Motorcycles

Overall Trends

1 Introduction

Despite concerns that the consumption tax hike would lead to a drop in production and shipments, motorcycle production exhibited positive growth for the first time in four years, rising 6% compared to the previous year, while overall shipments remained essentially steady (99.4%).

2 Production and Demand Trends

2. 1. Production

As shown in Fig. 1, Japanese motorcycle production in 2014 rose by 6.0% to 597,000 units over the previous, the first positive growth in four years. Buoyed by the inexpensive yen, exports rose by 8.0% to 466,000 units, and shipments in Japan fell by 0.6% to 417,000 units.

2. 2. Demand in Japan

On the basis of engine displacement, demand in Japan dropped for class 1 and 2 motor-driven cycles, as shown in Fig. 2. By contrast, demand for mini- and small-sized motorcycles grew considerably, and the total for all displacement categories was essentially the same as the previous year (99.4%), or 417,000 units.

2. 2. 1. 50 cm^3 or less (class 1 motor-driven cycles)

In 2014, demand for this class fell by 4.1% to 229,000 units from the previous year. This was the third successive year-on-year decline since the surge in demand in the wake of the 2011 Great East Japan Earthquake.

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

In 2014, demand for this class fell by 4.7% to 96,000 units from the previous year.

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

In 2014, demand for this class increased greatly by 11.4% to 53,000 units.

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

In 2014, demand for this class increased by 20.7% to 38,000 units, partly due to the launch of new models.

2. 3. Exports

As shown in Fig. 3, motorcycle exports in 2014 rose by 8.0% over the previous year to 466,000 units. A recovery in demand could be seen in all regions except Central and South America. This is undoubtedly largely due to the low exchange rate of the yen.

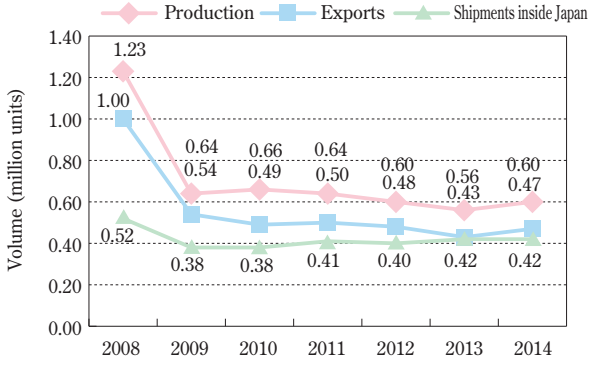

Fig. 1 Trends for production, exports, and shipments inside Japan

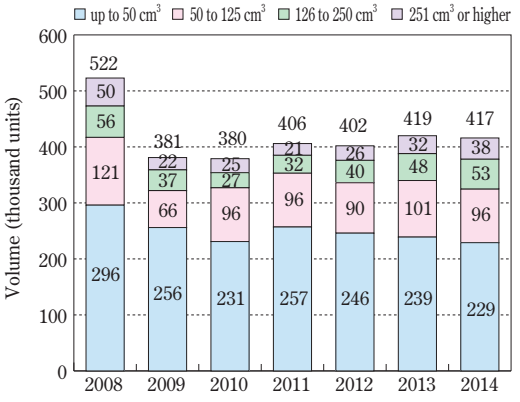

Fig. 2 Shipments inside Japan based on displacement

2. 3. 1. North America

In 2014, exports to North America rose by 3.0% to 184,000 units.

2. 3. 2. Europe

Exports to Europe in 2014 exhibited a strong growth, rising by 17.9% to 175,000 units compared to the previous year. This suggests that the continued decrease that started in 2011 has come to a halt.

2. 3. 3. Asia

In 2014, exports to Asia rose by a considerable 36.0% to 25,000 units. These results are attributed to moving production back to Japan from overseas bases due to the low exchange rate of the yen.

2. 3. 4. Oceania

Exports to Oceania in 2014 rose by 5.1% to 33,000 units.

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

In 2015, exports to the Middle-East and Africa rose by 5.7% to 25,000 units.

2. 3. 6. Central and South America

In 2014, exports to Central and South America fell by 20.1% to 27,000 units.

