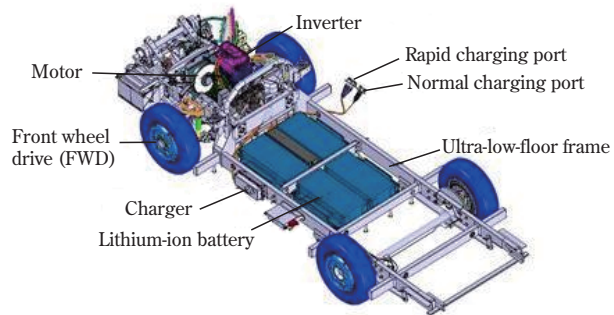
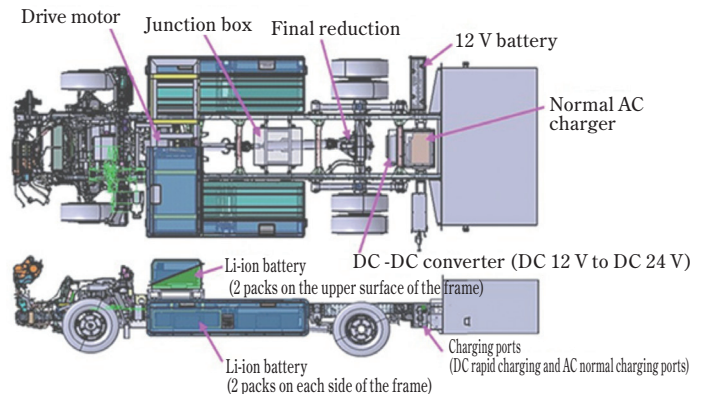


Fig. 11 Mitsubishi Canter E-Cell.



In February, Hino Motors, Ltd. announced that it was developing an ultra-low-floor EV truck (Fig. 10) envisioned to be used for short-range driving in urban areas. Trial operations of this EV truck to verify its viability have begun in cooperation with major delivery companies.

In May, Toyota Motor Corporation and Hino Motors, Ltd. equipped some manual transmission vehicles, as well as the Dyna Toyoace, and Dutro with a switch based electric parking brake system. It also equipped some automated manual transmission HVs with an electric parking brake linked to the parking position. These features represent safety enhancements.

In June, Mitsubishi Fuso Truck and Bus Corporation reached out to private users by adding a compact size model to its Canter Eco HV lineup. In the same month, it announced the second-generation Canter E-Cell (Fig. 11) compatible with the CHAdeMO Quick Charger as well as magnetic resonance wireless charging, for which trial operations to verify viability began in autumn. Instead of an engine, this electric vehicle uses a permanent magnet synchronous motor with a maximum power of 96 kW and a maximum torque of 650 Nm. The gear box has been removed to improve efficiency. Efforts to increase the continuous driving range to over 100 km from its current 80 km are underway.

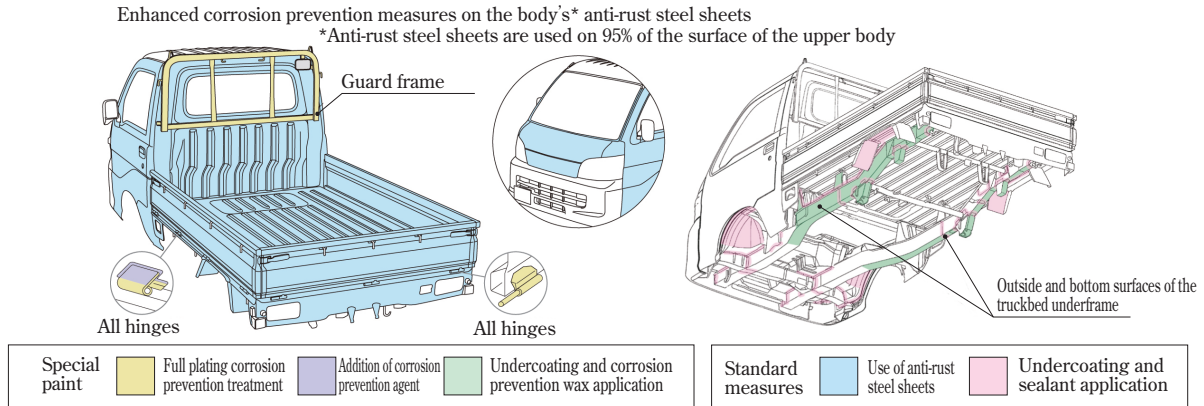


Fig. 13 Corrosion prevention Measures Applied to the Daihatsu Hijet and Subaru Sambar.

