MOTORCYCLES

Overall Trends

1 Introduction

Bucking the increasing trend that began in 2016, motorcycle production in Japan in 2019 fell to 567,000 units, 87% of the level in 2018 and the first decrease in four years. Exports also fell by 13.2% from the previous year to 396,000 units. In contrast, the number of motorcycles shipped inside Japan increased slightly by 0.7% to 365,000 units. However, although this figure was around the same level as the previous year, it remains at a low level below 400,000 units.

2 Production and Demand Trends

2. 1. Production

As shown in Fig. 1, the number of motorcycles produced in Japan in 2019 decreased by 13% from 2018 to a total of 567,000 units. Exports also fell by 13.2% to 396,000 units. In contrast, the number of motorcycles shipped inside Japan increased by 1.5% to 365,000 units.

2. 2. Demand in Japan

Figure 2 shows motorcycle demand in Japan based on engine displacement. Overall demand for all displacements rose by 0.7% from the previous year to 365,000 units due to an increase in demand for mini-sized motorcycles after recent decreases as well as the second successive year-on-year increase in demand for small-sized motorcycles, which offset lower demand for class 1 and class 2 motor-driven cycles.

(1) 50 cm^3 or Less (Class 1 Motor-Driven Cycles)

In 2019, the demand for this class decreased by 2.5% from the previous year to 165,000 units.

(2) 51 to 125 cm^3 Displacement Motorcycles (Class 2 Motor-Driven Cycles)

In 2019, the demand for this class decreased slightly by 0.6% from the previous year to 105,000 units.

(3) 126 to 250 cm^3 Displacement Motorcycles (Mini-Sized Motorcycles)

In 2019, the demand for this class increased again by 5.5% from the previous year to 53,000 units. This increase ran counter to recent trends for this class.

(4) 251 cm^{3}or Higher Displacement Motorcycles (Small-Sized Motorcycles)

In 2019, the demand for this class increased substantially by 12.6% from the previous year to 42,000 units.

2. 3. Exports

As shown in Fig. 3, motorcycle exports in 2019 to all regions decreased, falling by 13.2% from the previous

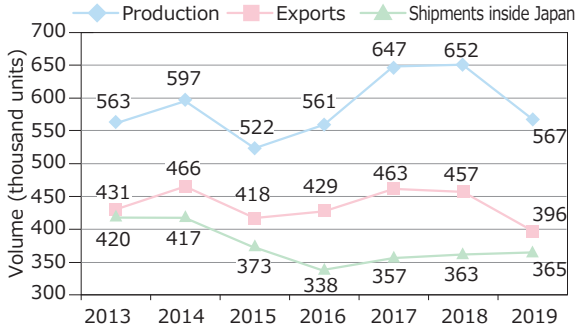

Fig. 1 Trends for Production, Exports, and Shipments inside Japan

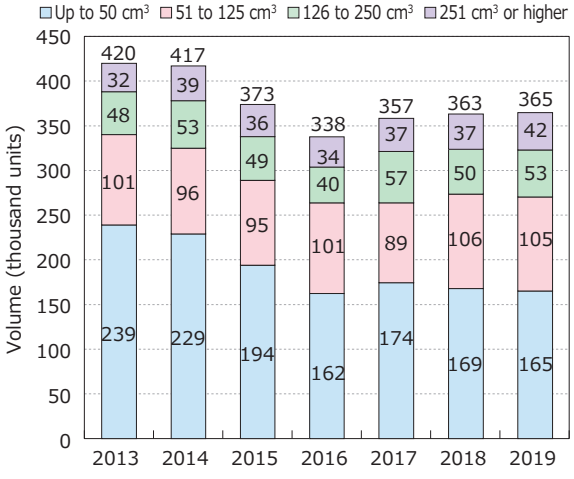

Fig. 2 Shipments inside Japan based on Displacement

year to 396,000 units. In particular, exports to three regions (North America, Europe, and Oceania) declined substantially.

