MOTORCYCLES

Overall Trends

1 Introduction

The number of motorcycles produced in Japan in 2017 increased 15.4% compared to that in 2016 to a total of 647,000 vehicles. In addition, the number of motorcycles shipped inside Japan increased 5.6% to 357,000 vehicles, representing the first increase in shipments in four years. Nevertheless, they remain at a low level below 400,000 vehicles.

2 Production and Demand Trends

2. 1. Production

As shown in Figure 1, the number of motorcycles produced in Japan in 2017 increased by 15.4 % compared to that in 2016 to a total of 647,000 vehicles. Exports of motorcycles from Japan also increased by 8% to 463,000 vehicles. At the same time the number of motorcycles shipped inside Japan increased 5.6% to 357,000 vehicles.

2. 2. Demand in Japan

Figure 2 shows motorcycle demand in Japan based on engine displacement. The demand for mini-sized motorcycles increased by 42.3% compared to the previous year, and demand for class 1 motor-driven cycles and small-sized motorcycles also rose. The overall rise in demand, except for class 2 motor-driven cycles, exceeded that of the previous year by 5.6% to reach 357,000 vehicles.

2. 2. 1. 50 cm^3 displacement motorcycles (class 1 motor-driven cycles)

In 2017 the demand for this class increased by 7.5% compared to the previous year to 174,000 vehicles, a first increase in six years.

2. 2. 2. 51 to 125 cm^3 displacement motorcycles (class 2 motor-driven cycles)

In 2017 the demand for this class decreased by 12.5% compared to the previous year to 89,000 vehicles, maintaining the trend of hovering around the 90,000-vehicle mark seen for the past seven years.

2. 2. 3. 126 to 250 cm^3 displacement motorcycles (mini-sized motorcycles)

Efforts by manufacturers to enhance their product lineup in this class led to a massive 42.3% increase in demand compared to the previous year, reaching 57,000 vehicles and rebounding near the 60,000-vehicle mark for the first time in ten years.

2. 2. 4. 251 cm^3 or higher displacement motorcycles (small-sized motorcycles)

The demand for the small-sized motorcycle class increased slightly by 7.5% from the previous year, its first increase in two years.

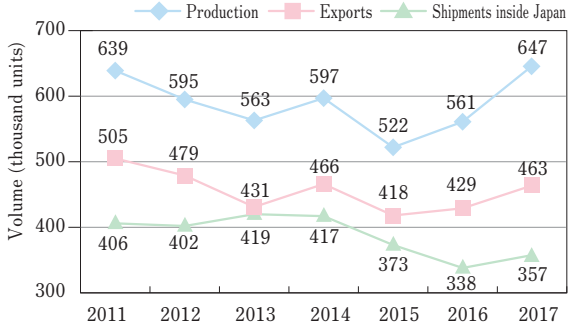

Fig. 1 Trends for production, exports, and shipments inside Japan.

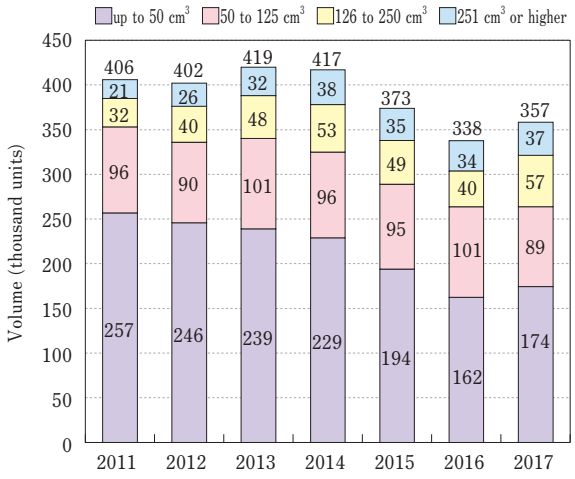

Fig. 2 Shipments inside Japan based on displacement.

2. 3. Exports

Figure 3 shows that Japanese motorcycle exports in 2017 increased by 8% compared to the previous year to 463,000 vehicles. This is due to a recovery in demand in the European market as well as growth in the Asian and South American markets.

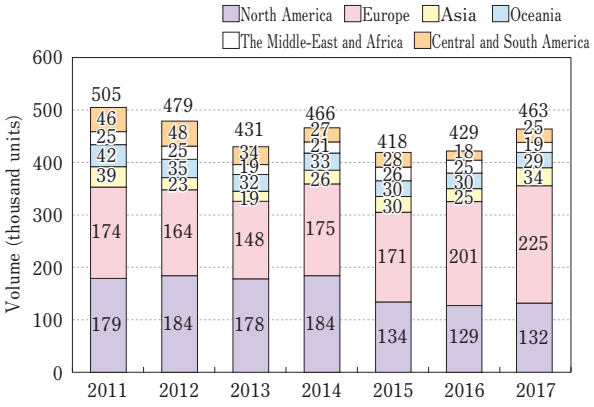

Fig. 3 Shipments per market.

2. 3. 1. North America

In 2017 motorcycle exports to North America increased 1.6% compared to the previous year to 132,000 vehicles.

2. 3. 2. Europe

In 2017 motorcycle exports to Europe increased 11.7% compared to the previous year to 225,000 vehicles.