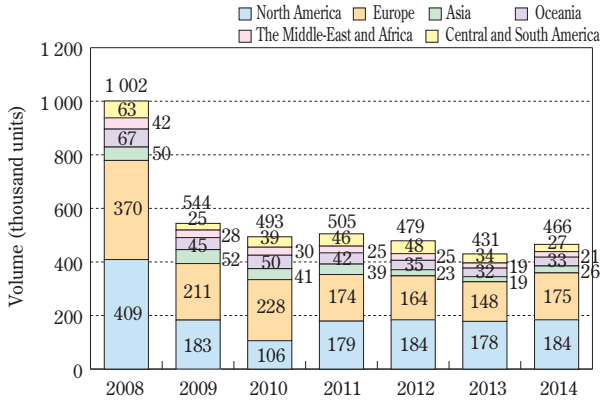

Fig. 3 Shipments per market

3 Product and Technological Trends

3. 1. Product trends

Table 1 lists some representative models of motorcycles launched in Japan in 2014. New models on the market include the Honda Dunk and Suzuki Let's G class 1 motor-driven cycles, the Honda PCX/PCX150, the Suzuki Burgman 200, the Yamaha Tricity and YZF-R25 class 2 motor-driven cycles, as well as the Honda CTX1300, NM4-01/02 and CBR650F/CB650F, the Suzuki V-Strom 1000 ABS, and the Yamaha MT-09/09A and MT-07 small-sized motorcycles. Even as the trend to share platforms between multiple models continues, new concepts

Table 1 Details of main new motorcycles launched in 2014

Month of launch	New	Modified	Manufacturer	Name of model	Characteristics
January		○	Suzuki	RM-Z250	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	RM-Z450	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	Estrella	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	GSR250, GSR250S	Water-cooled/4-stroke/2-cylinder/SOHC/2-valve/FI
		○	Suzuki	Intruder Classic 400	Water-cooled/4-stroke/V2/SOHC/4-valve/FI
		○	Suzuki	Address V50	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	Tricker (250)	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	Majesty YP250	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Yamaha	Serow 250	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Honda	Giorno, Giorno Deluxe	Air-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
	○		Honda	NC750X, NC750S	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
		○	Yamaha	Tmax 530 Bronze Max ABS	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZF-R1	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Yamaha	FZ1 Fazer	Water-cooled/4-stroke/inline 4-cylinder/DOHC/5-valve/FI
February		○	Kawasaki	Ninja ZX-6R (track-only model)	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Kawasaki	ZRX 1200 DAEG	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
	○		Honda	Integra	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
	○		Suzuki	Hayabusa	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Yamaha	Vox XF50, Vox XF50D	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	Vino XC50	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
	○		Honda	CBR1000RR, CBR1000RR SP	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
	○		Honda	CB1100, CB1100EX	Air-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
	○		Honda	Dunk	Water-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
	○		Honda	CTX1300	Water-cooled/4-stroke/V4/DOHC/4-valve/FI
	○		Suzuki	Burgman 200	Water-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
		○	Yamaha	YBR125, YBR250	Details not known

Table 1 Details of main new motorcycles launched in 2014 (cont.).