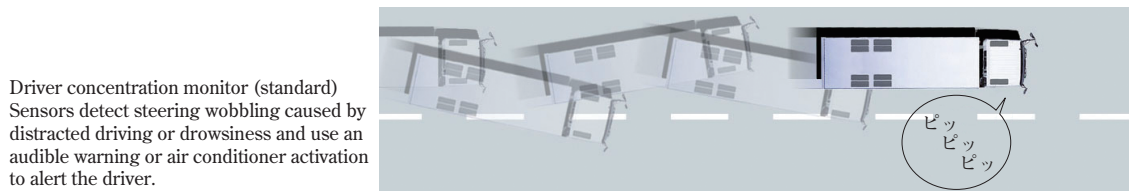


Fig. 15 Isuzu Driver Concentration Monitor.

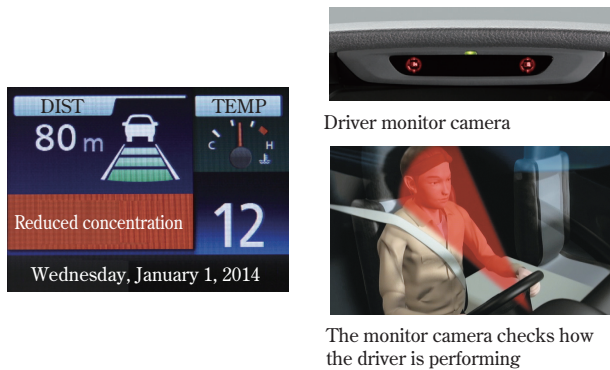


Fig. 14 Hino Driver Monitor.

### 3.1.4. Mini trucks

In August, Suzuki announced a full model change for the Carry (Fig. 12). A improved cab design provides extra space in front of the head and extra legroom. The new design makes it notably more comfortable to get in and out of the vehicle while wearing rain boots. At the same time, the vehicle's corrosion prevention efficiency was improved, with a long-term rust warranty of 3 years for the surface of the body (including the truckbed) and 5 years for panel perforations. The full model change was also concurrently applied to the Mazda Scrum and Nissan NT100 Clipper OEM supply models.

In December, Daihatsu Motor Co., Ltd. added a special specification vehicle featuring improved corrosion pre-



Fig. 16 Mitsubishi Fuso MDAS-III.

vention to its Hijet lineup, as well as to the Fuji Heavy Industries Sambar OEM supply model lineup (Fig. 13).

### 3.1.5. Safety and other equipment

Active safety technologies designed to prevent severe accidents caused by dozing off at the wheel are starting to spread, particularly in Heavy duty trucks. The systems vary from manufacturer to manufacturer and include a driver monitor that detect driver facial expression (Hino, Fig. 14), a driver concentration monitor that senses wobbly steering and emits a warning (Isuzu, Fig. 15), and the MDAS-III driver attention monitor that re-





Fig. 17 BharatBenz Lineup and Mitsubishi Fuso OEM Models (FA, FJ).



Fig. 19 Eicher Pro Series Lineup.



Fig. 18 UD Trucks Quester.

lies on lane recognition using camera images (Mitsubishi Fuso, Fig. 16).

### 3. 2. Trucks manufactured foreign manufacturers

From 2012, European manufacturers have led the way

in announcing models compliant with the Euro 6 regulations. However 2013 can be said to have been characterized by the separate successive announcement of specialized trucks targeting emerging countries, particularly in Asia and Africa.

At the end of 2012 the Daimler Group announced the Indian-produced BharatBenz for that country, which became the named Fuso brand vehicles for the Sri Lankan, Kenyan and Zambian markets that started shipping in September (Fig. 17).

For its part, the Volvo Group announced the launch of the UD Trucks Quester as a Thai-produced model target emerging countries (Fig. 18). Then, in December, it successively announced the group's new Pro series model by Eicher in India (Fig. 19) and the KuTeng by Dongvo Truck in China (Fig. 20).

In Europe, Volvo announced full model changes to the



Fig. 20 Dongvo Truck KuTeng.



