Edited by **Kevin Jost**

Japanese crossovers proliferate

Japan is a personal-utility-vehicle country, accounting for nearly 60% of annual new passenger car registrations (3.134 million units), according to the **Japan Automobile Dealers Association** (JADA). Added to that are the 1.5 million light passenger vehicles with tall one-and-a-half-box profiles, which have seating capacity limited to four by law.

Of this personal-utility-vehicle segment, which JADA categorizes RV but has hardly any resemblance in style and function to campers and motor homes, the largest portion is of the "semi-cab wagon" type, which accounts for 1.13 million of the total 1.86 million sold in 2006. It is a taller, elongated station wagon with a shortened nose to maximize passenger and cargo space that qualifies as a "crossover."

Competition among the Japanese manufacturers in the segment is intense, and intensity leads to proliferation. Two new vehicles from **Honda** and **Mitsubishi**, reserved for the Japanese market, are both based on crossover platforms, which impart a more rustic and masculine SUV ambience and appeal to

The Outlander-platform-based Mitsubishi D5's masculine off-road-ish face and ample approach and departure angles are meant to appeal to Japanese youth.

The D5 center console carries the CVT lever and AWD selector dial.

The D5 AWD system has three operating modes: automatic torque-modulating AWD, locked 4WD, and front-wheel drive.

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The D5 is powered by the B12 inline four-cylinder displacing 2.4 L.

The Honda Crossroad is based on the Japanese Stream minivan but with a boxier body.

The Crossroad interior has an automatic selector lever on the central console and versatile seating.

single and young married male buyers.

Mitsubishi's D5 shares the Outlander crossover platform and is powered by the aluminum, DOHC, 16-valve, inline four-cylinder, 2.4-L World Engine, the fruit of the joint design and development project of **Chrysler**, **Hyundai**, and **Mitsubishi** and produced in Japan, Korea, as well as the **Global Engine Manufacturing Alliance** (GEMA) plant in Michigan. The Japanese-market Outlander is also powered by this engine instead of the U.S. model's quad-cam 3.0-L V6. The Outlander also serves as the base architecture for **Peugeot**'s distinctively styled 4007 crossover, which is propelled by the HDi turbocharged, common-rail, four-cylinder, 2.2-L diesel engine combined with a six-speed manual transmission.

A Tale of Two Crossovers
Mitsubishi D5 vs. Honda Crossroad

	D5	Crossroad
Length	4795 mm (188.8 in)	4285 mm (168.7 in)
Width	1795 mm (70.7 in)	1755 mm (69.1 in)
Height	1870 mm (73.6 in)	1670 mm (65.7 in)
Wheelbase	2850 mm (112.2 in)	2700 mm (106.3 in)
Curb mass	1780 kg (3920 lb)	1410-1500 kg (3110-3310 lb)

The D5 features sliding rear doors and a top-hinged tailgate with available electric-power operation. Also available is the triple panorama roof, with front and rear manually operated tilt-up and center power sliding glass roofs letting in natural light over all three rows of seats.

The all-steel integral body structure is built around four transverse loops in the A- through D-pillar sections that are tied to longitudinal frame members, which Mitsubishi calls a "rib-bone frame structure." The closed-section "rib" loops surround the cabin. The theme is reflected in the interior design, emphasizing the octagonal loop and imparting a secure appearance and feel. The large front fenders are made of nylon-based, impact-resistant plastic and are painted and baked with the body. The fenders account for a mass reduction of 4 kg (8.8 lb) vs. conventional stamped steel ones.