2. 3. 3. Asia

In 2017 motorcycle exports to Asia increased significantly by 32% compared to the previous year to reach 34,000 vehicles.

2. 3. 4. Oceania

In 2017 motorcycle exports to Oceania decreased by 2.6% compared to the previous year to 29,000 vehicles.

2. 3. 5. The Middle-East and Africa

In 2017 motorcycle exports to the Middle East and Africa decreased by 23.5% compared to the previous year

Table 1 Details of main new motorcycles launched in 2017

Month of launch	New	Modified	Manufacturers	Name of model	Characteristics
January		○	Honda	VFR800 F	Water-cooled/4 -stroke/V4 /DOHC/4 -valve/FI
		○	Honda	VFR800 X	Water-cooled/4 -stroke/V4 /DOHC/4 -valve/FI
		○	Honda	CB1100	Air-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CB1100 EX	Air-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
	○		Honda	CB1100 RS	Air-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
	○		Yamaha	Tricity MW150 A	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
	○		Suzuki	Gixxer	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	Z125 Pro Special Edition	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	Z125 Pro	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	Vulcan S ABS Special Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Vulcan S	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja H2 R	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
February		○	Honda	PCX	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	PCX150	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	CBR250 R	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CB250 F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Honda	CRF250 Rally	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF250 L	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF250 M	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Honda	CRF1000 L Africa Twin	Water-cooled/4 -stroke/inline 2 -cylinder/SOHC/4 -valve/FI
		○	Honda	NC750 X	Water-cooled/4 -stroke/inline 2 -cylinder/SOHC/4 -valve/FI
		○	Honda	Monkey 50 th Anniversary	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	MT-09 ABS	Water-cooled/4 -stroke/inline 3 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT-07 ABS	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT-07	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	MT-09 Tracer ABS	Water-cooled/4 -stroke/inline 3 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Jog	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	Jog Deluxe	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Yamaha	Jog Petit	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Yamaha	Jog ZR	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Yamaha	Vino Deluxe	Water-cooled/4 -stroke/single-cylinder/SOHC/3 -valve/FI
		○	Yamaha	Majesty S Special Edition	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Yamaha	Cygnus-X XC125 SR Special Edition	Air-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
	○		Kawasaki	Ninja ZX-10 RR	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja ZX-10 R	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

Table 1 Details of main new motorcycles launched in 2017 (Cont.)

Month of launch	New	Modified	Manufacturers	Name of model	Characteristics
March		○	Honda	CBR1000 RR	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CBR1000 RR SP	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R3	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R25	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R25 ABS	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
	○		Suzuki	GSX-S750 ABS	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	Ninja 1000 ABS	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Estrella Special Edition	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	Estrella	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
April		○	Honda	CBR400 R	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Honda	400 X	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Honda	Dio 110	Air-cooled/4 -stroke/SOHC/2 -valve/FI
		○	Honda	X-ADV	Water-cooled/4 -stroke/inline 2 -cylinder/SOHC/4 -valve/FI
		○	Honda	CBR650 F	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CB650 F	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
	○		Honda	Rebel 250	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Honda	Rebel 500	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Honda	CBR1000 RR SP2 Race Base model	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZF-R1 Race Base model	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
	○		Yamaha	NMAX 150	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Yamaha	TMAX530 DX	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	TMAX530 SX	Water-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
	○		Yamaha	Axis Z LTS125	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Suzuki	GSX250 R	Water-cooled/4 -stroke/2 -cylinder/SOHC/2 -valve/FI
		○	Kawasaki	Ninja 400 ABS Limited Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	Z1000 ABS	Water-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	Versys-X 250 ABS	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	Versys-X 250 ABS Tourer	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
May	○		Honda	CBR250 RR	Water-cooled/4 -stroke/inline 2 -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
	○		Yamaha	SCR950 ABS	Air-cooled/4 -stroke/V2 /SOHC/4 -valve/FI
	○		Yamaha	MT-10	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
	○		Yamaha	MT-10 SP	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	V-Strom 650 ABS	Water-cooled/4 -stroke/90° V-twin/DOHC/4 -valve/FI
		○	Suzuki	V-Strom 650 XT ABS	Water-cooled/4 -stroke/90° V-twin/DOHC/4 -valve/FI
		○	Kawasaki	Z250 SL	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z250 ABS Special Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z250 ABS	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	Z650 ABS	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	Ninja 650 ABS KRT Edition	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
	○		Kawasaki	Ninja 650 ABS	Water-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
June		○	Honda	CBR1000 RR SP2	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Suzuki	V-Strom 1000 ABS	Water-cooled/4 -stroke/90 degree V2 /DOHC/4 -valve/FI
		○	Suzuki	V-Strom1000 XT ABS	Water-cooled/4 -stroke/90 degree V2 /DOHC/4 -valve/FI
		○	Kawasaki	Estrella Final Edition	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
July		○	Honda	CRF450 R	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Honda	CRF450 RX	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
		○	Honda	CRF150 R	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve
		○	Honda	CRF150 R II	Water-cooled/4 -stroke/single-cylinder/SOHC/4 -valve
		○	Honda	Monkey 50 th Anniversary Special	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	Grom	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	Dunk	Water-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
	○		Suzuki	V-Strom 250	Water-cooled/4 -stroke/2 -cylinder/SOHC/2 -valve/FI
		○	Suzuki	GSX-R1000 R ABS	Water-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX450 F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
	○		Kawasaki	KX250 F	Water-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Kawasaki	KX100	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Kawasaki	KX85 -II	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Kawasaki	KX85	Water-cooled/2 -stroke/single-cylinder/piston reed valve
		○	Kawasaki	KX65	Water-cooled/2 -stroke/single-cylinder/piston reed valve

Table 1 Details of main new motorcycles launched in 2017 (Cont.)