Month of launch	New	Modified	Manufacturer	Name of model	Characteristics
March		○	Kawasaki	Z250	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
	○		Honda	VFR1200X Dual Clutch Transmission	Water-cooled/4-stroke/V4/OHC/4-valve/FI
	○		Honda	CB1300 Super Four, CB1300 Super Bol d'Or	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Honda	CB400 Super Four, CB400 Super Bol d'Or	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
April		○	Suzuki	GSR 400 ABS	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Yamaha	Cygnus-X SR YSP 30th Anniversary Edition	Air-cooled/4-stroke/single-cylinder/SOHC/4-valve/FI
	○		Yamaha	MT-09, MT-09A	Water-cooled/4-stroke/inline 3-cylinder/DOHC/4-valve/FI
		○	Honda	Monkey Kumamon Version	Air-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
		○	Suzuki	Let's 4 Basket	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	ST250 E Type	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Kawasaki	W800 Chrome Edition	Air-cooled/4-stroke/inline 2-cylinder/SOHC/4-valve/FI
		○	Kawasaki	Ninja 400 ABS Special Edition	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
		○	Honda	Grom	Water-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Skywave 250 Type S Basic, SS, M, Limited	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
	○		Honda	VFR800F	Water-cooled/4-stroke/V4/DOHC/4-valve/FI
	○		Honda	CBR650F, CB650F	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Honda	NC750X, NC750S, Integra	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
	○		Honda	NM4-01	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
	○		Honda	Gold Wing F6C	Water-cooled/4-stroke/horizontally opposed 6-cylinder/OHC/2-valve/FI
	○		Honda	PCX	Water-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
May		○	Suzuki	GSR 750 ABS	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
	○		Honda	PCX150	Water-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
	○		Honda	CBR250R	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	Serow 250 YSP 30th Anniversary Edition	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
June	○		Suzuki	V-Strom1000 ABS	Water-cooled/4-stroke/V2/DOHC/FI
		○	Honda	NM4-02	Water-cooled/4-stroke/inline 2-cylinder/OHC/4-valve/FI
July		○	Kawasaki	KLX250	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve
		○	Kawasaki	D-Tracker X	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve
		○	Suzuki	Grasstracker Bigboy	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Yamaha	Vino XC50 D Vacation Style	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Honda	VTR, VTR-F, VTR Type LD	Water-cooled/4-stroke/V2/DOHC/4-valve/FI
		○	Yamaha	Bolt R-Spec ABS YSP 30 th Anniversary Edition	Air-cooled/4-stroke/V2/SOHC/4-valve/FI
August		○	Honda	CB250F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
	○		Kawasaki	KX450F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
	○		Kawasaki	KX250F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Kawasaki	KX85 II, KX85, KX65	Water-cooled/2-stroke/single-cylinder/piston reed valve
		○	Kawasaki	Vulcan 900 Classic	Water-cooled/4-stroke/V2/SOHC/4-valve/FI
		○	Yamaha	PW50	Air-cooled/2-stroke/crankcase reed valve
		○	Yamaha	YZ450F, YZ250F	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Yamaha	YZ250	Water-cooled/2-stroke/single-cylinder/piston reed valve
		○	Yamaha	YZ125	Water-cooled/2-stroke/single-cylinder/ crankcase reed valve
	○		Yamaha	MT-07	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve
		○	Suzuki	Grasstracker	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
September		○	Kawasaki	Ninja 250	Water-cooled/4-stroke/parallel 2-cylinder/DOHC/4-valve/FI
		○	Kawasaki	W800	Air-cooled/4-stroke/parallel 2-cylinder/SOHC/4-valve/FI
		○	Suzuki	RM-Z250	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
	○		Suzuki	RM-Z450	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
	○		Yamaha	Tricity	Water-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
			Yamaha	WR250R	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	GSR250F	Water-cooled/4-stroke/2-cylinder/SOHC/2-valve/FI
		○	Honda	CRF250R	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Honda	CRF450R	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
October		○	Kawasaki	KLX125	Air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	V-Strom1000 650XT ABS	Water-cooled/4-stroke/90° V-twin/DOHC/4-valve/FI
		○	Suzuki	Address V125 SS	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
		○	Suzuki	Skywave 400 Type S ABS	Water-cooled/4-stroke/single-cylinder/DOHC/4-valve/FI
		○	Suzuki	Gladius 400 ABS	Water-cooled/4-stroke/90° V-twin/DOHC/4-valve/FI

Table 1 Details of main new motorcycles launched in 2014 (cont.).

Month of launch	New	Modified	Manufacturer	Name of model	Characteristics
November		○	Yamaha	YZ85LW, YZ85	Water-cooled/2-stroke/single-cylinder/ crankcase reed valve
		○	Yamaha	XJR1300	Water-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve/FI
		○	Honda	Goldwing SE, SE with airbag and GPS	Water-cooled/4-stroke/horizontally opposed 6-cylinder/OHC/2-valve/FI
		○	Honda	Giorno, Giorno Deluxe	Air-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
December		○	Yamaha	VMAX	Water-cooled/4-stroke/V4/DOHC/4-valve/FI
		○	Honda	Gold Wing F6B	Water-cooled/4-stroke/horizontally opposed 6-cylinder/OHC/2-valve/FI
		○	Yamaha	BW's	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI
		○	Yamaha	WR450F	Water-cooled/4-stroke/single-cylinder/DOHC/5-valve/FI
	○		Suzuki	Let's G	Forced air-cooled/4-stroke/single-cylinder/SOHC/2-valve/FI
	○		Honda	VFR800X	Water-cooled/4-stroke/V4/DOHC/4-valve/FI
		○	Honda	Cross Cub	Air-cooled/4-stroke/single-cylinder/OHC/2-valve/FI
	○		Yamaha	YZF-R25	Water-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve/FI
		○	Yamaha	Jog CE50P	Water-cooled/4-stroke/single-cylinder/SOHC/3-valve/FI

were also tackled.