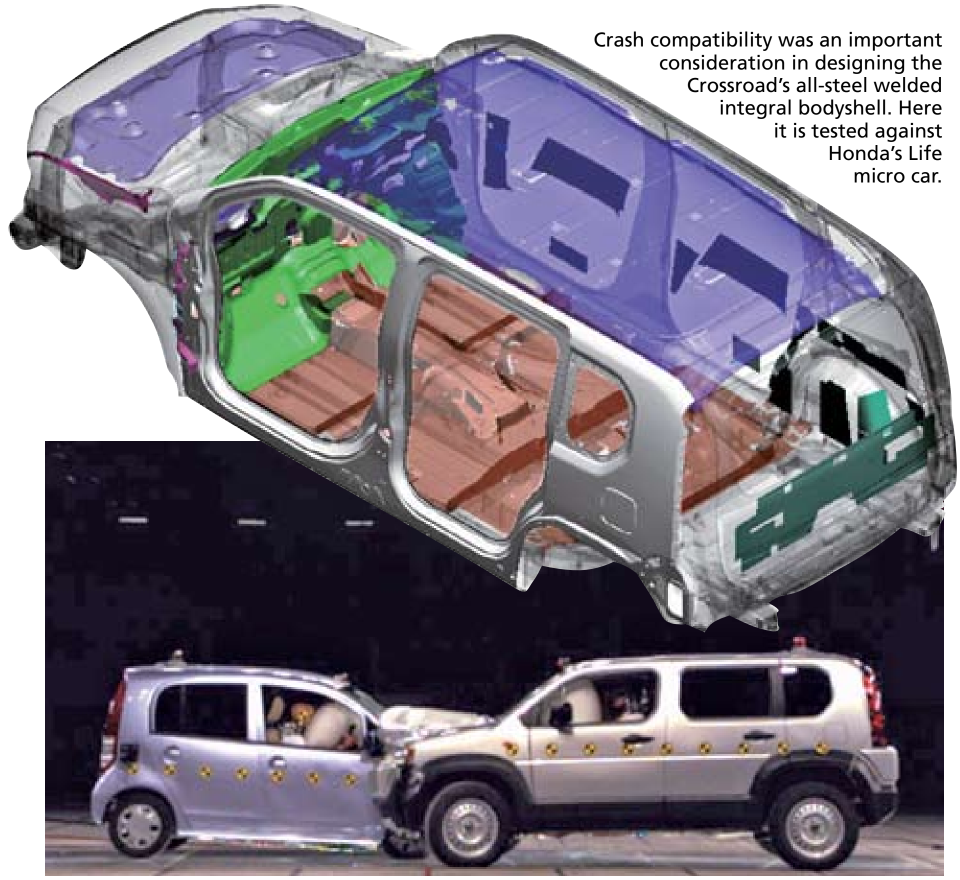
The D5's 4B12 aluminum-block engine displaces 2359 cm^3 using an 88-mm (3.46-in) bore and 97-mm (3.82-in) stroke. Variable valve phasing devices, which Mitsubishi calls MIVEC, are employed on both intake and exhaust camshafts. The engine is also equipped with a cassette-type twin-contra-rotating balancer unit within the lower cylinder block. It produces 125 kW (168 hp) at 6000 rpm and 226 N·m (167 lb·ft) at 4100 rpm on a 10.5:1 compression ratio with regular-grade gasoline.

The front-intake, rear-exhaust engine is torque-inertia-axis mounted transversely with an electronically controlled CVT via four mounts—the two side mounts being liquid-filled types and the front and rear ones roll-arresting designs, the latter specifically tuned for the CVT to reduce idling vibrations and accelerating/decelerating shocks.

The CVT is Mitsubishi's electronically controlled steel-belt-and-pulley type with a lockup torque converter for startup. It features a wider ratio spread of 5.9 vs. the current sedan unit's 5.2, its extended overall lower ratio suiting the vehicle's SUV performance role.

On upscale models, the CVT features Sport mode, enabling manual selection of six ratios by the magnesium upshift and downshift paddles. The Sport model may be engaged in both normal D and higher-rpm-holding Ds positions in the quadrant. The manual Sports mode may be disengaged by pulling the upshift paddle for longer than two seconds, reverting to the automatic mode.

The standard electronically controlled and magnetically actuated 4WD unit is integrated with the rear final drive. It operates in three modes—2WD (front-wheel drive), 4WD auto, and 4WD lock—select-



Crash compatibility was an important consideration in designing the Crossroad's all-steel welded integral bodyshell. Here it is tested against Honda's Life micro car.

able on the go via a dial on the central console. In 4WD auto mode, the system automatically varies front and rear torque distribution according to road surface conditions and to driver demand. During steady cruising on paved surfaces, the split ratio is 86% front and 14% rear. On full throttle at peak acceleration, it can reach 58%/42%. On pressed snow, the split ratio can be 76%/24%, while on hard acceleration about 60% of driving torque is directed to the rear wheels.