Fig. 21 Volvo New FE.



Fig. 22 Mercedes-Benz New Atego.

FL and FE in May (Fig. 21). Mercedes-Benz made a full model change to its medium duty size Atego (Fig. 22) at around the same time.

In line with Euro 6 regulation compliance, Renault Trucks also made full model changes to its Heavy duty and medium duty trucks. This new model series breaks with the past and now consists of the three broad categories of D for delivery, C and K for construction, and T for long hauls (Fig. 23).

In December, Renault also announced a small waste collection model equipped with a 47 kW, 270 Nm motor for it's the maxity light duty truck line (Fig. 24).

Scania, who had already adapted some models to the Euro 6 regulations, announced its first compliant NGV



Fig. 23 New Renault Trucks.



Fig. 24 Renault The maxity Electric Vehicle.



Fig. 25 Scania Euro 6 NGV.



Fig. 26 Scania R730 Euro 6.





Fig. 27 New DAF CF Series.

model in June (Fig. 25).

It also established a full lineup of diesel trucks with



Fig. 28 Kenworth T880.

the addition of an R730 model equipped with a V8, 16.4 L, 730 hp DC 16 engine (Fig. 26).

In April, DAF Trucks announced model changes to the CF and mid-size LF series (Fig. 27).

In the North American market, although no major changes were made by any manufacturer, Kenworth Trucks announced a model change involving mounting the PACCAR MX-13 engine in its T880 model (Fig. 28) in October.

## ❖❖❖❖❖❖❖❖❖❖ Design Trends ❖❖❖❖❖❖❖❖❖❖

### 1 Trends in Japanese Truck Design

Japanese commercial vehicle manufacturers are rapidly globalizing through means such as setting up local production overseas or tie-ups with foreign manufacturers, and are actively engaged in establishing local production bases worldwide, primarily in Asian and other emerging countries. In terms of design, this affects the three points of improved environmental performance, use-based lineup expansion, and global deployment. In this context, UD Trucks, a member of the Volvo Group, announced the new Quester Heavy duty truck for Asian and other emerging markets in Bangkok, Thailand in August 2013 (Fig. 1). Produced primarily in Thailand, with further production in China and India, this vehicle is scheduled to be sold in Africa, the Middle East, and Central and South America, as well as in Asia.

#### 1.1. Exterior design

Unlike many of the Heavy duty trucks seen in emerging countries, which are assembled with a 2,300 mm width cabin designed for midium duty trucks, the Quester only comes with a 2,500 mm width full-size cabin. Its doors, windshield, and other frame parts are shared



Fig. 1 UD Trucks Quester.

with the Quon. The front features a bold structure where the trademark UD Trucks hexagonal grille has been enlarged to reach the bumper, providing a strong and distinctive appeal for the UD Trucks brand. The graphic headlamps harmonized with the grille present a distinctive vertical style that evokes the Volvo group. In addition, the design stresses ways to improve the operation rate of the vehicle through approaches such as using a separate removable part for the easily damaged bumper corners and adopting an assembly structure that allows headlamps to be replaced quickly. The design of the steel off-road bumpers is functional and accounts for





Fig. 2 Quester Instrument Panel.



Fig. 3 Interior of Quester.



Fig. 4 Mercedes-Benz Arocs Lineup.



Fig. 5 Mercedes-Benz Arocs.

the approach angle. The front corners have been made rounder and smoother than in conventional vehicles for better aerodynamic performance, which contributes to improving fuel economy and reducing CO<sub>2</sub> emissions.

### 1. 2. Interior design

The instrument panel (Fig. 2) of the Quester is shaped for ease-of-use to help reduce fatigue when driving long distances, and features a 4.5-inch wide LCD screen in the gauge cluster that is easy to read even while driving. The fuel efficiency driver assistance system clearly shows optimal driving operations on the panel, guiding low-fuel consumption driving possible at any level of driver skill. The width of the cab interior matches that of the Quon while boasting a long high roof – a first in a large trucks from a Japanese manufacturer – and also extends the sleeper area rearward by 200 mm. In conjunction with the steel roof panel, this offers a top class interior space. The interior height from the driver's seat floor reaches 2,000 mm, 555 mm more than a standard roof, providing a more spacious vehicle interior. The instrument panel (Fig. 2), based on the medium duty Condor's straight-line shape, uses a layout that does not protrude in the center and offers expanded legroom when there are three people on-board. Unlike the Quon's cockpit-style instrument panel, this design is optimized for its intended purpose. Further, a double bed configu-

ration is provided to address the needs of two-driver operations (Fig. 3). The cab also includes a 270 L capacity multi-purpose storage space.