Month of launch	New	Modified	Manufacturers	Name of model	Characteristics
August		○	Yamaha	Jog CE50	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Jog CE50 D	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Jog CE50 P	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Jog CE50 ZR	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Vino XC50 D	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Vino Molfe XC50 H	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Cygnus-X XC125 SR	Air-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Yamaha	NMAX ABS	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
	○		Yamaha	YZ450 F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZ250 F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZ250	Water-cooled/2-stroke/single-cylinder/reed valve
		○	Yamaha	YZ125	Water-cooled/2-stroke/single-cylinder/reed valve
		○	Yamaha	YZ85 LW	Water-cooled/2-stroke/single-cylinder/reed valve
		○	Yamaha	YZ85	Water-cooled/2-stroke/single-cylinder/reed valve
		○	Yamaha	YZ450 FX	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZ250 FX	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZ250 X	Water-cooled/2-stroke/single-cylinder/reed valve
		○	Yamaha	YZ125 X	Water-cooled/2-stroke/single-cylinder/reed valve
		○	Yamaha	PW50	Air-cooled/2-stroke/single-cylinder/ crankcase reed valve
	○		Suzuki	Burgman 400 ABS	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Ninja 650	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Z650	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
September		○	Honda	Gyro X (standard)	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Honda	Gyro Canopy	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Yamaha	YZF-R3 ABS Movistar Yamaha MotoGP Edition	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
		○	Yamaha	Jog CE50 ZR Movistar Yamaha MotoGP Edition	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Vino XC50 D 20 th Anniversary Edition	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Cygnus-X XC125 SR Movistar Yamaha MotoGP Edition	Air-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
	○		Suzuki	Address 125	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	Ninja 1000	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Z1000	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
October		○	Honda	CRF250 R	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Honda	Tact	Water-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	CB400 Super Four	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	CB400 Super Bold'or	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	CB1300 Super Four	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	CB1300 Super Bold'or	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	Benly 110	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Benly 110 Pro	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	YZF-R25 Movistar Yamaha MotoGP Edition	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
	○		Suzuki	GSX-S125 ABS	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Ninja 650 KRT Edition	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Versys-X 250	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
November		○	Honda	Super Cub 50	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Super Cub 110	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Super Cub 50 Pro	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Super Cub 110 Pro	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Benly	Water-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Benly Pro	Water-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Giorno	Water-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	XSR900 ABS	Water-cooled/4-stroke/inline 3-cylinder/DOHC/4-valve/FI
	○		Yamaha	XSR700 ABS	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Ninja H2 R	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Versys-X 250 Tourer	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
December		○	Honda	CB400 Super Four (Instructional vehicle spec.)	Water-cooled/4-stroke/4-cylinder/DOHC/4-valve/FI
		○	Honda	Lead 125	Water-cooled/4-stroke/single-cylinder/DOHC/2-valve/FI
		○	Honda	CB1100 RS	Air-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
	○		Kawasaki	Z900 RS	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI

down to 19,000 vehicles.

2. 3. 6. Central and South America

In 2017 motorcycle exports to Central and South America increased significantly by 41% compared to the previous year to reach 25,000 vehicles.

3 Design Trends

In both developed countries and emerging nations, the design of motorcycles continues to unfold around a common concept that leverages the strengths of the manufacturer and the image of the brand. At the same time, the diversification of customer preferences makes it obvious that manufacturers are exploring new ideas such as neo-retro and café racer designs that attempt to adapt to individual customer lifestyles as exemplified by the desire for "something different from what everyone else has".

4 Product and Technological Trends

4. 1. Product Trends

Table 1 lists some of the representative motorcycle models launched in Japan in 2017. New models on the market include the Yamaha Axis Z LTS125 and the Suzuki Address 125 class 2 motor-driven cycles, the Honda CBR250RR and Rebel 250, the Yamaha Tricity MW150A, the Suzuki V-Strom 250, and the Kawasaki Versys-X 250 ABS/Tourer mini-sized motorcycles, as well as the Honda CB1100 RS, Yamaha MT-10/SP, Suzuki GSX-S750 ABS, and the Kawasaki Z900RS small-sized motorcycles.

4. 2. Technological Trends

Common platforms for multiple vehicles in each class continue to be adopted, with multiple products launched for different categories and levels of engine displacement. While advances in electronic control technologies have led to unveiling some high-performance models with high horsepower, many products developed with an emphasis on fun and ease-of-use when driving in town and while touring have also appeared.

References

(1) Japan Automobile Manufacturers Association, Inc., Website database, http://jamaserv.jama.or.jp/newdb/eng/index.html

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Engines

1 Technological Trends in Japan

1. 1. Overview

Table 1 shows the specifications of the main new engines launched by manufacturers in Japan in 2017. The various new motorcycles introduced in 2017 suggest that manufacturer focus for engine development and improvement has turned to enhancing the sports performance and riding enjoyment for everyday use on urban streets and during touring, rather than simply increasing engine speed and power. In addition, further advances in electronic controls enhances multi-functionality and environmental performance while emphasizing comfort and handling.