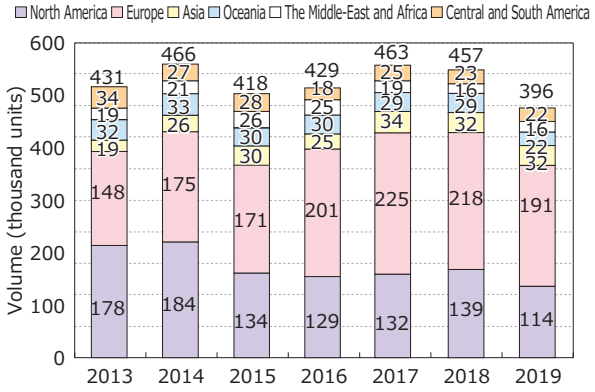

Fig. 3 Shipments per Market

(1) North America

In 2019, motorcycle exports to North America decreased by 18% from the previous year to 114,000 units. This was the first substantial decrease in four years.

(2) Europe

Motorcycle exports to Europe in 2019 fell substantially by 12.1% from the previous year to 191,000 units.

(3) Asia

In contrast, motorcycle exports to Asia in 2019 decreased only slightly from the previous year by 3% to 32,000 units.

(4) Oceania

Motorcycle exports to Oceania in 2019 decreased substantially by 24.4% from the previous year to 22,000 units.

Table 1 Details of Main New Motorcycles Launched in 2019

Month of launch	New	Modified	Manufacturers	Name of model	Characteristics
January		○	Honda	CB1100	Air-cooled/4 -stroke/inline 4 -cylinder
		○	Honda	CB1100 EX	Air-cooled/4 -stroke/inline 4 -cylinder
		○	Honda	CB1100 RS	Air-cooled/4 -stroke/inline 4 -cylinder
		○	Honda	CBR1000 RR	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CBR1000 RR SP	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CBR400 R	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Honda	CBR400 X	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Honda	Rebel 250	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	Giorno Special Edition (limited order-based availability)	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Tact Special Edition (limited order-based availability)	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Suzuki	SV650 ABS	Water-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Suzuki	SV650 X ABS	Water-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
February		○	Honda	Rebel 500	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Honda	CRF250 L	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF250 Rally	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	X-ADV	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Honda	Dio 110	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Giorno	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Giorno Deluxe	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Tact	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Tact Basic	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Yamaha	Vino	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Yamaha	Axis Z	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	TMAX530 SX ABS	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	TMAX530 DX ABS	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	GSX-S750 ABS	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	GSX-S1000 F ABS	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z400	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z250	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
March	○		Honda	CBR650 R	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Honda	VFR800 F	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Honda	Super Cub 110 Street (limited edition)	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Super Cub 50 (limited edition)	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Super Cub 50 Street (limited edition)	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Dunk	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Yamaha	Tracer 900 ABS	Water-cooled/4 -stroke/3 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Tracer 900 GT ABS	Water-cooled/4 -stroke/3 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT07 ABS	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT03	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT25	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Tricity 125	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI

Table 1 Details of Main New Motorcycles Launched in 2019 (Cont.)