## 2 Trends in Truck Design foreign market

Most of European truck manufacturers unveiled face lifts to their models to comply with the latest European emissions regulations (Euro VI) at the 2012 IAA International Motor Show held in Hannover, Germany.

In April 2013, at bauma, the world's leading trade fair for construction machinery held in Munich, Germany, European manufacturers announced derivatives of their new models specialized for construction purposes. On the heels of the previous year's Actros and Antos models, Mercedes-Benz announced the Arocs (Figs. 4 and 5). A full lineup of cabs is available in 2,300 mm and 2,500 mm widths, and S/M/L-cab lengths. Volvo Trucks also announced a new model derived from the FM, the FMX (Fig. 6). It distinguishes itself from the FM (Fig. 7) through a design that takes the angle of approach into account, particularly at the bumper, projecting an image of toughness. Similarly, GAC Hino, the joint venture between China's GAC Group and Hino Motors, Ltd., launched the 700 Series of construction vehicles (Fig. 8) in 2013. A powerful design featuring a shortened front bumper lower edge was adopted for better performance



Fig. 6 Volvo Trucks FMX.



Fig. 9 Arocs Radiator Grille.



Fig. 7 Volvo Trucks FM.



Fig. 10 Arocs Outer Mirror Cover.



Fig. 8 GAC Hino Motors, Ltd. 700 Series Construction Vehicle.

on rough roads. This trend in creating extensive cab variations with purpose-optimized designs is expected to pick up momentum worldwide.

### 2.1. Exterior design

The radiator grille of the Mercedes-Benz Arocs (Fig. 9) projects strength and robustness worthy of construction use through a design inspired by the claws on construction machinery shovels which clearly differentiates it from vehicles intended for other purposes. As a nod to keeping replacement costs down, optional headlight protectors can be installed to prevent damage from stepping stones when driving on rough roads. In addition, to reflect the toughness associated with construction, and to protect against scratches, the exterior mirror housing (Fig. 10) is grooved, achieving balance between style and

functionality.

Moreover, safety is not forgotten, as a roofside handrail and steps at the bottom along the side of the cab provide safe access to the rear body. The new Volvo Trucks FMX (Fig. 6) differs from the previous model, particularly in terms of changes to the frontal area. Product appeal has been enhanced by, for example, emphasizing its use in construction and changing the headlamps. Changes centering on the bumper area have been made to the base FM model (Fig. 7). While retaining the easily replaceable 3-part steel bumper of the previous model, the addition of a robust bull bar projects toughness, and the design is functional, as shown by the lack of a plastic cover on the center towing bar. The distinctive V-shaped LED headlamps (Fig. 11) act as a symbol of the new Volvo trucks and clearly brand them as a family. Taking potential damage into account, the headlamps have been set high, and can also be fitted with an optional specially designed protective cover. A notable difference from previous models is the shifting of Volvo mark and diagonal line from the grille to the panel below the windshield, a brand appeal strategy adopted for the new generation of Volvo trucks that has also been applied to other models.



Fig. 11 FMX Headlamps.



Fig. 12 Interior of FMX.



Fig. 13 UD Trucks Quon Fuel Demonstrator.

## 2.2. Interior design

The interior of the Volvo FMX (Fig. 12) retains many elements of the base FM model, allowing it to balance the durability necessary for harsh construction work with a stylish design while enhancing visibility, operability, and comfort. One feature that stands out is the holder for 2-liter PET bottles provided for drivers working in grueling environments. An air gun using the compressed air in the air suspension seat is provided to facilitate cleaning off dirt or sand from the instrument panels and the seat in dirt-filled environments. To prevent stains and dirt from standing out, a darker brown than the base FM model was chosen as the interior color, and a wide range of seats is available, from tough, durable vinyl to elegant leather finishes. Finally, the honeycomb design used on the grille is also applied to the rubber mats, giving both interior and exterior a unified motif.



Fig. 14 Hino Motors, Ltd. Light-Duty Commercial EV Platform Full-Size Model.