3. 2. Technological trends

On the environmental front, scooters are at the forefront of improved fuel efficiency technology derived from extensive refinement of core technologies. Amendments to safety regulations will make it mandatory for new motorcycles other than class 1 motor-driven cycles to be equipped with advanced brakes (anti-lock braking system (ABS) or combined braking system (CBS)) starting from 2018. This has also led to the gradual installation of ABS on on-off road models as well. In addition, attention also focused on the launch of the first Japan-made three-wheel model featuring two front wheels that lean with the roll.

References

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(2) Honda Motor Co., Ltd. website, http://www.honda.co.jp/ (in Japanese)

(3) Yamaha Motor Co., Ltd. website, http://www.yamaha-motor.co.jp/ (in Japanese)

(4) Suzuki Motor Corporation website, http://www1.suzuki.co.jp/motor/ (in Japanese)

(5) Kawasaki Motors Corporation Japan website, https://www.kawasaki-motors.com (in Japanese)

Engines

1 Technological Trends in Japan

1. 1. Overview

Table 1 shows the new engines launched by each manufacturer in Japan in 2014.

In the small-sized motorcycle category, efforts to balance the emphasis on fuel efficiency and environmental performance with running performance are universal, and all makers are promoting that concept through their brand names (e.g., eSP, Blue Core, SEP).

Among large-sized motorcycles, a growing number of models are manifesting an appeal that does not rely on one-time factors such as high power or driving performance. In contrast, the first motorcycle with a supercharger announced by Kawasaki Heavy Industries, Ltd. has been drawing attention.

1. 2. Trends of each manufacturer

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

(i) Dunk: equipped with the newly developed enhanced Smart Power (eSP) featuring advanced technologies such as the ACG starter and fuel-efficient technology, as well as a wide array of low-friction technologies, this model balances fuel efficiency and environmental performance based on a stop-start system with strong power characteristics. These enhancements provide a weight reduction of 11% over the Today's air-cooled engine, and achieve a WMTC test cycle fuel economy of 56.4 km/L. At the same time, the original stop-start system has been supplemented with a sub-system the reads battery voltage when the engine starts and avoids the battery going flat by stopping the stop-start function when a low battery voltage is detected. Figure 1 shows the external appearance of the Dunk.

(ii) CBR650F: this engine was made more compact by optimizing the mounting angle of the throttle body and adopting an efficient layout for auxiliary equipment.

Table 1 Specifications of new engines in 2014

Manufacturer	Name of model	Engine type	Displacement (cm^3)	Bore (mm)	Stroke (mm)	Compression ratio	Maximum power (kW/rpm)	Maximum torque (Nm/rpm)
Honda	Dunk	Water-cooled/4-stroke/SOHC/2-valve/single-cylinder	49	39.5	40.2	12.0	3.3/8 000	4.1/7 500
	CBR650F	Water-cooled/4-stroke/DOHC/4-valve/parallel 4-cylinder	648	67.0	46.0	11.4	61/9 500	63/8 000
	NC750X	Water-cooled/4-stroke/SOHC/4-valve/parallel 2-cylinder	745	77.0	80.0	10.7	40/6 250	68/4 750
Yamaha	Nozza Grande	Water-cooled/4-stroke/SOHC/2-valve/single-cylinder	124	52.4	57.9	12.0	N.A.	N.A.
	YZF-R25	Water-cooled/4-stroke/DOHC/4-valve/parallel 2-cylinder	249	60.0	44.1	11.6	27/12 000	23/10 000
	MT-07	Water-cooled/4-stroke/DOHC/4-valve/parallel 2-cylinder	689	80.0	68.5	11.5	54/9 000	68/6 500
Suzuki	Let's G	Water-cooled/4-stroke/SOHC/2-valve/single-cylinder	49	N.A.	N.A.	N.A.	3.0/8 500	3.7/6 500
	V-Strom 1000	Water-cooled/4-stroke/DOHC/4-valve/90° V2	1 036	100.0	66.0	11.3	74/8 000	103/4 000
Kawasaki	Ninja 250	Water-cooled/4-stroke/DOHC/4-valve/parallel 2-cylinder	248	62.0	41.2	11.3	23/11 000	21/8 500

Fig. 1 External appearance of the Dunk

Fig. 2 External appearance of CBR650F

Bore × stroke was set and valve timing adjusted to as small an overlap as possible to achieve ease of handling at low to medium engine speed ranges and extended engine speeds in the high range. At the same time, smooth acceleration in the 6,000 to 9,000 rpm range was obtained through measures such as setting the minimum diameter of the air funnel to ϕ30 mm. Optimizing the length of the exhaust pipe without sacrificing design yields a powerful torque at low engine speed ranges of 4,000 rpm or less, making the vehicle easy to handle. Placing the short muffler in the lower middle part of the body achieves concentration of mass, and the structure is designed to produce an exhaust sound that clearly belongs to an inline 4 cylinder engine. Figure 2 shows the external appearance of the CBR650F.