1. 2. Trends of Each Manufacturer

1. 2. 1. Honda Motor Co., Ltd.

(1) CBR250RR

This motorcycle is equipped with a 249 cm^3, water-

Table 1 Specifications of new engines in 2017

Manufacturers	Name of model	Engine type	Displacement (cm^3)	Bore (mm)	Stroke (mm)	Maximum power (kW/rpm)	Maximum torque (Nm/rpm)
Honda	CBR250RR	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI	249	62.0	41.3	28/12,500	23/11,000
	CRF1000L Africa Twin	Water-cooled/4-stroke/parallel 2-cylinder/OHC/4-valve/FI	998	92.0	75.1	70/7,500	99/6,000
	CBR1000RR	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI	999	76.0	55.1	141/13,000	114/11,000
Yamaha	XSR700	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI	688	80.0	68.5	54/9,000	68/6,500
	TRICITY 155 ABS	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI	155	58.0	58.7	11/8,500	14/6,000
	YZ450F (racing model)	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI	449	97.0	60.8	N.A.	N.A.
Suzuki	GSX-S750 ABS	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI	749	72.0	46.0	83/10,500	80/9,000
	V-Strom 650	Water-cooled/4-stroke/V2/DOHC/4-valve/FI	645	81.0	62.6	51/8,800	61/6,500
	Gixxer	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI	154	56.0	62.9	10/8,000	14/6,000
Kawasaki	Ninja 250 (model for outside Japan)	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI	248	62.0	41.2	27/12,500	23/10,000
	Ninja H2 SX (model for outside Japan)	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI	998	76.0	55.0	147/11,000	137/9,500
	Z900 RS	Water-cooled/4-stroke/parallel 4-cylinder/DOHC/4-valve/FI	948	73.4	56.0	82/8,500	98/6,500

Fig. 1 External appearance of CBR250RR.

Fig. 2 External Appearance of CRF1000L Africa Twin

cooled, 4-stroke, DOHC, 4-valve, parallel 2-cylinder engine. The bore × stroke dimensions are 62.0 × 41.3 mm and its compression ratio is 11.5. A downdraft air intake layout with large-diameter valves and a large-diameter throttle bore were adopted to achieve both easier handling characteristics over the normal speed range and good high speed performance. Friction was reduced via the adoption of aluminum cylinder sleeves and a molybdenum coating on the piston skirts in an effort to realize a lightweight and compact design with even higher power. The dual tail pipe exhaust has exhaust pipes connected to chambers 2 and 3 of the 3-chamber muffler structure to realize an exhilarating exhaust sound and feel of acceleration in combination with the optimized transmission gear ratio. Figure 1 shows the external appearance of this motorcycle.

(2) CRF1000L Africa Twin

This motorcycle is equipped with a 998 cm^3, water-cooled, 4-stroke, OHC, 4-valve, parallel 2-cylinder engine. The bore × stroke dimensions are 92.0 × 75.1 mm and its compression ratio is 10.0. This newly designed engine achieves greater concentration of mass and a lower center of gravity thanks to the technical feedback from racing motorcycles, such as the CRF450. The lowest possible height above the ground was secured via space-saving technologies such as the unique rocker arm-type

Fig. 3 External appearance of CBR1000RR.

valve train and a dry-sump oil pump housed within the crankcase, further improving rough road performance over that of the 2016 model. The newly designed air intake and exhaust system also highlights the pulse feeling and the sound of the exhaust. Figure 2 shows the external appearance of this motorcycle.

(3) CBR1000RR

This motorcycle is equipped with a 999 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 4-cylinder engine. The bore × stroke dimensions are 76.0 × 55.1 mm and its compression ratio is 13.0. The valve timing, amount of lift, compression ratio, shape of the combustion chamber, throttle bore diameter, and muffler structure of the 2016 model were all changed. The air intake resistance inside the air cleaner box was reduced while the intake air density was increased and power was improved over the entire engine speed range by raising the fuel discharge pressure by about 14%. In addition, the piston rings have a DLC coating that improves sealing. Magnesium was chosen as the material for the left cover of the crankcase and the oil pan and excess weight was removed from the transmission gear, reducing the weight of the engine as a whole by about 2,000 grams. Furthermore, downsizing was achieved by adopting titanium for the muffler material and a high density core for the radiator, leading to better concentration of mass and reducing weight by about 2,900 grams. Figure 3 shows the external appearance of this motorcycle.

1. 2. 2. Yamaha Motor Co., Ltd.

(1) XSR700

This motorcycle is equipped with a 688 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 2-cylinder engine. The bore × stroke dimensions are 80.0 × 68.5 mm and its compression ratio is 11.5. This engine with a proven track record in the MT-07 model was introduced into the European market in 2016 and into the Japanese domestic market in 2017. It uses a 270-degree crossplane

Fig. 4 External appearance of XSR700

Fig. 5 External appearance of Tricity MW155A

crankshaft that emphasizes torque over the practical speed range, and exhibits tenacious torque characteristics especially in the 4th to 6th gears. This engine features a horizontal air intake system layout and fuel injection (FI)-based fuel supply. Its fuel economy of 23.9 km/L in the WMTC test cycle offers excellent economic benefits. Figure 4 shows the external appearance of this motorcycle.