Fig. 15 Hino Motors, Ltd. Hino Poncho Mini.



Fig. 16 Small EV Trucks Undergoing Viability Trial Operations (Refrigerated Vans).

## 3 Design of Concept Vehicles

The 43rd Tokyo Motor Show was held in 2013. In addition to improved aerodynamic designs and reduced fuel consumption based on HV technology, the various commercial vehicle manufacturers presented commercial concept models for EVs, which continue to undergo viability trials, providing a glimpse into the future for next-generation commercial vehicles. Among the concepts presented, the Quon Fuel Demonstrator from UD Trucks (Fig. 13), an experimental vehicle designed for fuel efficiency, features a large size spoiler bumper and side covers around the cab and rear body that reduce air resistance by rectifying the air flow from side winds and around the chassis, as well as a diffuser in the rear integrated bumper. For its part, Hino Motors, Ltd. presented its Light-Duty Commercial EV Platform Full-Size





**Table 1 Main product trends for large trucks in 2013.**

Month of launch	Truck model name	Main characteristics
January	Super Great (Mitsubishi Fuso Truck and Bus)	80 th special specifications vehicle (complete wing vehicle)
	Xcient (Hyundai, South Korea)	Model targeting industrialized markets
May (September)	FJ, FO, FZ (Mitsubishi Fuso Truck and Bus)	Model targeting emerging markets
August	Quester (UD Trucks)	Model targeting emerging markets

**Table 2 Main product trends for mid-size trucks in 2013.**

Month of launch	Truck model name	Main characteristics
February	Canter 8.55 t (Mitsubishi Fuso Truck and Bus)	Canter-based mid-size truck targeting overseas markets
May (September)	FA, FI (Mitsubishi Fuso Truck and Bus)	Model targeting emerging markets

Table 4 shows the mini trucks announced in 2013 and the main product technology trends. Although there have been full model changes and the addition of special equipped model in this class, development costs and reduced investments are leading manufacturers to move from in-house products to OEM models (production by a competing brand). The Suzuki Carry was fully redesigned for the first time in 14 years. In addition to a 13% improvement in fuel efficiency achieved through the use of a new engine and weight reduction, both the interior and platform were made larger through measures such as moving the windshield forward to provide more head space. It is also characterized by the use of special steel sheets for better corrosion prevention. Overall length was unified to that of the shortest model. A minimum turning radius of 3.6 m improves the ability to make tight turns, and weight was reduced by 50 kg through the adoption of high-tension steel sheets for approximately 20% of the structure. At 18.6 km/L (for gasoline engines), it achieves top-class fuel efficiency. With Mitsubishi Motors discontinuing its production of commercial mini-vehicles, Nissan Motors turned to Suzuki as an OEM supplier for its Clipper model in December 2013, while Mitsubishi Motors switched its Minicab to Suzuki OEM supply in February 2014. The Daihatsu Hijet offers a large 350 kg payload and a front-engine layout. It has served as an OEM model for Toyota Motor Corporation (Pixis Truck) since December 2011 and for Subaru (Sambar) since spring 2012.

#### 1. 1. 5. Trucks manufactured foreign brands

At the Seoul Motor Show in April 2013. South Korean

**Table 3 Main product trends for small trucks in 2013.**

Month of launch	Truck model name	Main characteristics
June	Canter E-Cell (Mitsubishi Fuso Truck and Bus)	Experimental EV Aims for an operating range of 100 km or more under continuous driving at 80 km/h
May to August	Canter Eco Hybrid (Mitsubishi Fuso Truck and Bus)	Compliant with Euro 5 emissions regulations

**Table 4 Main product trends for mini-vehicle Japanese trucks in 2013.**

Month of launch	Truck model name	Main characteristics
August	Carry (Suzuki)	First full model change in 14 years Revamped interior and exterior, improved fuel efficiency, enhanced rust protection, reduced weight
December	Clipper (Nissan)	Suzuki (Carry) OEM model

