PORSCHE

911 50

50 Years of the Porsche 911 – Tradition: Future

Press Information

The innovations

The innovations

For five decades, the Porsche 911 has set the standards for its class in terms of performance and efficiency. With each generation, the Porsche 911 has raised the bar even higher. The Porsche engineers from Zuffenhausen and Weissach have reinvented the 911 again and again and have thus impressively demonstrated the innovativeness of the Porsche brand. Although the 911 has constantly been ahead of the field in terms of sportiness, driving performance has never been the developers' only focus. The 911 has always stood out due to intelligent ideas and technologies which combined performance, everyday usability, safety and durability.

1963: Three-part safety steering system

For its launch in 1963, the Porsche 911 was fitted with rack-and-pinion steering which had already been praised for its precise and very direct mode of operation in previous test reports. This steering system was also part of the vehicle's safety concept. The linkage had a three-part design and the steering box was positioned in the centre of the vehicle. Therefore the steering wheel did not move directly towards the driver in the event of frontal impact but, due to the steering rod angle, moved away from the driver via the impact tubes and the release elements. Porsche continued to improve the safety steering system. Subsequent generations also featured a mesh tube as the crumple element. From 1991, Porsche was the first car manufacturer to equip all its models with driver and front passenger airbags as standard.

1965: Targa roll-over protection bar

The first standard safety cabriolet in the world – these were the headlines when Porsche presented the first 911 Targa at the IAA in September 1965. The innovation in the new sports car model was the fixed Targa bar, derived from the roll-over protection bar which had proven itself in motor racing events and guaranteed a high level of protection for the occupants. With its removable folding roof and the plastic rear window that could be folded down, the 911 Targa was also extremely flexible and offered its occupants no less than

four different options for open-top or closed-top driving. And the hood concept, patented in August 1965, also had other advantages. It solved the problem of the fabric hood bulging unattractively at speed on motorways just as reliably as it did the issue of body distortion, which was common with convertibles at that time. However, the main concept behind the 911 Targa was clearly its high standard of passive safety which was appreciated by many customers. As early as the beginning of the 1970s the Targa had an approximately 40 per cent share of the 911 series.

1966: Internally ventilated disc brakes

Effective cooling of the brakes is important in a high-performance vehicle – only then can they stably and repeatedly brake the car at high speeds. Therefore Porsche introduced internally ventilated discs to the 911 S as early as 1966. These discs are double-walled so that air can circulate and frictional heat is reduced. Furthermore, the perforations also have the advantage that water spray is conducted away from the discs very quickly. To improve cooling even more, the disc brake systems on later 911 types also have ram air ducts that guide fresh air through channels onto the brake discs from the front – from openings in the spoiler. No other manufacturer invests so much know-how into the brake systems on their series production cars as Porsche. This is because no other manufacturer has as much experience from motor racing as Porsche. The reason being that Porsche has always developed the brake systems for its racing cars itself. The rewards for all this effort are not only brake systems that are extremely stable and therefore play their part in high-precision driving, the Porsche series production vehicles also always boast the shortest braking distances in their class – a significant safety benefit on public roads.

1972: Front and rear spoilers

The Porsche engineers have worked unceasingly to make the entire 911 package even better. This includes improved aerodynamics – which was taken into account in 1971 with the first front spoiler, based on knowledge taken directly from the field of motor racing. It was used on the 911 S and later on the 911 E. The spoiler guided the air away to the side, thus reducing the lift on the front section. It improved directional stability and made the

car easier to handle. The 911 T was also fitted with the front spoiler one year later. The 911 Carrera RS 2.7 introduced the rear spoiler – it featured the distinctive "ducktail" and was one of the reasons why this type became a cult car. The next rear spoiler which could genuinely be called "historic" was that on the 911 Turbo. Its large, flat design adorned the vehicle and, in addition to its reliable function, it was also a statement about the power and the speed of the Turbo. To briefly explain the technical principle: spoilers at the front and rear enhance the vehicle's aerodynamics and improve directional stability, braking and steering characteristics, cornering behaviour and the car's response to cross winds, especially at high speeds. They guide the air around the outside of the vehicle (front spoiler) and prevent too much air underneath the car which would result in unnecessary lift and significant turbulence on the underside of the vehicle, especially if it is not lined and therefore has clefts. The role of the rear spoiler is to discharge the air flowing around the vehicle at the right place, the spoiler lip, with as little turbulence as possible. The rear spoiler being designed as a wing in the form of an upside-down aeroplane wing makes it possible to increase the negative lift on the rear wheels and therefore generate downforce. The vehicle's even air flow and the controlled negative lift increase the top speed and reduce fuel consumption.