(2) Tricity 155 ABS

This motorcycle is equipped with a 155 cm^3, water-cooled, 4-stroke, SOHC, 4-valve, single-cylinder engine. The bore × stroke dimensions are 58.0 × 58.7 mm and its compression ratio is 10.5. This engine is characterized by its economy and excellent torque characteristics. Variable valve actuation (VVA), which switches the operations of the air intake valves in the low-to-mid-speed range and in the high-speed range, was adopted. The ports and combustion chamber, as well as the FI settings, were optimized to realize easy-to-handle torque characteristics. The use of aluminum cylinders and a bypass thermostat for cooling water circulation reduced weight and shortened the warm-up operation time while ensuring a high level of cooling performance, achieving excellent fuel economy. Figure 5 shows the external appearance of this motorcycle.

(3) YZ450F (racing model)

This motorcycle is equipped with a 449 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, single-cylinder engine. The bore × stroke dimensions are 97.0 × 60.8 mm and its compression ratio is 12.8. In comparison to the 2016 model, the shape of the air intake port and the combustion chamber were changed, fuel filling efficiency was improved, and friction loss was reduced by applying a DLC coat to the piston pins. The cam profiles for both air intake and exhaust were changed to have high lift, and excellent power characteristics were realized by optimizing the valve timing. The shape of the pressure plate of the clutch was changed to reduce weight without compromising on rigidity, and both sides of the clutch plate were subjected to grinding to reduce transmission loss. In the transmission, all reduction ratios were revised and the shape of the dog was optimized to improve operability. A self-starter motor was adopted to facilitate the restart of the engine during racing, and the resulting weight increase was countered by adopting a lithium-ion battery as a power source. Devising a unique arrangement for the torque limiter also reduced weight and made everything more compact. Figure 6 shows the external appearance of this motorcycle.

1. 2. 3. Suzuki Motor Corporation

(1) GSX-S750 ABS

This motorcycle is equipped with a 749 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 4-cylinder engine. The bore × stroke dimensions are 72.0 × 46.0 mm and its compression ratio is 12.3. This engine is based on the one in the GSX-R750. However, the cam profile and air intake and exhaust systems were changed so that the engine not only generates powerful torque in the low-speed range, but also provides nimble pick-up characteristics up through the high-speed range. The ECU settings were optimized to ensure good response and acceleration performance in the low to medium speed range, improve fuel economy, and decrease emissions. A system to support driving by raising engine speed slightly at starts from a stop or during low-speed running improves start-off performance, and setting the final reduction ratio to a lower gear provides better acceleration performance at all engine speeds. Figure 7 shows the external appearance of this motorcycle.

(2) V-Strom 650

This motorcycle is equipped with a 645 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, V2 engine that is based on the one in the SV650. The bore × stroke dimensions are 81.0 × 62.6 mm and its compression ratio is 11.2. The characteristic low speed torque and medium to high

Fig. 6 External appearance of YZ450F.

Fig. 7 External appearance of GSX-S750

Fig. 8 External appearance of V-Strom 650 ABS.

speed performance of the V-twin engine are easy to handle, allowing power to be drawn from any engine speed range and realizing a relaxed riding feeling at higher gears. The aluminum die cast cylinders use a unique plating technology that reduces friction and ensures high heat dissipation, wear resistance, and tight seals. Friction has been further mitigated by the application of a resin coating to the piston skirts. Two spark plugs are used per cylinder to raise combustion efficiency and lower fuel consumption, and an atomizing injector was added to the fuel supply system to reduce emissions. The throttle body is equipped with an ISC (Idle Speed Control) to realize smooth starting and stable idling. Figure 8 shows the external appearance of this motorcycle.

(3) Gixxer

This motorcycle is equipped with a 154 cm^3, air-cooled, 4-stroke, SOHC, 2-valve, single-cylinder engine. The bore × stroke dimensions are 56.0 × 62.9 mm and its compression ratio is 9.8. Produced and sold in India starting in 2014, it was first exported mainly to Asian countries and Central and South America, and was introduced to the Japanese market in 2017. The engine developed specifically for this model incorporates friction reduction technologies and combustion efficiency improvement technologies gleaned from more advanced models to achieve an excellent fuel economy of 58.8 km/L (value reported to the Ministry of Land, Infrastructure, Transport and Tourism, 60 km/h steady state fuel economy). To comply with emissions regulations, the fuel supply system replaced the carburetor with fuel injection when this motorcycle was brought to the Japanese market. In India, it has won Bike of the Year awards in 13 different categories. Figure 9 shows the external appearance of this motorcycle.