Mitsubishi's strategy with the D5 is to exploit its SUV characteristics both in style and capability. The body and chassis are set up so that its approach and departure angles and ground clearance are greater than the Outlander crossover's as the D5 also is slightly larger overall. Later, more on-road and urban front-wheel-drive versions are to be added to expand its market appeal.

Suspension is independent with front MacPherson struts and a rear multilink arrangement, with coil springs and tubular shock absorbers all around. Hydraulically assisted rack-and-pinion steering and all-wheel disc brakes are standard with ABS and ASC (active stability control).

Mitsubishi has no plan to export the D5 at the time of this writing.

The Honda Crossroad revived the name that had been given to the 1993 4x4, a serious off-road vehicle based on the **Land Rover** Discovery that slotted into the growing Japanese 4x4 market where annual sales surpassed the 300,000 mark. Since then the segment has been on a decline, now with about 200,000 unit sales a year. The first-generation Crossroad was subsequently discontinued, giving way to the CR-V crossover.

The new Crossroad's character is true to its name, being more of a crossover but with strong hints of off-road-toughness expressed by its boxy, sturdy appearance. It has hinged rear doors and an upswinging tailgate. Its approach and departure angles are greater than those of the Stream minivan on which it is based.

The vehicle seats up to seven people in three-row seating, a Japanese norm for personal-utility vehicles. Unlike the Mitsubishi D5, which is a "standard vehicle" in the Japanese road vehicle classification, the Crossroad meets Japanese Small Vehicle dimensional and engine displacement limits, key factors being overall length under 4.7 m (15.4 ft), width under 1.7 m (5.6 ft), and engine displacement less than 2000 cm^3. (Diesel engines have no displacement limit, the law not recognizing the compression-ignition engine's recent advancement in performance.)

Two engine choices are offered. The R18A and R20A SOHC 16-valve i-VTEC inline four-cylinders share 81.0-mm (3.18-in) bores. The R18A displaces 1799 cm^3 via a 87.3-mm (3.44-in) stroke and the R20A's 1997 cm^3 is obtained with a longer 96.9-mm (3.81-in) stroke. Compression ratio is the same for both units at 10.5:1. The R18A is rated at 103 kW (138 hp) at 6300 rpm and 174 N·m (128 lb·ft) at 4300 rpm, and the R20A produces 110 kW (148 hp) at 6200 rpm and 190 N·m (140 lb·ft) at 4200 rpm—both on unleaded regular gasoline.

Both engines control intake air volume by i-VTEC cam profile switching. For low-load operations, the late intake-valve-closing cam profile is engaged, and throttle opening is optimized by DWB (drive by wire), resulting in a pumping loss reduction of as much as 16% in an Atkinson-type cycle. For idling and high-load operations, the early intake-valve-closing cam profile is engaged.

Five-speed automatic transmissions are employed with both engines. AWD models get Honda's dual-pump reactive transfer system, which now incorporates a one-way cam unit to improve reaction times. Suspension is all independent by front MacPherson struts and rear double-wishbone arrangement. Electrically assisted rack-and-pinion steering is standard, and the brake system comprises front discs and rear drums. The AWD model is equipped with VSA (vehicle stability assist) incorporating hill-start assist that holds the brakes for one second after the foot is removed on a hill of 5 to 35% grade.

Tires for the 2.0-L model are specific to the Crossroad, with different rubber compounds used in the shoulder sections and the center portion. The shoulder compound is a high-grip type contributing to improved performance, while the center compound is of lower rolling resistance for fuel economy.

Jack Yamaguchi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More prancing horses

A new **Ferrari** is always something of a seismic event in the motoring world, but when it is also the most powerful series production road model ever to emerge from the Modena factory, the reverberations through markets and the upper reaches of automotive technology are global. There is absolutely nothing modest about the new 599 GTB Fiorano. You get what you see: power, technical sophistication, massive road presence, comfort, and capability.

For this is a kW machine: 456 (612 hp) of them from a front-mid-positioned 5999 cm^3 V12 engine that revs to 7600 rpm and produces 608 N·m (448 lb·ft) at 5600 rpm. The rev limiter keeps things in check when the counter touches 8400 rpm, but during development the engine was allowed to reach 9500 rpm. Complementing all this is the availability of the new F1-SuperFast gearshift system. It can achieve shift times between six ratios in 100 ms to the accompaniment of a sound track that spans menacing to mellifluous (third and sixth harmonics). Performance figures include a 0-200 km/h (0-124 mph) time of 11 s and a top speed in excess of 330 km/h (205 mph).