1973: Turbocharging

Engineers searching for the "ideal charge" – optimum combustion of the air-fuel mixture – is almost as old as the combustion engine itself. The technicians aim to get as much air as possible into the cylinders so that, when it is compressed and mixed with fuel, it can create a high operating pressure and therefore high output by means of combustion. The 911 Turbo, presented in 1973, was a forward-looking study as its 3-litre turbo engine boasted charge pressure control on the exhaust side which had previously been thoroughly tested in the motor racing sector. With the 911 Turbo, which was ready for series production in 1974, Porsche was the first car manufacturer to successfully adapt the turbocharger to the various driving states. Instead of the conventional intake-side control, the company developed exhaust-side charge pressure control. This prevented unwanted excess pressure during partial load or overrun by guiding excess exhaust gases via a bypass instead of through the exhaust gas turbine. When charge pressure was needed again during an acceleration phase, the bypass valve closed and the turbine could work to its full capacity in the exhaust stream.

1975: Galvanised body

In 1975, Porsche responded to the issue of corrosion with emphatic success. The 911 was the first series production car to be given a body which was galvanised on both sides – allowing Porsche to offer a six-year corrosion warranty which was extended to seven years for the 1981 model year and then later to as much as ten years. The treated body-in-white not only improved the service life but also vehicle safety as the process preserved the overall rigidity and the crash safety characteristics of the body, despite vehicle aging. It plays a part in the reputation of the 911 as being an extremely durable vehicle – two thirds of all the 911 cars ever built are still licenced for road use today. Extensive tests were carried out before the body was launched for series production. This included trials with stainless steel as the body material – three shiny silver prototypes were made from this material, one of which can be seen today at the Deutsches Museum in Munich. However, the engineers decided not to use stainless steel but to galvanise the body-in-white as this was easier to produce. Driving the prototypes through a bath of salty water to test the resistance to corrosion is a legendary part of the test course in Weissach.

1977: Charge air cooling

One of the secrets of the success of the 911 series is that it has been enhanced constantly and systematically. Each year, lots of small details on the 911 have been improved so that it has become closer and closer to Ferry Porsche's ideal image of a perfect sports car. This philosophy was also applied to the 911 Turbo. The main features of the 911 Turbo, reworked in 1977, were an increased displacement of 3.3 litres and a charge air cooler positioned underneath the rear spoiler. Derived from the field of motor racing, it was a world first in a series production car. The charge air cooler reduces the intake air temperature by up to 100 degrees Celsius, thus enabling the engine to achieve higher output and torque in all engine speed ranges – cooler gases are denser and therefore charge the engine more effectively. The result was a stable 300 hp at 5,500 rpm and a maximum torque of 412 Newton metres. Furthermore, the charge air cooling also reduces the thermal load on the engine. The exhaust gas temperatures fall, as do the emissions, and fuel consumption is reduced. Another advantage is the improvement in antiknock properties – excess temperatures causing the mixture to self-ignite is virtually ruled out.

1983: Digital engine electronics

Digital engine electronics (DEE) celebrated its debut in 1983 with the new naturally aspirated engine with 3.2-litre displacement. Its most important advantages were better fuel consumption, cleaner combustion and therefore maximum power output. The system worked with a shared control unit which all the engine's operating states were programmed into. The correct injection quantity and the exact ignition point were assigned to each engine speed, each accelerator position and temperature. The overrun fuel cutoff, i.e. no fuel was consumed when the engine was overrunning, and electronic idle speed control when auxiliary components were activated were useful additions provided by the digital engine electronics. The knock control system ensured "healthy" engine operating conditions. DEE is combined with various injection systems, depending on the engine.

1988: All-wheel drive

Porsche gained extensive experience of using all-wheel drive in a sports car in the Type 959, a technology demonstrator in every respect. Produced in low numbers as a special series, its influence could be seen in its successor, Porsche's first series production all-wheel drive sports car, the 911 Carrera 4, which was introduced in 1988. For excellent driving dynamics, the 959 had an electronic, infinitely variable centre differential lock, and torque was distributed to the two axles depending on the wheel-load distribution and the friction coefficients of the wheels on the road. For the same purpose, the engineers then set up the Carrera 4 with a basic torque distribution of 31 to 69 per cent (front axle to rear axle) via a planetary transfer gear. The car also featured a hydraulically operated centre and axle differential lock for virtually infinite adjustment of the distribution ratio. Their function was controlled by an electronics system integrated into the ABS control unit. The next Carrera 4, introduced in 1994, represented the next evolutionary stage of the Porsche all-wheel drive. For example, it was fitted with an optimally adapted, very light Visco multi-plate clutch as the axle clutch.