Month of launch	New	Modified	Manufacturers	Name of model	Characteristics
March		○	Yamaha	Tricity 125 ABS	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Yamaha	Tricity 155 ABS	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Yamaha	XSR900 ABS	Water-cooled/4 -stroke/3 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	XSR700 ABS	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R25	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R25 ABS	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
	○		Yamaha	Niken GT (order-based sales)	Water-cooled/4 -stroke/3 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	V-Strom1000 ABS	Water-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Suzuki	V-Strom 650 XT ABS	Water-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Suzuki	V-Strom1000 ABS	Water-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Suzuki	V-Strom 1000 XT ABS	Water-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
		○	Suzuki	Burgman 200	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Kawasaki	W800 Street	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
		○	Kawasaki	W800 Cafe	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
April		○	Yamaha	MT10 ABS	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	XMAX ABS	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Yamaha	NMAX155 ABS	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Suzuki	GSX-R1000 R ABS	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
May		○	Honda	CRF250 L	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF250 Rally	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF450 R	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF450 RX	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF250 R	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF250 RX	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Yamaha	Bolt ABS	Air-cooled/4 -stroke/V2 /SOHC/4 -valve/FI
		○	Yamaha	BOLT R-Spec ABS	Air-cooled/4 -stroke/V2 /SOHC/4 -valve/FI
	○		Suzuki	Katana	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
June		○	Honda	Super Cub C125	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Yamaha	NMAX125 ABS	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Yamaha	YZF-R3 ABS	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
July		○	Honda	Monkey 125	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Honda	Dio 110 (limited color)	Air-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Suzuki	GSX250 R	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
August		○	Yamaha	YZF450 F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF250 F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZ250 /125 /85 /85 LW/65 , etc.	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Yamaha	YZ250	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Yamaha	YZ125	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Yamaha	YZ85	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Yamaha	YZ85 LW	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Yamaha	YZ65	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Suzuki	Address 110	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	V-Strom 250	Water-cooled/4 -stroke/2 -cylinder/SOHC/4 -valve/FI
		○	Suzuki	V-Strom1000 ABS	Water-cooled/4 -stroke/2 -cylinder/SOHC/4 -valve/FI
		○	Kawasaki	Z900 RS	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z900 RS Cafe	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX450	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX250	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KLX110 L	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve
		○	Kawasaki	KX100	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Kawasaki	KX85 -II	Water-cooled/2 -stroke/single-cylinder/piston reed valve
September		○	Yamaha	Cygnus-X Monster Energy Yamaha (limited edition)	Air-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Suzuki	Address 125 (flat seat specifications)	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Burgman 400 ABS	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 400	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 400 KRT Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 250	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 400 KRT Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
October		○	Honda	CB1300 Super Four SP	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CB1300 Super Four/Super Bol D′ Or SP	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve/FI
		○	Honda	Lead 125	Water-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
		○	Yamaha	YZF-R3 ABS Monster Energy Yamaha (limited edition)	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R25 ABS Monster Energy Yamaha (limited edition)	Water-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja H2 SX SE	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja H2 SX SE+	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI

Table 1 Details of Main New Motorcycles Launched in 2019 (Cont.)

Month of launch	New	Modified	Manufacturers	Name of model	Characteristics
October		○	Kawasaki	Versys 1000 SE	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	KLX230	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Kawasaki	KLX230 R	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
November		○	Yamaha	Niken/Niken GT (order-based sales)	Water-cooled/4 -stroke/3 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja ZX-10 R SE	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja ZX-10 R SE KRT Edition	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja ZX-10 RR	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja ZX-6 R	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja ZX-6 R KRT Edition	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z400	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z250	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
December	○		Honda	CRF1100L Africa Twin Adventure Sports ES	Water-cooled/4 -stroke/2 -cylinder/OHC/4 -valve/FI
		○	Suzuki	Let's	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Let's Basket	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Suzuki	Address V50	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	W800	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI

(5) The Middle-East and Africa

Similarly to Asia, motorcycle exports to the Middle-East and Africa in 2019 decreased only slightly from the previous year by 1.5% to 16,000 units.

(6) Central and South America

Finally, motorcycle exports to Central and South America in 2019 decreased by 3.3% from the previous year to 22,000 units.

3 Product and Technological Trends

3. 1. Product trends

Table 1 lists some of the representative motorcycle models launched in Japan in 2019.

New models in the class 1 motor-driven cycle segment included the Honda Tact, Giorno, Dunk, and Super Cub, the Yamaha Vino, as well as the Suzuki Let's and Address V.

New models in the class 2 motor-driven cycle segment included the Honda Dio 110, Super Cub 110 and C125, Monkey 125, and Lead 125, the Yamaha Axis Z, Tricity 125, NMAX 125, and Cygnus-X, the Suzuki Address 110 and 125, as well as the Kawasaki KLX110L, KX100, and KX85.

New models in the mini-sized motorcycle segment included the Honda Rebel 250 and CRF250, the Yamaha MT-25, Tricity 155, YZF-R25, NMAX 155, and XMAX, the Suzuki Burgman 200, GSX250R, and V-Strom 250, as well as the Kawasaki Z250, KX250, Ninja 250, and KLX230/R.

New models in the small-sized motorcycle segment included the Honda CB1100, CBR1000RR, Rebel 500, X-ADV, CBR650R, VFR800F, CB1300, and CRF1100L, the Yamaha TMAX 530, Tracer 900, MT-07, MT-03, XSR900, Niken GT, MT-10, and Bolt, the Suzuki SV650, GSX-S750, GSX-S1000, V-Strom 650, V-Strom 1000, GSX-R1000R, Katana, and Burgman 400, as well as the Kawasaki Z400, W800, Z900, KX450, Ninja 400, Ninja H2, Versys 1000, Ninja ZX-10R, Ninja ZX-6R, and Z400.