It is said that 80% of all Ferraris ever made are still in existence and that the remainder have been crashed by overexuberant drivers. Keeping the power of the 599 in check are highly sophisticated chassis electronics and optional carbon-ceramic disc brakes.

The car's 65° V12 engine (code-named F140C) is directly related to that of the Enzo and to the power unit of the track-only FXX. The 599 uses the basic architecture of the Enzo, including block, cylinder heads, sump, and combustion-chamber geometry. At 102 hp/L (76 kW/L), the specific output of the 599's engine is said by Ferrari to be the highest achieved by a naturally aspirated engine of its displacement. The engine has twin overhead camshafts for each cylinder bank and continuously variable timing for inlet and exhaust cams.

A design focus on engine mass reduction has resulted in the 599's unit scaling 19 kg (42 lb) less—21 kg (46 lb) if the in-unit clutch and its housing are included—than the engine of the 575M Maranello, which the car replaces. The engine's base is aluminum with wet liners having a Nicasil coating. Space between bores is 104 mm (4.1 in). The pistons have been newly designed and the structure of the cylinder heads is new, providing increased rigidity and new outlet oil passages.

Ferrari has long incorporated **Formula One** (F1) technology and expertise in its road cars. The 599 benefits from many aspects of this, including what the company describes as a F1-style integral sump. It incorporates the journal bearings and a more efficient oil-scavenge circuit to help reduce pressure in the sump. Height from the base of the sump to the center of the crankshaft is 128 mm (5.0 in)—in the 575M Maranello, it is 280 mm (11.0 in)—also aiding a lower center of gravity (cg).

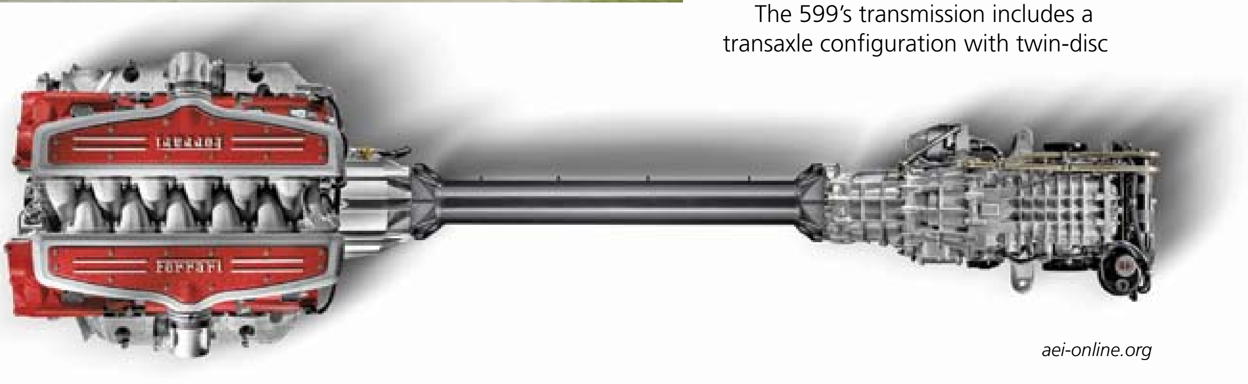
Engine management is by a **Bosch** Motronic ME7 control unit for each cylinder bank. The car meets Euro 4 and LEV2 requirements. Combined CO_2 emissions are 490 g/km, and combined fuel consumption is 21.3 L/100 km.

The subtleties of achieving the right engine sound are many and varied. The air-filter housing is fed by a tube connected to an intake in the front bumpers to transmit the intake sound into the cabin. Bypass valves are used in the exhaust system to generate resonance to complement intake frequencies, the design also maximizing power delivery at high revs. Mechanical engine vibration was cut by a damping system incorporated into the intake plenums to absorb higher amplitudes.