Hyundai Motors announced the Xcient, a Heavy duty truck aimed at industrialized markets. That same year, it was also presented at the Tokyo Motor Show, drawing the attention of engineers from Japanese truck manufacturers as well as from users. Based on its concept of continuous emphasis on safety, Volvo Trucks publicized its advanced safety technologies at Motor Shows worldwide, including the Tokyo Motor Show, where it presented a cab that had passed the Swedish Cab Strength Test, said to be the toughest such test in the world. The strength cab's structure allows its doors to open without problem even after rollover or impact accidents, enabling escape and rescue. The vehicle is also equipped with the latest technologies such as the Electronic Brake System (IEEBS) and the Electronic Stability Program (ESP). Daimler Trucks, based on its growth strategy, offers a full lineup of reasonably-priced models aimed at emerging markets. It has begun production in India of the Fuso brand for export to Asian and African markets, and of the BharatBenz brand for the Indian market. Dongvo trucks, in collaboration with UD trucks, started production and sales of large commercial trucks based on the Quester at their Hangzhou plant in 2014. After Nissan Diesel became UD Trucks, Dongfeng Motor and the former Nissan Diesel established a fifty-fifty joint venture, whose name was changed to Dongvo Trucks Co., Ltd. in November 2013. It is now transferring its production of medium duty and Heavy duty trucks from the previous knock down (CKD) approach to local production.

#### 1. 2. Interior comfort

Truck drivers spend the majority of the day in the

truck cabin. The cabin is both a work and a living space. It must be easy to get into and out of as well as comfortable and safe. Consequently, improving the interior comfort of the cabin has become an important theme for manufacturers. Cabins in Japanese trucks must be packaged within the 12 m overall length regulatory limit which, in conjunction with development that has given priority to space at the trailer end, means that despite various efforts, cab sizes are smaller and compare poorly to those of manufacturers outside Japan. Consequently, giving serious competition to vehicles produced by overseas manufacturers calls for measures such as expanding the margin of adjustment for seats and head room. Cabin size itself remains a future issue, and it is becoming necessary to perform development that includes both domestic and overseas variations.

### 1.3. Operability

Society is aging rapidly, approaching the point where approximately 25% of the population will be 65 or older, and the shortage of drivers is becoming a serious issue. In particular, there is a lack of younger and middle-aged drivers, and the number of professional drivers is decreasing. As the number of older drivers and women drivers increases, driving operations must be further simplified and driver fatigue must be taken into consideration. More and more trucks are now being equipped with automatic transmissions, manual transmissions without clutch pedal, and devices that aid the driver when starting on a hill. This trend of making trucks for easy drive, uncommon in Heavy duty trucks until now, has recently been expanding in all size categories, and the proportion of trucks using these devices has been increasing. Cockpits, in particular, are increasingly being improved and redesigned based on the latest ergonomic ideas to provide a functional, comfortable layout in line with driver motions, and can be said to be moving from the traditional focus on operation to a focus on driving. One example is the round-form instrument panel providing easy access to all controls while seated to achieve a feeling similar to that of driving a passenger car, and help reduce driving fatigue. In addition, the number of trucks incorporating control technologies to maximize driving comfort and achieve similar levels of fuel efficiency even when drivers differ, removing the need to constantly worry about fuel consumption while driving, minimizing driver stress, and realizing more fuel efficient driving is continuing to increase.

### 1.4. Noise and vibration

Advances in engine fuel combustion efficiency driven by emissions regulations tend to be accompanied by increases in engine noise and vibration. These issues are addressed through extra covers around the engine compartment or the addition of sound-absorbing material, but noise and vibration filtering through to the cabin nevertheless remain a cause of driver fatigue. Eliminating these causes of fatigue is essential to improving comfort, and various measures to reduce noise and vibration are being carried out. These include the adoption of air suspensions for cabins, seats with a fine degree of control, and the optimal placement of sound insulation and sound-absorbing material in the cabin interior.

### 1.5. Safety

All truck manufacturers have been developing truck safety technologies focusing on minimizing the deformation of the cab in the event of a collision, strengthening the structure of the vehicle body to ensure a safe space for the driver, and enhancing the safety equipment. Adaptation to the global market is proceeding, with ECE R14 seat belt anchorage and ECE R29 cab strength compliance allowing vehicles to be sold not only in Japan, but in any other country in the world. Studies on updating to even more stringent conditions have also begun. To mitigate collision injuries, the front and rear under-run protection devices that help to prevent passenger vehicles from submarining underneath the truck are being further improved. Spurred by tragic highway bus accidents, as well as legal regulations, all manufacturers are researching and adopting safety devices. In August 2013, the Ministry of Land, Infrastructure, Transport and Tourism introduced standards concerning lane departure warning systems (LDWS). By establishing standards that also focuses on the global market for the installation of LDWS, an active safety technology targeting buses with a capacity of 10 passengers or more and trucks with a gross vehicle weight exceeding 3.5 t, production and development costs are compressed, helping to bring the system into more widespread use. LDWS emit an audible warning to alert the driver to when an unintended lane change seems imminent. They represent an active safety technology that contributes to preventing accidents by providing an advance warning, and all manufacturers are increasingly equipping their vehicles with such systems. Pre-collision safety technologies such as collision mitigating brake systems and electronic stability