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

(i) Nozza Grande (for markets outside Japan): the use of a forged aluminum piston and offset DiASil cylinder,

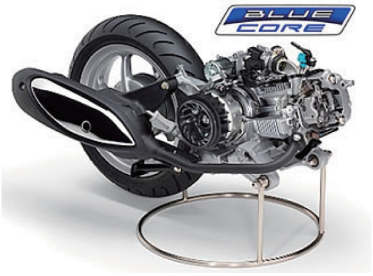

Fig. 3 External appearance of Blue Core engine (Nozza Grande)

as well as a compact, high-efficiency fan, new shroud shape, and a high number of slim cooling fins, fully achieves (a) high combustion efficiency, (b) excellent cooling performance, and (c) power loss reduction. The next-generation compact engine was developed based on the Blue Core concept, which aims to take riding enjoyment, fuel efficiency and environmental performance to all-new levels, will be progressively introduced in various models as the core of their platforms. Figure 3 shows the external appearance of the engine.

(ii) YZF-R25: the structure features straight intake and exhaust valves and adopts a carburized connecting rod and forged aluminum pistons. Based on the latest analysis technology, tumble (a longitudinal vortex of the air-fuel mixture) is actively generated while keeping an optimal flow for the air-fuel mixture, stimulating quick combustion, and achieving both the highest power in its class and ease of handling in day-to-day ranges. This is also the first model to use Yamaha's unique lightweight die-cast aluminum silicon cylinder with superior heat dissipation capacity in a 2-cylinder engine. Figure 4 shows the external appearance of the YZF-25.

(iii) MT-07: following the launch of the earlier MT-09 using the crossplane philosophy, this model has an inline 2-cylinder engine with a 270 degree offset crankshaft, which is combined with a single-axis balancer to reduce

Fig. 4 External appearance of YZF-R25

Fig. 5 External appearance of MT-07

Fig. 6 External appearance of SEP engine (Let's G)

Fig. 7 External appearance of V-Strom 1000

vibration. As in the MT-09, the direct-plated cylinders are offset to help reduce slide resistance. A one-piece, 2-into-1 exhaust system with an underslung muffler is used to reduce weight and make the vehicle more compact. Figure 5 shows the external appearance of the MT-07.

1. 2. 3. Suzuki Motor Corporation

(i) Let's G: this engine us equipped with the unique Suzuki Eco Performance (SEP) advanced technology. The newly developed fuel injection system and optimized shape of the intake ports, as well as thoughtful component placement, simultaneously carries on the compact engine tradition and achieves a WMTC test cycle fuel efficiency of 54.8 km/L, a top rating among air-cooled class motorcycles. Figure 6 shows the external appearance of the engine.

(ii) V-Strom 1000: this engine features a lighter engine with enhanced control performance resulting from the use of finite element method (FEM) analysis to design pistons emphasizing rigidity and weight reduction, as well as the adoption of a radiator with high cooling capability. In addition, refinements were made to the engine electronic control system to improve torque at low speeds. The flywheel was also modified to increase the inertial mass of the magnet, improving control at low engine speeds. In the newly designed transmission, clutch lever operation is made easier by the new Suzuki Clutch Assist System (SCAS), and a back torque limiter was adopted to mitigate rear wheel skidding due to engine braking.

A lower center of gravity was obtained by placing the exhaust system in the lower middle part of the body. The unique Suzuki Exhaust Tuning (SET) system controls the opening of the butterfly valve inside the exhaust pipe according to engine speed, maximizing the tuning of the exhaust pulse at the low speed range, and the high-capacity catalyzer in the exhaust pipe reduces emissions.

The fuel injection system with Suzuki Dual Throttle Valves (SDTV) improves both combustion and fuel efficiency, and the use of two iridium spark plugs per cylinder ensures stable engine starts. Fuel is atomized by new 10-hole fuel injectors, contributing to an improvement in combustion and fuel efficiency. Fuel economy is 20.9 km/L under the WMTC test cycle. Figure 7 shows the external appearance of the V-Strom 1000.