3. 2. Technological trends

In the class 1 motor-driven cycle segment, manufacturers reduced the number of new models while working to maintain product appeal through coloring changes and the like. In contrast, in the class 2 motor-driven cycle and larger segments, manufacturers were able to efficiently launch a wider range of model types using the same platforms as motorcycles aimed at non-Japanese markets. In addition, anti-lock brake systems (ABS) were installed on a large number of mini- and small-sized motorcycle models, reflecting the mandate requiring the installation of ABS or combined braking systems (CBS) on new models from 2018. In addition, energy-saving, longer-life LED lamps were installed on many of the new models launched in 2019. An increasing number of models also featured electrification and Internet of things (IoT)-based technology, especially EV models for delivery work and larger models.

Engines

1 Technological Trends in Japan

1. 1. Overview

Table 1 lists the specifications of the engines equipped on the major new motorcycle models that went on sale from each Japanese manufacturer in 2019.

In the small-size motorcycle category, in addition to the launch of hybrid models in 2018, the continued emphasis on fuel efficiency and environmental performance prompted Yamaha to fully enter the EV market in Taiwan and Honda to prepare the limited introduction of EVs for postal deliveries in Japan. In the large-size motorcycle category, Harley Davidson held a test-ride event before a full-scale launch and is apparently now capable of introducing models powered by either an engine or a motor, depending on the application.

1. 2. Trends of Each Manufacturer

(1) Honda Motor Co., Ltd.

(a) CBR650R: This motorcycle is equipped with a 648 cm^3, water-cooled, 4-stroke, duel overhead cam (DOHC), 4-valve, inline 4-cylinder engine that changes its power characteristics to provide a feeling of increasing engine speed toward peak revs without any dips. In addition to greater ease of handling, this engine realizes higher power at high engine speeds. This was accomplished by changing the specifications of the valve train and the shape of the piston head to optimize the combustion chamber geometry, adopting iridium plugs to increase combustion efficiency, and using dedicated twin ram air intakes for the air cleaner to boost intake efficiency, resulting in a keenly felt sense of engine performance. In addition, enhanced handling pleasure was achieved by the adoption of a new assist and slipper clutch as well as selectable torque control (HSTC). Figure 1 shows the external appearance of this motorcycle.

(b) CRF1100L Africa Twin Adventure Sports: This motorcycle is equipped with a 1,082 cm^3, water-cooled, 4-stroke, overhead cam (OHC), 4-valve, 2-cylinder engine. The piston stroke of the previous model was increased from 75.1 to 81.4 mm to increase displacement while minimizing the size of the engine. This measure increased power and torque, thereby enabling exciting off-road performance and ample power over long distances. In addition, the response of the throttle-by-wire system was speeded up to improve the linearity of response to rider inputs. Two types of transmission were adopted: a dual clutch transmission that requires neither clutch nor shift operations, and a manual transmission that can be operated by the rider. Thanks to the evolution of launch controls, the dual clutch transmission enables even smoother starts, while the evolution of shift controls helps to realize a direct sense of power transmission with a truly

Table 1 Specifications of New Engines in 2019

Manufacturers	Name of model	Engine type	Displacement (cm^3)	Bore (mm)	Stroke (mm)	Compression ratio	Max. output (kW/rpm)	Maximum torque (Nm/rpm)
Honda	CBR650 R	Water-cooled/4 -stroke/V4 /DOHC/4 -valve	648	67.0	46.0	11.6	70/12,000	65/8,500
	CRF1000 L Africa Twin	Water-cooled/4 -stroke/2 -cylinder/OHC/4 -valve	1,082	92.0	81.4	10.1	75/7,500	105/6,250
Yamaha	EC-05 (model for outside Japan)	EV						
Suzuki	Katana	Water-cooled/4 -stroke/4 -cylinder/DOHC/4 -valve	998	73.4	59.0	12.2	109/10,000	107/9,500
Kawasaki	KLX230	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve	232	67.0	66.0	9.4	14/7,600	19/6,100
	KLX230 R	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve	232	67.0	66.0	9.4	14/8,000	20/6,000

Fig. 1 External Appearance of the CBR650R

Fig. 2 External Appearance of the CRF1000L Africa Twin

Fig. 3 External Appearance of the EC-05

Fig. 4 External Appearance of the Katana

Fig. 5 External Appearance of the KLX230

Fig. 6 External Appearance of the Streetfighter V4

sporty feeling. Figure 2 shows the external appearance of this motorcycle.