control systems that control skids and rollovers are also being refined and gradually becoming more common.

### 1.6. Aerodynamic characteristics

The aerodynamic characteristics of a truck are a performance aspect that can make a large contribution to reduced fuel consumption. Consequently, all manufacturers are putting more effort into improving aerodynamics. The cab of the truck in particular is the first part of the truck that contacts the wind and then funnels it to the left and right, up and down, and toward the rear of the vehicle. Consequently, the cab is being designed with more flush surfaces, such as a narrower front to the cab and innovations to the corners to rectify the flow of air and reduce drag. However, when the design is changed to change the flow of air around the cab, it also can have a negative effect on the wind noise in the cabin, the aerodynamics around the tires, driving stability in a crosswind, engine cooling performance, and interior comfort. This means that any design changes must also try to minimize these kinds of problems at the same time as improving the aerodynamics. In recent years, manufacturers have timed model changes with revised emissions regulations, but due to funding-related difficulties, the tendency has been to leave basic frameworks unchanged, modify appearance through cosmetic changes to exterior parts, and improve aerodynamic performance. With manufacturers also recently offering complete vehicles customized with wings or panels, initiatives to improve overall vehicle aerodynamic performance, including seals to reduce the gap between the cab and the cargo trailer, side guards, rear spoilers, and tapered rear bodies are being undertaken. The improvement of analytical technologies, such as optimization calculation methods, has led to major improvements in the flow of air under the floor, which has a large impact on the cooling performance, as well as in the flow of air in the engine compartment, and to the negative pressure region behind the rear body. A lot of time and effort is now going into initiatives that make use of computational fluid dynamics (CFD) analysis in addition to conventional wind tunnel testing with scale models to carry out these aerodynamic design activities more efficiently.

### 1.7. Corrosion prevention

In recent years, improved corrosion prevention has been promoted, even on mini trucks. After the model change to the Hijet, the same treatment was applied to

the Suzuki Carry with 95% of the exterior panels using special steel sheets to improve corrosion resistance. These vehicles are now sold with a three-year rust warranty for the surface, and a five-year warranty for the panel perforations. On large and mid-size trucks, until now, corrosion resistance has been maintained by recoating chassis parts at every safety inspection. However, improved corrosion resistance is now also sought through measures that include structures and component layouts that make it difficult for salt-filled snow or mud to accumulate and the use of highly weather resistant electrodeposition coatings.

## 2 Rear Body

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As logistics become more and more diversified, truck manufacturers are addressing the need to further improve freight handling and transport efficiency by integrating the chassis and trailer into a single package and offering lightweight, reasonably-priced vans and complete wing body trucks. The number of wing body trucks with refrigerated storage has continued to rise and they are becoming increasingly common. Models using the electricity produced by the vehicle's hybrid system to power the refrigerator unit in the trailer entered the market, introducing technology that solves the problem of poorer fuel efficiency caused by the use of a cooling compressor linked directly to the engine. There is also a strong general customer demand for expanded capacity aimed at improved loading efficiency. In response vehicles combining short cabs with trailers featuring an inner length of 9.965 m rather than the conventional 9.3 m, thereby allowing 18 containers (conventionally 16) measuring 1.1 m × 1.1 m to be loaded, have been put on sale, and are proving popular. The use of aluminum and plastic materials for the trailer structure has expanded for some time and improvements to design and structure have helped to reduce weight. There has also been a continuing trend of adopting interior materials with antibacterial and odor eliminating specifications to address hygiene issues and the spread of odors when transporting foods. There has also been a shift from using apitong plywood material, which is often used as the material for truck trailer floors, to using material from planted trees, laminated lumber, rubber trees, and bamboo to better protect the natural environment.