1. 2. 4. Kawasaki

Ninja 250: equipped with the newly designed engine launched in 2013, this is the first 250-class model equipped with the Assist & Slipper Clutch developed based on feedback from racing activities. In addition to making clutch lever operation easier and smoother, the self-servo mechanism provided by the assist cam also fully delivers the transmission force under high loads. When sudden or accidental downshifts cause excessive engine braking, the slipper cam relieves pressure on the clutch plates, reducing back torque and mitigating hopping and skidding of the rear tire. Figure 8 provides an

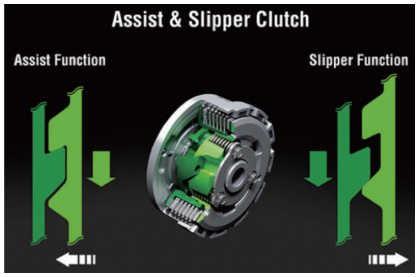

Fig. 8 Assist & Slipper Clutch (Ninja 250)

Fig. 9 External appearance of Street 750

illustration of the clutch.

2 Trends Outside Japan

2. 1. Trends of each manufacturer

2. 1. 1. Harley-Davidson

Street 750: following the water-cooled V-Rod model, this model is fitted with the new Revolution X water-cooled 60-degree V-twin engine. With both 748 cm^3 and 494 cm^3 versions available, this model has the smallest displacement in the current Harley-Davidson lineup. The valve system uses a 4-valve SOHC rather than DOHC configuration, and the vehicle is fitted with a 6-speed transmission. Figure 9 shows the external appearance of the Street 750.

2. 2. 2. Ducati

Monster 821: powered by an 821cc engine called the Testastretta 11° which, as its name indicates, features an 11° valve overlap. The injector placement that sprays the fuel jets directly on the back of the overheated intake valve accelerate the vaporization of fuel, and a secondary air system similar to the one used on the 1199 Panigale effectively takes in clean air to reduce combustion cycle variability, improving engine functionality while minimizing the proportion of unburned fuel. A type 2-1-2 exhaust system was adopted, and the inclusion of O_2 sensors in each individual cylinder provide the information used by the engine control unit to optimize

Fig. 10 External appearance of Monster 821

the amount of fuel injection. The stacked silencers are equipped with catalytic converters ensuring compliance with Euro 3 standards, and an electronically controlled mid-section adjustment valve optimizes exhaust pressure according to engine speed. An oil bath clutch with a slipper function has been adopted. This clutch is also equipped with a gradual self-servo system that compresses the discs when engine speed decreases, reducing the load on the pressure plate springs. This makes the clutch lever very light to the touch. When the transmission force is reversed (overload), the same mechanism activates the slipper mode, which relieves the pressure on the clutch plates, reduces the destabilizing effect on rear end behavior and gives a feeling of greater fluidity when decelerating or downshifting in normal driving conditions. Figure 10 shows the external appearance of the Monster 821.

3 Research and Development Trends

In Japan, the third generation of emissions regulations is scheduled to begin by the end of 2016, and in Europe, the Euro 4 regulations will apply starting in 2016. Compliance with those regulations requires the application of combustion control technologies and emission purification systems, and various methods are being researched. In motorcycles, significant differences in characteristics arise from displacement. Expensive, large-displacement high performance vehicles require technology that both improves combustion at low load ranges and provides power at high load ranges, such as variable valve mechanisms. Compliance for low-price, compact vehicles primarily targeted at markets such as emerging countries require less expensive systems. Research on both types of systems is being stepped up.

In addition to vehicles using hybrid or fuel cell systems, vehicles with superchargers are also recently

starting to make a comeback. How to balance power, attractiveness and driving performance in the context of the inherent size limit of motorcycles, the large number of restrictions imposed by their shape, and ever stricter environmental performance requirements is a looming issue that is expected to drive upcoming research and development.

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Design Trends

1 Rise in Manufacturer-Led Custom Builds

For many motorcycle enthusiasts, customizing and modifying their vehicle is not a special undertaking, but rather a major part of the fun.

In essence, customizing involves owners altering the appearance of their motorcycles to reflect their individual tastes, making it an extremely personal action that involves building a vehicle unique to its owner. While it is usual for manufacturers to complement components that expand functionalities such as load capacity or comfort with parts to modify motorcycle appearance, such parts can hardly be said to be varied enough to allow owners to emphasize their own lifestyle through customization.