(2) Yamaha Motor Co., Ltd.

The EC-05 (model for outside Japan) is an electric scooter developed in a joint venture with Gogoro Inc. for the Taiwanese market. Yamaha designed the model based on a commercially available platform provided by Gogoro, and it is sold under the Yamaha brand through the sales channels of Yamaha's local affiliate. Gogoro Energy Network has set up more than 1,200 so-called "GoStation R" battery swap stations throughout Taiwan, and the model is produced by Gogoro. Figure 3 shows the external appearance of this motorcycle.

(3) Suzuki Motor Corporation

The Katana is equipped with an engine that provides high torque at low engine speeds and high power at high engine speeds, based on the 998 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, inline 4-cylinder engine from the GSX-R1000. These characteristics are achieved through street-bike tuning and the adoption of Suzuki's own Suzuki Composite Electro-chemical Material (SCEM)-plated cylinders that reduce friction loss while ensuring high heat dissipation, wear resistance, and airtightness. In addition, ventilation holes are provided below each cylinder. Pressure is vented into the neighboring cylinders when the piston moves downward to reduce pumping loss. A slipper clutch was also adopted to ensure exciting on-road performance. This clutch controls the back torque transferred from the rear wheel, and restricts rear-wheel locking and hopping due to excess engine braking during downshifts and the like. The Suzuki Dual Throttle Valve (SDTV) was adopted in the fuel injection system. The muffler has a short, compact design, and the main silencer unit is blacked out to emphasize a trim external appearance. The air cleaner contains a partition plate that guides the airflow, thereby increasing intake efficiency and tuning the intake sound. Combined with the exhaust sound, this creates an uplifting sensation of acceleration that stimulates all five senses, while also achieving excellent environmental and dynamic performance. Figure 4 shows the external appearance of this motorcycle.

Fig. 7 External Appearance of the S1000RR

(4) Kawasaki

The KLX230/R is equipped with a 232 cm^3 air-cooled, 4-stroke, single overhead camshaft (SOHC), single-cylinder engine that delivers high power and smooth torque in low to middle engine speed ranges, with a simple and highly reliable engine structure. This motorcycle is also equipped with a 6-speed transmission that enables even more comfortable cruising without sacrificing off-road capabilities.

Figure 5 shows the external appearance of the KLX230.

2 Technological Trends outside Japan

2. 1. Trends of Each Manufacturer

(1) Ducati Streetfighter V4

This motorcycle is equipped with a 1,103 cm^3 water-cooled, DOHC, 4-valve, Desmosedici Stradale 90-degree V4 engine that puts out maximum power of 208 PS (153 kW), which is unmatched in the naked motorcycle segment, and symbolizes the lightning-fast characteristics of this new Streetfighter V4 engine. Although the maximum torque of 123 Nm (12 kgm) at 11,500 rpm is the same as the Panigale V4 engine, dedicated engine map-

Fig. 8 External Appearance of the R1250GS

Fig. 9 External Appearance of the 1290 Super Duke

ping maximizes the performance of the Streetfighter V4 engine on public roads.

The final gear ratio is smaller than the Panigale V4, which helps to boost output torque by 10% and enhance throttle response. The Ducati Performance Full Racing Exhaust manufactured by Akrapovic d.d. is also available for the Streetfighter. This exhaust system boosts power to 220 hp (162 kW) and torque to 130 Nm (13.2 kgm), while reducing weight by 6 kg. Figure 6 shows the external appearance of this motorcycle.