1. 2. 4. Kawasaki Heavy Industries

(1) Ninja 250 (model for outside Japan)

This motorcycle is equipped with a 248 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 2-cylinder engine. The bore × stroke dimensions are 62.0 × 41.2 mm and its compression ratio is 11.6. The engine was newly designed and offers significantly improved power compared with the 2016 model. The adoption of downdraft air intake ports and an atomizing fuel injector, along with optimized fuel injection settings, realized high-response power characteristics. A significant weight reduction in comparison to the 2016 model was also achieved through numerous improvements, such as a simplified water flow path that decreases the amount of cooling water, an optimized oil pan shape that reduces the amount of oil, a smaller clutch diameter, a thinner exhaust pipe, and the adoption of a lightweight crankshaft and a forged camshaft. In addition, a cylinder difference was provided in the air intake path length and the torque valley was eliminated, leading to smooth power characteristics. The addition of a piston oil jet and adoption of an open deck cylinder with excellent heat dissipation alleviate temperature rise and ensure reliability. The increased capacity of the air cleaner box structure enhances the feeling of acceleration through the air intake sound. This model was introduced in Asian countries ahead of the Japanese domestic market. Figure 10 shows the external appearance of the motorcycle.

(2) Ninja H2 SX (model for outside Japan)

This motorcycle is equipped with a 998 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, inline 4-cylinder engine. The bore × stroke dimensions are 76.0 × 55.0 mm and its compression ratio is 11.2. It is based on the engine in the Ninja H2 and achieves both excellent power and fuel economy performance. Thermal efficiency was raised to the utmost by maximizing the compression ratio and striking a balance with supercharging. As a result, fuel consumption was reduced by about 25% in comparison to the Ninja H2. Moving to a tourer-oriented performance reduced the thermal load and made it possible to elimi-

Fig. 9 External appearance of the Gixxer.

Fig. 10 External appearance of Ninja 250

Fig. 11 External appearance of Ninja H2 SX

nate the oil jet for piston cooling, as well as reduce oil pump loss. The air intake duct was made smaller, and a sound hole emphasizing the intake sound unique to superchargers was set in the air intake pathway. The supercharger impeller and intake chamber shape were optimized to achieve both higher power and better fuel consumption. In addition, the low and medium speed performance was improved by optimizing the air intake funnel length, narrowing the cam profile, reducing the overlap, and optimizing the shape of the intake port. The diameter of the exhaust pipe was reduced compared to that on the Ninja H2, and further improvements to low and medium speed performance and fuel economy were also realized by changing the exhaust collection method from 180 to 360 degrees. Sound muffling was improved by adopting a two-chamber structure for the exhaust pre-chambers, decreasing the volume of the muffler by about 30% compared to the Ninja H2, and reducing overall size and weight. This model was introduced in Europe and Asian countries ahead of the Japanese domestic market. Figure 11 shows the external appearance of this motorcycle.

(3) Z900 RS

This motorcycle is equipped with a 948 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 4-cylinder engine. The bore × stroke dimensions are 73.4 × 56.0 mm and its compression ratio is 10.8. It diverges from the base Z900 model with an external appearance more closely aligned with a neo-retro design and an engine cover made entirely from aluminum die cast parts to enhance the sense of quality. The compression ratio was changed, the cam profile was narrowed, and the valve overlap was reduced to improve low and medium speed torque. The area and positioning of the air intake port of the air cleaner box was optimized and the feeling of acceleration and exhilaration were also improved by emphasizing the air intake sound. The air intake funnel length has been optimized for each cylinder to help realize flat torque characteristics. An assist and slipper clutch similar to the one on the Z900 was adopted, and the operation load and back torque were both reduced. The first and sixth gears were changed within the transmission gear ratio. The first gear was set to a lower gear to improve acceleration from a stop, and the sixth gear was set higher to reduce the engine speed during high-speed running as well as to improve fuel economy. The exhaust pipe uses a double pipe structure to improve low and medium speed torque and reduce discoloration due to heat. Sound muffling was improved by increasing the volume of the exhaust pre-chambers by about 20% compared to the Z900, while weight was reduced by finding a way to straighten and downsize the muffler structure. A two-chamber structure was adopted for the internal structure, and the low frequency exhaust sound at low engine speed was emphasized by giving the communication pipe a taper angle and a vent hole. Figure 12 shows the external appearance of this motorcycle.

2 Technological Trends outside Japan

2. 1. Trends of Each Manufacturer

2. 1. 1. BMW

(1) G310R

This motorcycle is equipped with a newly designed 313 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, single-cylinder engine. The bore × stroke dimensions are 80.0 × 62.1 mm and its compression ratio is 10.6. The normal air intake and exhaust layout has been reversed to a front intake and rear exhaust. A downdraft air intake pathway was adopted and the cylinder was tilted backwards to enlarge the volume of the air cleaner box. In addition, mass was concentrated and the front-to-rear weight balance was optimized. The absence of an exhaust system at the front of the engine allows the radiator to be placed directly ahead of it, which contributes to a further con-

Fig. 12 External appearance of Z900RS

Fig. 13 External appearance of G310R

Fig. 14 External appearance of Street Triple.

centration of the mass. The capacity of the muffler was increased to compensate for the decrease in sound muffling performance caused by the positioning of the exhaust system at the rear of the vehicle. Figure 13 shows the external appearance of this motorcycle.

2. 1. 2. Triumph Motorcycles Ltd.