Complementing the 599's engine is the F1-SuperFast gearshift, which allows 100-ms change times. The system facilitates combined disengagement/engagement of the gears partly in parallel with letting the clutch in and out. Elastic energy within the transmission components is used to speed up shifts. According to Ferrari, engagement and disengagement of the gears occurs slightly ahead of the clutch being let out or when the speed of rotation of the input shaft approaches that of the output shaft. Gear engagement is achieved in 40 ms. The system's action is dependent on engine speed and accelerator pedal position. Steering-wheel-mounted paddles control manual shifting.

The 599's transmission includes a transaxle configuration with twin-disc

Ferrari's new 6.0-L V12 599 GTB Fiorano produces 456 kW (612 hp) and has a top speed of more than 330 km/h (205 mph).



In the balance: engine and transmission layout of the new Ferrari 599.

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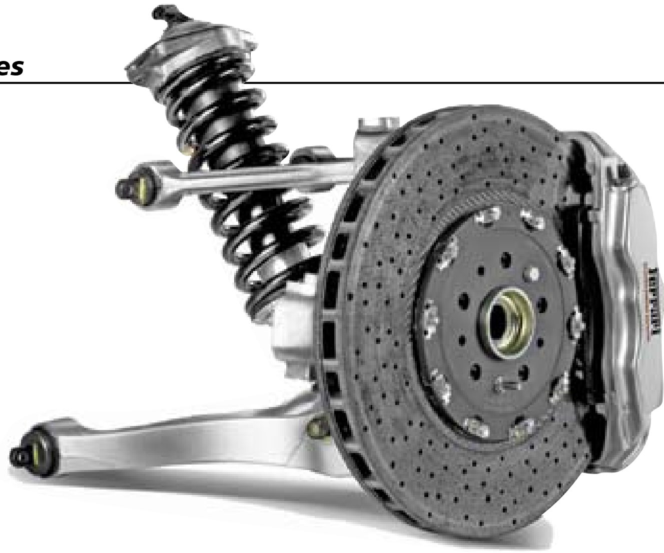


Carbon-ceramic disc brakes, developed by Ferrari and Brembo, together with Bosch, are an option on the 599.

clutch, the first time such an arrangement has been used on a Ferrari V12 berlinetta. The twin-plate configuration helps to reduce rotating masses for faster shifts, and smaller disc diameters allow a slight lowering of the cg—in unit with the engine, steel driveshaft, and rear-mounted transaxle gearbox with an aluminum casing of Avional, which is an aerospace-standard alloy. The whole design delivers benefits in terms of packaging, weight, and reduced engine inertia.

To cope with the ultra-rapid gear changes provided by the F1-SuperFast gearshift software, the gear selector forks are of pressed steel (C43) rather than cast iron, and the fork rods are produced via microcasting techniques. Durability and longevity are both said to be improved. Tested by this ***AEI*** editor on the road and on Ferrari's Fiorano test track, the F1-SuperFast system demonstrated its efficacy, its only minus point being an occasional slight transmission judder during very-low-speed maneuvering. A regular six-speed manual gearbox with gated shift pattern remains available.

Complementing the 599's engine and transmission is a highly sophisticated chassis that includes Sospensioni a Controllo Megnetoreologico (SCM), a semi-active magnetorheological damping system developed by Ferrari together with **Delphi**. It has a response time of 10 ms, which Ferrari says is four times faster than a conventional oleodynamic setup. It reads and reacts to the road surface and to the inputs of four sensors on the suspension wishbones, which monitor the wheels and consequently the movement of the car's body. The movement of each wheel is controlled by a damper that contains a fluid, the viscosity of which is modified by applying an electronically controlled magnetic field.

An electronic control unit (ECU) processes signals within 1 ms. Such a rapid response time permits the same damping curve to be used to achieve enhanced tire control regardless of whether the car's tires are compressed or extended, allowing greater force to be applied when moving from maximum extension to maximum compression and vice versa. The system reduces vehicle body movement "drastically," claims Ferrari. Other suspension aspects include forged-aluminum double wishbones front and rear, mounted on rubber and aluminum rose joints. The rear suspension facilitates passive steering and incorporates an additional radius arm to control toe-in as the suspension rises and falls.