(2) BMW S1000RR

This motorcycle is equipped with a newly designed 999 cm^3 water-cooled, 4-stroke, DOHC, 4-valve, parallel 4-cylinder engine that delivers maximum power of 207 PS at 13,500 rpm and an optimized torque curve. The engine is provided with BMW's new ShiftCam technology that varies the valve timing and lift using a variable camshaft even at middle and low engine speeds to boost torque and power. Furthermore, it also includes a wide range of components (such as intake valves manufactured using hollow titanium cutting and a refined wet multiplate anti-hopping clutch with self-reinforcement) that reduce weight and size while optimizing the design. These measures result in a streamlined engine that is 4 kg lighter than previous models and that helps to enhance both handling and ergonomics. Figure 7 shows the external appearance of this motorcycle.

(3) BMW R1250GS

This motorcycle is equipped with a 1,254 cm^3 air-cooled, 4-stroke, DOHC, 4-valve horizontally opposed 2-cylinder engine. The displacement of this engine is 84 cm^3 higher than previous models, enabling powerful and smooth dynamic performance at low speeds. It is also equipped with BMW's ShiftCam variable camshaft control system that delivers a powerful torque curve at all speeds with excellent control performance under all conditions. The increase in displacement also helps to boost fuel efficiency. Figure 8 shows the external appearance of this motorcycle.

(4) KTM 1290 Super Duke GT

This motorcycle is equipped with a 1,301 cm^3 water-cooled, 4-stroke, DOHC, 4-valve V2 engine with new functions such as titanium inlet valves and a refined resonator chamber that ensure powerful and smooth dynamic characteristics. As a result, this engine ensures a wide torque band from low engine speeds even for a fully equipped model with two riders on winding roads. This torque band is wide enough so that the rider does not feel the need to change gears even under these difficult conditions. In addition, the application of thorough weight reduction measures to the crankshaft enhances throttle response while delivering a smooth engine sensation. Figure 9 shows the external appearance of this motorcycle.

3 Research and Development Trends

With the application of Euro 5 standards to new models starting in 2020, the integration and consolidation of models and engines, and changes to platforms gathered pace in 2019. In the development of engines for small-size motorcycles in particular, efficient measures have been applied by the gradual combination of specifications in accordance with emissions standards in different regions based on the same engines. For large-size motorcycles, manufacturers have concentrated on improvements to basic engine performance and the evolution of weight reduction and other technologies. At the same time, manufacturers have also focused on finely tuned development activities, such as partially changing components and adjusting control systems to modify engine characteristics in accordance with the purpose of model variations, with the aim of providing greater product appeal and customer satisfaction. Development is also making progress to extend electrification from small-size motorcycles and scooters to more enthusiast-oriented large-size models by taking advantage of the inherent benefits of electrifica-

tion and eliminating the negative aspects. The exciting possibility of engine- and battery-powered motorcycles competing in the same market place is becoming more likely.

Design Trends

1 Introduction

It has been said for a long time that the mobility industry stands on the verge of a once-in-a century period of profound transformation. However, transformative technologies as embodied by connected, automated driving, sharing, and electrification (CASE) systems seem to pair poorly with the world of conventional motorcycles that combines simple commuter based models and enthusiast bikes that emphasize the joy of riding. Despite this feeling, social sentiment has begun to undergo a definite change. The external design of motorcycles is also clearly evolving to meet these changes. This section discusses the design trends in this period of transformation and also looks to the future.

2 Rising Enthusiasm for Motorcycle Culture as Leisure Transportation in Emerging Markets

Changes in customer values toward motorcycles in emerging markets has had a major impact on the design of small-size motorcycles. The design of whole-family mopeds and tough business bikes that were treated as the shared property of all members of the household has changed in line with economic growth to meet the growing need for self-expression, particularly by younger people. This trend has been accelerated by the launch of small scooters such as the Yamaha Mio. Products from all manufacturers offer a wide variety of individualistic exterior designs. As the middle class has expanded from the 2010s, medium and large scooters typified by the Honda PCX have also prompted increasing interest in large-displacement sports bikes as an even greater means of self-expression.

Sporty motorcycles in the 150 to 250 cc class are more easily available to customers in emerging markets. With this segment attracting the most attention, this is becoming a global trend to accompany demand in developed markets, which is seeing signs of a drop off in entries aimed at younger riders.