Although manufacturers have included customizable models in their lineup before, with the motorcycles known as American cruisers by Harley-Davidson providing one example of a customization program including optional parts to alter the vehicle's appearance, such programs remained focused on "additional" or "replacement" optional parts and did not extend to the more extensive changes in vehicle body proportions or configuration made by custom builders.

This makes the BMW R nine T an interesting offering in terms of a new approach to customization (Fig. 1). BMW, known for emphasizing functionality and being at the furthest end of the spectrum from appearance alterations that have no bearing on enhancing performance, has released a motorcycle clearly designed with customization in mind from the start. Promotion of the R nine T, which included having custom builders make concept models before the motorcycle was announced, obviously differ from past approaches and make it clear that BMW is seeking to expand beyond its existing customer base.

Fig. 1 BMW R nine T[(1)]

The R nine T uses an existing engine with no notable new features, and its design can be described as the neo-classic model sold by all manufacturers. The chassis and tire combination underscore sturdiness, and the short and small tail relative to the glamorous fuel tank which, along with other body parts, makes extensive use of aluminum, thereby presenting a high-quality finish.

The lineup of optional parts on offer does not, as in the past, consist mainly of components designed to enhance performance, but rather covers a broad range of customization, including modifying proportions. Moreover, BMW set up custom projects where 8 of the top Japanese and European custom builders were asked to extensively customize the R nine T without confining themselves to the original form.

At first glance, the Scrambler launched by Ducati may only appear to be a nostalgic remake, but it also offers four variations, each brimming with attention to details, to match diverse customer lifestyles (Fig. 2). Featuring a casualness unprecedented in Ducati models, it suggests fine adaptations targeted at new users.

Unveiling multiple pre-customized variations at the

Fig 2. Ducati Scrambler[1]

same time allows the manufacturer to take the lead in customization, and this trend is expected to grow as other manufacturers have started to adopt similar approaches. When it launched the Scrambler, Ducati also presented suggested lifestyles at events and on the Internet, signaling a gradual shift to promotions focused on closely tying the design in to the concept.

Even if many users have the desire to build their own unique machine, not everyone has the know-how to actually do so. Offering easy, yet highly refined, customization reaches out to the subconscious needs of users and could become a business model that yields even greater profit. Manufacturer-led customization that provides lifestyle suggestions has focused on this and is expected to expand the market.

2 Japanese Manufacturers Unveil Models for the Pinnacle of Supersport

Featuring the MotoGP as its pinnacle, the motorcycle racing world has long been dominated by Japanese manufacturers, and since the introduction of handicaps based on engine configuration and the number of cylinders, it had been a long time since European manufacturers actively joined the competition. State-of-the-art road racing motorcycles designs incorporate rider vision as well as feedback on the technology used by the rider, forming a category known as supersport. As a result of recent proactive participation following continued lineup expansion by European manufacturers, this segment is turning into a stage where manufacturers engage in fierce

Fig. 3 Honda RC213V-S[1]

Fig. 4 Yamaha R1[1]

competition to make their technological presence felt and raise their brand image.

The functional value required by the super sport category is speed, and with model redesigns strongly turning into a form of regular maintenance aimed at coming out on top in the competition for the best specifications, advances have reached the point where it is said to be difficult for supersport riders to make full use of the motorcycles' specifications.

In 2014, Honda announced the limited production RC213V-S, a road-legal version of its RC213V factory-backed racer that keeps as much of the same configuration and design as possible (Fig. 3).

Yamaha unveiled the YZF-R1/R1M model series, whose design cleaves closely to that of its MotoGP factory backed racer while also incorporating the latest control technologies (Fig 4). The series consists of a standard model and a flagship model that incorporates technology proposals.

Kawasaki revealed the supercharger-equipped Ninja H2/H2R series whose design suggests a clear distinction from racer replicas (Fig. 5). The series includes a standard model that can be ridden on public roads and a track-only model that foregoes riding on public roads to allow full-blown use of its specifications.

Strangely enough, the 2014 supersport scene was one

Fig 5. Kawasaki H2[1]

where the role of flagship models in highlighting manufacturer identity through the latest technologies and design methods become more manifest, with one manufacturer after another releasing such models bearing a commensurate price.

While Suzuki did not announce any models, it did state its intention to enter the 2015 MotoGP and is testing a prototype racing machine.

3 Conceptual Changes for Headlamps in Supersport Models

This section discusses headlamps, which various technological advances have turned into the natural component that presents the critical design element represented by the "face" of the vehicle.