As always with Ferrari, the designers focused on reducing unsprung mass. Extensive use is made of aluminum components. Although vented, cross-drilled, cast-iron discs are standard on the car, a carbon-ceramic system is an option. The CCM (carbon composite material) technology was developed by Ferrari in collaboration with **Brembo,** together with Bosch. In this configuration, front discs are 398 x 36 mm (15.7 x 1.4 in), with one-piece, aluminum, radial-mount six-pot calipers; rear discs are four-pot. The CCM system reduces mass by 12 kg (26.5 lb).

The 599's chassis also benefits from F1-Trac traction control. Developed from F1 racecar technology, it monitors the speed of all wheels and uses predictive software to estimate optimal grip. A vehicle dynamics model is stored in the controller; the system compares this to real-time information collected from the wheels and optimizes traction by modulating power. Ferrari claims a 20% increase in average longitudinal acceleration exiting bends. With the system, it reduced the 599's lap time on the Fiorano circuit by 1.5 s compared to a car fitted with conventional ASR technology. The system is integrated with the driver-controlled, steering-wheel-mounted manettino (small switch) with settings that allow the driver to dial in specific conditions from "ice" to "racetrack," with the car's electronic aids acting in sympathy.

The 599 has an aluminum bodyshell and a spaceframe chassis developed in conjunction with **Alcoa** that comprises 174 structural components. Of those, 102 are sheet metal, 64 extrusions, and eight sand castings. Ferrari uses MIG welds and (at higher stress joints) rivets for the chassis construction. The sand-cast components are adjacent to areas of greatest stress. Compared to the Ferrari 575M Maranello, bare chassis weight is down by 13%, although the wheelbase is 8% longer.

With a sharp design focus on safety, the 599 exceeded all current regulatory requirements on its first crash test. The car meets the European Phase 1 pedestrian impact requirements, and does so without the necessity of an unusually high hood line—although it does have a "power bulge," or pop-up hood, thanks particularly to the front-mid engine position.

Aerodynamic performance is a very big item for any Ferrari. Distinctive details include flying buttresses flanking the rear window and a large rear diffuser integrated with the fairing around the quadruple exhaust pipes. The suction created under the car is "far superior" to the lift generated by the upper part of the bodywork, says Ferrari. The result is an aerodynamic load (Cz=0.190) of 70 kg (154 lb) at 200 km/h (124 mph), 160 kg (353 lb) at 300 km/h (186 mph), and 190 kg (419 lb) at top speed. This is distributed between the front and rear axles in proportion to the car's mass. Cd is 0.336.

The two-seat cockpit of the 599 is both luxurious and spacious. Leather, carbon fiber, and aluminum are the dominant trim materials. An option is a carbon-fiber steering wheel with a series of red warning lights in its upper arc to indicate engine rpm. A "Multidisplay" is positioned alongside the main instruments to provide added information such as navigation and manettino mode input. A red engine-start button is positioned on the steering wheel. The rev counter is the main instrument. Seat design includes a single-shell backrest with prominent, exposed carbon-fiber side supports. The seats have a carbon double harness feed to facilitate a four-point system.

Stuart Birch

Third generation for Porsche Turbo Cabriolet

It has been 20 years since the original **Porsche** 911 Turbo Cabriolet made its debut. That car produced 221 kW (296 hp) from its 3.3-L engine to give a 0-100 km/h (0-62 mph) time of 5.4 s and 260-km/h (162-mph) top speed. Early cars had a four-speed gearbox, but a five-speed was introduced after a year of production.

The latest- and third-generation 911 Turbo Cabriolet may be mainly about acceleration and top speed, but its designers did not lose sight of other essential criteria to make it an exceptional sports car. Its torsional stiffness of 9000 N·m/degree (6640 lb·ft/degree) puts it "right at the top" of open 2+2 seaters, claims the company, and at 1655 kg (3649 lb), unladen mass is a relatively modest 70 kg (154 lb) greater than that of the coupe. Its folding roof has a mass of 42 kg (93 lb), and at 33 kg (73 lb), a detachable aluminum hardtop is optional.

Fitted with Tiptronic S transmission, the car reaches 100 km/h (62 mph) from a stop in 3.8 s, 200 km/h (124 mph) in 12.6 s. Top speed is 310 km/h (193 mph). New European Driving Cycle fuel consumption is 12.9 L/100 km.