The Kawasaki KLX150 (Fig. 1) shows a typical example of recent design trends. This motorcycle has a fresh wholly off-road style that projects an impression of outdoor leisure. Off-road leisure activities and touring are currently enjoying a boom in popularity, including in emerging markets. From the standpoint of design tastes, major changes seem to be occurring to conventional perceptions that “modern” equals urban refinement, power, and speed. The same trends are also occurring in developed markets. The key points behind the recent popularity of adventure-based styling include the incorporation of explicit functional expressions and impressions of agility and leisure, while also suppressing aspects of so-called “modern” design.

The Yamaha Tenere 700 (Fig. 2) has an ambitious design that incorporates full-scale rallying machine performance and details based on a medium-displacement off-road platform.

Furthermore, the design of the Yamaha Ray ZR Street Rally (Fig. 3) demonstrates a new expression for sporty

Fig. 1 Kawasaki KLX150

Fig. 2 Yamaha Tenere 700

Fig. 3 Yamaha Ray ZR Street Rally

Fig. 4 GPX

Fig. 5 Kawasaki W800 Cafe

Fig. 6 Honda ADV150

scooters with a thorough appreciation of the leisure-oriented tastes of emerging markets.

3 Contradiction between Free Self-Expression and Tradition

The growth of urban employment in emerging markets and the rise in controlled societies and barriers to economic growth in developed markets are placing a large amount of stress on people. These trends have given a new boost to interest in motorcycles, which seem to offer an easier way to enjoy a lifestyle with more freedom. Many customer design preferences that make an appeal to freedom have an authenticity based on established past trends, such as the café racer trend. For this reason, a strong heritage movement has continued. This awareness of "traditional" styling is still common throughout the world, and emerging brands are launching a series of models with sophisticated designs that reflect these preferences. One example is the GPX from Thailand (Fig. 4).

Although these motorcycles can be seen as the antithesis to conventionally integrated modern designs that emphasize high-performance, it cannot be denied that a contradiction has grown up between designs that express "freedom" and those that emphasize "tradition." For mass-producers, this is mainly expressed by revivals of renowned models and brands that reflect the historical values of those companies. However, doubts still remain whether these have real appeal to younger customers who are chasing after real freedom in their lives.

A good example of this trend is the Kawasaki W800 Cafe (Fig. 5) that combines the image of traditional motorcycle culture in the guise of freedom-based design. It combines the contradictory features of stylish coloring design with the explosive energy of upcoming trends.

4 Expression of Identity through Crossover Design

What is probably needed at the moment is design with a clear awareness of the intersection between customer aspirations and creator (manufacturer) concepts. Since this type of expression is not achievable through a plainly traditional design approach, the focus has shifted to a crossover design language that ultimately combines several different traditions and that fuses function and form. Recently, the outdoor touring style motorcycles described above can be seen as the typical representation of aspirational design. In addition, many motorcycles with crossover design themes were exhibited at the 2019 Milan Motorcycle Show (officially called the Esposizione Internazionale Ciclo Motociclo e Accessori (EICMA)).

For example, the Honda ADV150 (Fig. 6) proposes a new sense of enjoyment to customers through a package that combines commuter bike functionality with touring-style aspiration.

Husqvarna Motorcycles GmbH, which recently shed its specialist off-road brand image with the Vitpilen announced the Norden, which fuses a cool and futuristic expression with adventure-based functions. The Norden has a multifaceted design that somewhat resembles an old-school rally machine.

Harley Davidson is another company that is taking on the challenge of breaking away from an established brand image, in this case with the Pan America. The brand itself is closely associated with adventure, and the details of every part of the design play a role in achieving that expression.

The design of the Suzuki DR1050XT (Fig. 7) may be seen as a fusion between the company's heritage design cues, which underline the fact that Suzuki was the originator of this kind of motorcycle, and rally machine tastes.

Fig. 7 Suzuki DR1050XT

The coloring further emphasizes this simple message.

Crossover designs embrace multiple values within the same package. As these designs come into full flower, the range of combinations is currently dominated by hybrids between different motorcycle categories, and it feels as if the design that will decisively show the way to the next generation of motorcycles has yet to emerge. The Gogoro 3, which is not burdened by the traditional language structure of motorcycles, may show hints for the world of electric scooters. Original design in the true sense of the word is stimulated by changes in society and triggers simultaneous actions by creators. It should express itself through transformative styling that shows the way toward a new age.

Although the mobility transformation may still be some way off, the powerful tides that will rock the world will inevitably cause the advent of new designs.