(1) Street Triple

This motorcycle is equipped with a 765 cm^3, water-cooled, 4-stroke, DOHC, 4-valve, parallel 3-cylinder engine. It is still based on the 675 cm^3 engine from 2007, but the bore and stroke were changed, engine displacement was raised, and the compression ratio was increased to improve power and torque. In the transmission, the first and second gears were set lower to effectively extract the low-speed torque unique to three-cylinder engines, producing good gear changes that provide agile acceleration. Three grades of this motorcycle model are offered, and the two higher-grade models are equipped with an assist and slipper clutch to improve controllability and comfort. A ride-by-wire system was adopted for the throttle and the highest grade model is equipped with five types of traction control. The level of control is automatically optimized in accordance with driving conditions. Figure 14 shows the external appearance of this motorcycle.

3 Research and Development Trends

The fuel economy performance in the WMTC test cycle is now being displayed alongside motorcycles, indicating that it is becoming a major selling point. The various approaches to improving fuel economy include using high efficiency engine operation regions, improving combustion characteristics, and reducing energy losses, and they will likely remain the object of steady research and development for the foreseeable future. At the same time, advances are being made in other technologies, such as fuel cells and electric motorcycles (EVs). A recent example is the Impulse TT made by Victory Motorcycles, which was introduced to the US market in 2016. While improving fuel economy and responding to increasingly stringent emissions regulations will remain important, research and development must also emphasize the creation of fun-to-ride products that achieve both high environmental and dynamic engine performance. Motorcycles are already used around the world and fulfill a variety of roles in every market. However, they are more than just a means of transportation, and manufacturers must continue improving performance and quality to deliver enjoyable and exciting products to the customer.

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Design Trends

1 Introduction

The vehicles exhibited at the biannual Tokyo Motor Show 2017 (TMS) and also at the annual EICMA 2017 motorcycle show (EICMA) held in Milan, Italy provide insight on the motorcycle design trends that emerged in 2017.

The TMS was held from November 27 to December 6, 2017 and was attended by 770,000 people, a slightly lower total number than the previous show (in 2015). Due to the recent continual decline in the number of exhibits by non-Japanese manufacturers, and setting aside automobile motor shows, the motorcycle shows have definitely acquired the feel of shows for Japanese domestic manufacturers. In contrast, EICMA continues its tradition of attracting numerous manufacturers both large and small from all over the world as well as innumerable parts suppliers. The venues that feature everything from the latest in EV motorcycles to a truly huge selection of accessories impart the feeling of a rich and mature motorcycle culture. Furthermore, from a design standpoint, both of these events tend to promote their products with somewhat different approaches, making them crucial in terms of identifying design trends among motorcycle manufacturers.

2 Mature Markets and Searching for Breakthrough Products

In the worldwide motorcycle market, sales in developed countries have been hitting their ceilings, but some emerging countries, including the ASEAN nations, have exhibited a largely sustained sales growth, despite a general sense of slowing down. Consequently, manufacturer business strategy has focused on pursuing stable and high profitability in emerging countries, while at the same time promoting a design strategy that enhances the individuality and value of their brand to drive sales in developed countries. This is attributed to the rapid decline in regional differences, such as the national character of each country and the design preferences rooted in those cultures, brought about by the spread of the internet and social media.

Value systems around the world have also been diversifying in tandem with that decline. In what may be a reaction to the super sports motorcycle category itself, in which manufacturers lavishly pour their latest technologies and after which many riders long for years even though ordinary riders are only able to draw out a small portion of their performance, there has been a definite shift years toward product categories aligned with customers' varied lifestyles and evoking recreation in many forms. That shift suggests that once riders move beyond the speed-oriented notions of maximum speed and acceleration power, which represent one of the major attractions of owning a motorcycle, they have become more likely to project their original lifestyle and interests, such as "travel", "adventure", or "fashion", onto the motorcycle and choose a model from a category that suits them more precisely.

In addition, manufacturers are now offering minute variations of models, including accessories, to respond to the growing diversification of customer needs. Instead of pursuing the sale of a specific number of units of a single model, they appear to be strengthening their products' appeal to discerning users with years of experience riding motorcycles. At the same time, some manufacturers have begun using mass production models to explore a new sense of value that goes beyond the conventional motorcycle framework. One example is the Yamaha Niken (Fig. 1), a large-sized model that was announced at the TMS. This is a model to keep an eye on not only because of its original appearance, but also to see how the market will react to it, particularly in terms of handling and potential.

3 Diversification of Neo-Retro Models

At the TMS and EICMA, Honda announced the CB1000R "Neo Sports Café" motorcycle (Fig. 2) and Kawasaki announced the Z900 RS (Fig. 3), which is an hom-

Fig. 1 Yamaha Niken

Fig. 2 Honda CB1000

Fig. 3 Kawasaki Z900RS

age to one of its past famous models, the Z1. The Honda CB1000R is not designed to directly recall a famous model from its past, but rather returns to a simple structure centered on the fuel tank, a mainstay of the design of the original motorcycles. Nevertheless, modern design processing that leverages the latest technologies give it a high degree of refinement that would not look out of place in the current Yamaha XSR series of motorcycles. This same design method was also followed for the Honda CB300 R and 125 R, models aimed at new riders. This lineup of new naked models from Honda is making a strong statement about the direction of their design. In a different vein, the Kawasaki Z900 RS was designed under the concept of "heritage", and attempts to reproduce the image of its famous Z1 model from 45 years ago using the latest in modern technology. Coupled with its characteristic coloring, this model has had a big impact on the market.