1989: Tiptronic

From 1989, Porsche offered an innovative gearbox in the 964 series 911 – the Tiptronic, the perfect synthesis of comfort and sportiness. The driving data was only marginally lower than that of the same vehicles with manual 5 or 6-speed gearboxes. The Tiptronic was an automatic gearbox with intelligent shift programmes and the opportunity for individual manual intervention. In addition to the conventional selector lever positions, it also featured a second parallel gate in which simply tapping on the selector lever changed the gear immediately. “Tapping” the lever forwards shifted up a gear and “tapping” it backwards shifted down, as long as the engine speed limits were not exceeded. If you forgot to shift up, the gearbox automatically shifted to the next gear up when the permitted maximum engine speed was reached. The electronics system had five shift programmes. The programme with the most favourable shifting points was activated, depending on the temperament of the driver and the traffic situation. The engine speed was reduced temporarily by retarding the ignition point in order to facilitate smoother gear changes.

1993: LSA aluminium chassis

The new chassis designed in accordance with the “LSA” concept (Light, Stable, Agile) in the 993 series finally put an end to the capriciousness of the rear engine 911. It mainly affected the rear axle that was based on a multi-link suspension, tested in motor races, which facilitated excellent driving dynamics. The axle kinematics are designed to ensure that the vehicle’s suspension compresses significantly less when accelerating and driving round bends. This stabilises the driving characteristics in general. Furthermore, lightweight spring struts with aluminium dampers improve agility. The principle of systematic lightweight design was also applied in order to keep the vehicle gross weight and the weight of the unsprung masses low. The result of all these measures was that the chassis made it possible to change lanes quickly and safely, even at high speeds. And rolling noises and vibrations were also reduced.

1995: Bi-turbocharging

The 993 series 911 Turbo, presented in 1995, was given a 3.6-litre engine fitted with two small turbochargers, whose performance curve was not dissimilar to a high-displacement naturally aspirated engine. From as low as 2,000 rpm, the engine generated plenty of thrust which changed into impressive, rousing velocity from 3,500 rpm and pressed the occupants into their seats. In addition to the output that increased to 300 kW (408 hp) and the rise in the maximum torque to 540 Newton metres, the Weissach engineers also aimed to reduce the engine's acceleration turbo lag to a previously unknown minimum. They achieved this by using two small turbochargers instead of one large one, whereby the low moment of inertia of the smaller blades had the most significant effect. The two regulated turbines with integrated bypass flap generated a boost pressure of 0.8 bar. The impressive increase in output and engine speed was also due to optimisation of the charge cycle, the high level of efficiency of the two charge air coolers and the knock control system that facilitated running the engine at optimum efficiency.

1995: OBD II emissions control system

Another technical highlight of the six-cylinder car was the new OBD (onboard diagnostics) II emissions monitoring system which was used for the first time by a series production manufacturer. It facilitated early detection of faults or defects in the exhaust and fuel system. The extensive measures for reducing emissions were very effective on the 911 Turbo. To the great surprise of the experts, the turbo engine turned out to be the lowest emission series production engine in the world. The supercharged 993 was also the first bi-turbo with air mass control in automotive history. The OBD continually monitored the operation of the entire exhaust system with catalytic converters and oxygen sensors, the functioning of the tank ventilation system with activated charcoal filters, the secondary air system and the fuel system. Misfiring was also recorded. At the time it was launched, OBD II was already mandatory in the USA and other markets soon followed. OBD required a great deal of development work and an extremely complex engine management system.

2001: Ceramic brake disc

In the year 2000, Porsche introduced the 996 series 911 Turbo. It could be fitted with ceramic composite brake discs as an option. They came as standard on the 911 GT2. The new brakes, called the Porsche Ceramic Composite Brake (PCCB), were an important technological advance and set new standards, particularly with decisive criteria such as response, fading stability, weight and service life. Porsche was the first automotive manufacturer in the world to successfully develop a ceramic composite brake disc with involute cooling duct for efficient internal cooling. The ceramic composite brake discs were perforated, just like metal brake discs. However they weighed more than 50 per cent less. One the one hand, this lowered the weight of the vehicle by 20 kilogrammes, thus saving fuel. On the other hand the unsprung masses were also reduced which further improved the response characteristics of the shock absorbers. Ceramic brake discs also have other advantages. Their friction coefficient always remains constant and an emergency stop with PCCB does not require the brake pedal to be actuated with force nor any technical assistant systems which help to generate the maximum brake force in a fraction of a second. The PCCB provides maximum braking immediately and without hard pressure on the brake pedal. It also boasts excellent response characteristics in wet conditions as the newly-developed brake pads collect less water in comparison with conventional pads. The ceramic brake disc can easily cope with high brake loads that often arise with a sporty driving style in particular.