Porsche has managed to give the car the same 0.31 Cd figure as the Turbo Coupe. Its rear split wing extends 65 mm (2.6 in), which is 30 mm (1.2 in) farther than that of the Turbo Coupe. The operation is automatic at speeds above 120 km/h (75 mph), retracting at 60 km/h (37 mph). It is said to be the only production convertible in the world that generates downforce at the rear, in this case 27 kg (60 lb). Lift forces on the front axle at maximum speed are kept to about 18 kg (40 lb). In all, this establishes an optimum aerodynamic balance between the front and rear axle, creating positive yaw momentum for smooth and more understeering behavior at higher speeds, claims Porsche. Engineers used a new, instrumented dummy type to measure the effect of cockpit buffeting with the roof lowered and the wind deflector in place.

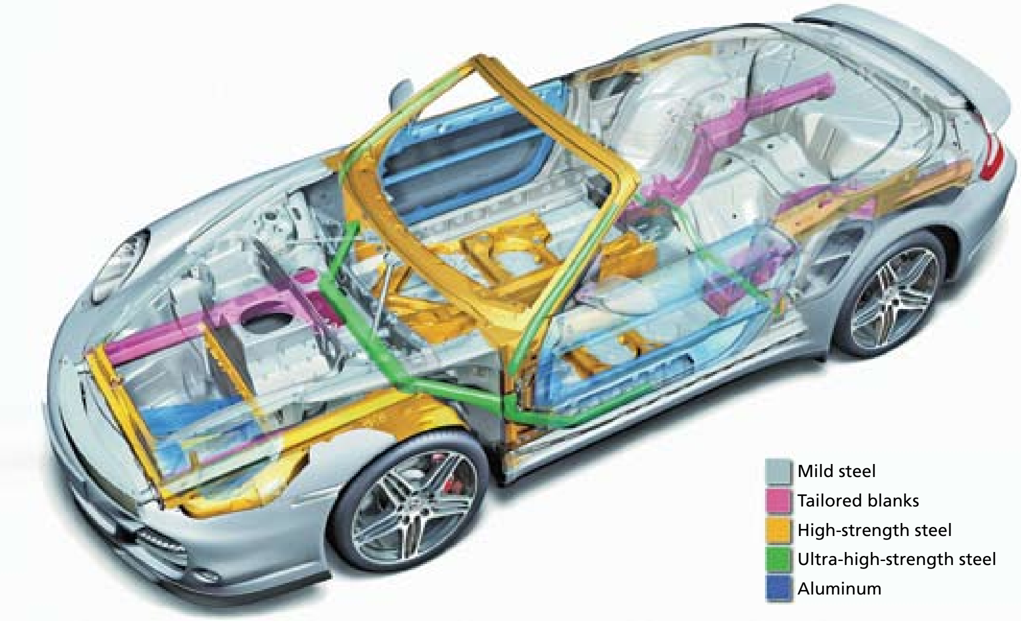
Aerodynamic attention extended to the underfloor, which is covered almost completely from front to rear. On the manual-gearbox version, this is achieved via six polypropylene panels that almost double the covered overall underfloor area compared to the former 911 Turbo Cabriolet. The front axle is vented by four channels in the front underfloor cover. A vent in the rear underfloor panel maintains a consistent balance of temperature in the transmission.

Mechanically, the all-wheel-drive Turbo Cabriolet is similar to the Turbo Coupe, with its flat-six 3.6-L engine producing 353 kW (473 hp) and 620 N·m (457 lb·ft) from 1950 to 5000 rpm. Like the Turbo Coupe, the engine features exhaust gas turbochargers with variable turbine geometry.

Crashworthy aspects of the bodyshell include a triangular load-bearing structure made of aluminum profiles in the front luggage compartment floor that also serves to absorb energy and pass on impact forces to the longitudinal arms in the front of the car. This special structure forms a load path down the middle, guiding impact forces at the front in the event of a collision both to the wheel carriers at the side and to the front axle drive. The car incorporates ultra-high-strength steel pipes in the A-pillars and spring-operated U-shaped rollover bars. Six airbags are fitted, the head airbags housed in the door beneath the side window.

Stuart Birch

At 0.31, the Cd of the new Porsche 911 Turbo Cabriolet is identical to that of the Turbo Coupe.



Porsche engineers tailored the materials mix of the 911 Turbo Cabriolet for crash safety and stiffness, as well as mass savings.

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