In the 1980s, approaches used by manufacturers in headlamp designs for supersport models, consisted of the two round functional lamps fitted to endurance racers or the realization of a racer image through use of small headlamps that drew as little attention to themselves as possible. In short, headlamps were treated as components expressing functionality.

Then, with vehicles such as the Honda NR in 1992 and the Ducati 916 in 1994 introducing variations like almond-shaped or narrow dual headlamps that broadened design choice, they grew beyond being simply lighting devices to also become expressive components playing the role of eyes that expressed the concept of a given model.

Even now, almond-shaped or narrow dual headlamps, which are essentially designed to present a fierce gaze, remain the mainstream design for supersport model "eyes". However, in 2014 new concepts expected to bring changes to this basic configuration have emerged. These new concepts are the design approaches adopted

Fig 6. Kawasaki H2[1]

in the Ninja H2/H2R, Yamaha YZF-R1/R1M and Honda RC213V-S introduced by Japanese manufactures as models for the pinnacle of supersport, which were presented in the preceding section. With all three models serving as flagships for their manufacturer's fun motorcycle branding, their design is expected to have considerable impact.

Specifically, where the cowl had, until now, been defined as the face and the headlamps as the eyes, these three models all present characteristics that fall outside such a definition.

The design of the front cowl of the Ninja H2/H2R goes out of its way to make the air intake originating in the supercharger that symbolizes the model's technological concept stand out (Fig. 6).

By contrast, given their roots in MotoGP factory-backed racers, the designs of the YZF-R1/R1M and Honda RC213V-S feature parts with a basic configuration and shapes that reflect the concept of redesigning racers that originally don't have headlamps for riding on public roads (Figs. 7 and 8).

All three examples are interesting in that they do not necessarily set the headlamps, which had until now reigned as the "eyes" in the front cowl "face", as the central constituent element of the design.

Headlamps, which have adopted new technologies originally used in four-wheeled vehicles, are difficult to make more compact within the space constraints imposed by motorcycles, and this has naturally limited their mounting position and illumination area. As stated earlier, advances in technology have expanded the role of headlamps from functional to expressive components, and now, conversely, further advances make it possible to give them an understated expression. The tremendous broadening of possibilities will make logical combinations and distinctiveness increasingly important.

Fig. 7 Yamaha R1[1]

Fig. 8 Honda RC213V-S[1]

Fig. 9 BMW R1200GS Adventure[1]

Fig. 10 Suzuki DR750S[1]

4 Unflagging Popularity of Adventure Models

Even as manufacturers are striving to outdo one another in achieving peak performance in the motorcycle market, adventure models have proven themselves as the category to focus upon in terms of actual sales potential. In 2014, ten models were released by various manufacturers.

The gradual climb of adventure models to the top of sales in developed countries since the 2000s can be broadly attributed to circumstantial factors on one hand, and subjective factors on the other.

One circumstantial factor is the higher average age of motorcycle users. Declining physical strength tends to lead to choosing models allowing sitting upright rather than sports models requiring the rider to lean forward, and since veterans do not want to ride a lower class of vehicle, they choose adventure models, which brim with a strong sense of design (Fig. 9).

The switch to motorcycles resulting from restrictions on four-wheeled vehicle traffic in cities in Europe may be another reason behind such a choice. Handling in cities is also surprisingly good, any many people use versatile adventure models offering high carrying capacity.

In addition, the impact of crackdowns on speed and horsepower regulations that grow stricter year after year cannot be overlooked. Adventure models are also appreciated for inducing less stress at low speeds than sports models. Among subjective factors, the powerful exterior design of adventure models, which exudes an out of the ordinary experience, should be noted. This constitutes a crucial element of fun motorcycles, and allowing users to express their own active lifestyle certainly accounts for the broad acceptance of adventure models.

Fig. 11 BMW R1100GS[1]

In contrast with such looks, the versatility afforded by their ease of use in cities or while touring is seen as another reason for the popularity of adventure models.

One characteristic design element of adventure models is the front fender beak shape seen on the Suzuki DR750 (Fig. 10) or BMW R1100GS (Fig. 11) from the early 1990s, which accentuates the shape and has become a design

icon symbolic of adventure and big on/off-road models.

However, the majority of adventure models launched in 2014 show a preference for eschewing this iconic beak shape.

At the same time, the previously predominant 2-cylinder variations have expanded to a variety of engines featuring such a diversity of displacements and types that it has become difficult to speak of adventure models as a single category. Nevertheless, there is no doubt that in terms of numbers, this genre will continue to lead the fun motorcycle market for the foreseeable future.

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