Among non-Japanese models, the Ducati Scrambler 1100 (Fig. 4) was also announced at EICMA as the pinnacle of the company's Scrambler series, which also attracted attention by offering minute variations of the model. Manufacturer "heritage" is thus being incorporated into new models with a modern interpretation that uses the latest designs and technologies, a trend that has also occasionally been seen in some high-priced luxury automobiles. For European manufacturers with a long history, as well as Japanese motorcycle manufacturers who are steadily building up their own histories and gaining recognition, this "heritage" can be utilized very effectively for brand strategy and sales promotion, and this approach is likely to become more prevalent.

Fig. 4 Ducati Scrambler 1100

The apparently straightforward neo-retro label actually covers a variety of styles born over the long history of motorcycles. As manufacturers attempt to respond very precisely to user demand for "something different from everyone else", a growing variation of models from café and scrambler styles, more recently, dirt-track style motorcycles illustrates the growing momentum of the wave of diversification in the neo-retro design space.

4 Motorcycles as a Travel Companion

As embodied by the word "touring", a motorcycle is a vehicle that is ideally suited to this fundamental concept of travelling about freely while experiencing the natural environment first hand. Consequently, manufacturers are now releasing various models envisioned for use in a variety of different scenarios, from models with an adventurous image designed for trips into the great outdoors, to models that provide high speed and comfortable transportation for the rider and their partner. In particular, motorcycles in the adventure category, as represented by the GS series of motorcycles from BMW, seem to firmly match up with their rider's daily uses. From their high line-of-sight and comfortable riding position, to their mobility on crowded urban streets and utility for holiday touring trips, many similar carefully designed models from numerous manufacturers were on display at EICMA.

At the top of the list of touring motorcycles is the Honda Gold Wing grand tourer (Fig. 5), which received its first complete redesign in 17 years. The Gold Wing,

Fig. 5 Honda Gold Wing

Fig. 6 Ducati Scrambler

which occupies a prominent position in this category, was reborn with styling that pushes "sportiness" to the forefront and a completely redesigned engine and body focused on weight reduction in an effort to respond to the changes in the user base. The headlight also benefitted from the adoption of a design method that makes full use of the characteristics of LEDs, which contributed greatly to the promoting the model as a complete redesign.

5 Design Innovations Produced by LED Lights

Initially adopted on automobiles, LED headlights are also becoming increasingly popular on motorcycles. Although they were first only available on large displacement, expensive models, they are now gradually being installed on motorcycles in the intermediate displacement class and below. Compared to headlamps and other lighting equipment using bulbs usually found on motorcycles, LED lights consume less electrical power, produce less heat, and allow for a more compact lighting unit, making them highly advantageous in terms of increasing the degree of freedom of designs. However, they have the disadvantage of being more expensive than bulbs. Although this is undeniably hindering the wider adoption of LED lights on motorcycles, this issue is expected to be mitigated in the near future.

5. 1. Visually Important Items for Brand Appeal

Audi was the first manufacturer to use LED lights for the daytime running lights (DRLs) in their automobiles, and, partly due to legislation enacted in Europe, LEDs subsequently came to be used throughout the vehicle. Although DRLs serve to increase the visibility of the vehicle, it is well-known that the design of the front face of a car is an important means of differentiating it from other brands. Consequently, LED DRLs can be used as a lighting icon even after sunset, and manufacturers are now using various means to focus heavily on their design. However, DRLs themselves are not yet mandatory worldwide for motorcycles, and have only been adopted on some European models, but manufacturers are nevertheless actively trying to differentiate their motorcycles from the competition by applying creative designs to the shape and layout of the headlight unit.

5. 2. European Motorcycles Take the Lead

Drawing on motorcycles exhibited at EICMA as examples, European manufacturers, such as Ducati, BMW, and KTM, were actively employing LED DRLs designs. The Ducati Scrambler stood out for its simple, retro-type round headlight in which the DRLs consisted of 4 separate LED lights shining around the circumference of the headlight. This illumination pattern was used as a representative icon of the model in advertisements (Fig. 6). Manufacturers are not just stopping at this simple switch in light source from the bulbs to LEDs, but are also capitalizing on the fact that using LEDs makes it easier to create appealing designs. In addition, LEDs are also using in the turn signals of some of the latest motorcycle models, and are predicted to see use in even more new design methods, including combinations of the various lighting equipment and ways of showing them off.

5. 3. What Advances in Technology Bring to Design

The changes in motorcycle design brought about by the adoption of LED lights started with the conversion of instrument panel meter lights to white colored lights. Next, the tail lights themselves were made smaller, eliminating the need for regular maintenance and leading to the tail section itself becoming shorter. The possibility of using LED license plate lights and turn signals, which are resistant to vibration, has also increased the number of models with a rear flap mounted on a swing arm. Some configurations may increase the difficulty of the design itself, but these types of models will likely become more common in certain categories. Beyond the use of LED lights, the adoption of thin-film transistors (TFT) for the instrument panel and the eventual conversion to EVs

highlight the extremely large influence of advances in technology on design. The value expected of motorcycles will continue to change with the times. As numerous industrial products turn into commodities, it will be necessary to ask how well these changes can be anticipated, as well as how to instill a high amount of added value to the company brand while also differentiating the product and incorporate these elements in the designs.

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