2008: Porsche Doppelkupplung PDK S

The optionally available Porsche Doppelkupplung (PDK) was featured in a series production sports car for the very first time when it was fitted into the 997 series of the 911 in 2008. It had seven forward gears and one reverse gear and was initially available in the Carrera and Carrera S. Its most important advantages were faster gear changes in comparison with manual gearboxes and automatic converter gearboxes. The gears were already engaged when the driver changed gear and drive was not lost during the process. The PDK also provided weight benefits – despite two additional gears in comparison with the manual gearboxes which were prevalent at that time, it weighs approximately ten kilogrammes less than the Tiptronic S gearbox. In the 1980s, Porsche was the first manufacturer in the world to use this gearbox technology successfully in motor racing in the 956/962 and therefore it had the most experience with dual-clutch gearboxes for high-performance sports cars.

The Porsche Doppelkupplung combined the driving dynamics and the good mechanical efficiency of a manual gearbox with the shifting and ride comfort of an automatic gearbox. The PDK was therefore designed in line with the requirements of a 911 driver, in terms of both sportiness and comfort. The first six of the seven forward gears had a sporty setup whereas the seventh gear had a long ratio for maximum fuel economy.

2011: Intelligent aluminium-steel design

In the 991 series of the 911, which was introduced in 2011, Porsche has further perfected lightweight design for sports cars. It achieves a number of goals: improving vehicle dynamics while reducing fuel consumption, as well as enhancing safety and raising levels of comfort in comparison with earlier vehicles. The engineers chose a concept which puts the right material in the right place, using the right construction method. The current vehicle generation is therefore lighter than its direct predecessor for the first time, by approximately 40 kilogrammes. And this despite the additional weight originally expected due to the longer wheelbase, the more stringent safety requirements and the enhancements to the overall package. The largest proportion of the weight saved (around 80 kilogrammes) was due to the new body-in-white with mixed aluminium-steel construction. With the exception of local reinforcement parts, the front body section and large parts of the floor and the rear section are made of aluminium. This is also true of the lids, wings and the door structure. The coupé is 44 per cent aluminium and the cabriolet 43 per cent. A significantly larger proportion of the steel parts are made of super high-strength and ultra high-strength materials. The hot forged, press hardened steels provide a particularly high degree of occupant protection. The intelligent mixed aluminium-steel construction also changed the production process at the Zuffenhausen plant. While resistance spot welding was the dominant production method in the age of steel bodies, today's mixture of materials requires different joining processes. And this with up to 400 individual parts which a body-in-white is made up of. The key areas are the many steel and aluminium joints – they cannot be welded. The increased use of structural adhesives, which also prevents bimetallic corrosion between the two materials, is one solution. However, new mechanical joining processes are also used, such as clinching, punch riveting and friction drilling. The ideal joint is selected in each case.

2011: Seven-speed manual gearbox

The world's first seven-speed manual gearbox is used in series production of the 911 – again in the 991 series. It gives the 911 a new, crisp shift characteristic. The new gearbox was designed on the basis of the seven-speed Doppelkupplung and provides excellent shifting comfort and sporty shift forces. The new 911 cars reach their top speed in sixth gear. The seventh gear has a long ratio and helps to save fuel – a high cruising speed is attained at a lower speed. The high level of efficiency and the optimised weight of the gearbox help to make the vehicle more fuel efficient. It is also combined with an automatic start/stop function as standard. As the seven-speed Doppelkupplung is designed as a modular system, many of the same parts could be used for the construction of the seven-speed manual gearbox. However, one particular challenge had to be overcome – due to the concept of the Doppelkupplung, the gears are arranged differently than with a normal "H" shift pattern. Therefore converted shift actuators were developed especially for the manual gearbox version. They enable the traditional "H" shift pattern to also be achieved with the Doppelkupplung gear sets. A patented system prevents the wrong gear from being engaged. For example, the seventh gear can only be engaged directly after the fifth or sixth gear.