Technology

The Legend Lives

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Photos by
Porsche AG

For more than 40 years, the engines used in the Porsche 911 models have provided for extraordinary driving pleasure as well as major racing victories. Providing reliable power in the rear of the car, this core component has evolved over four decades with major technical advances.

Grown-up: The engine in the current Porsche 911 GT3 generates 415 hp (305 kW) from a 3.6-liter capacity

A boxer engine never gives up. It ducks away, slips into the tightest gap, and releases a powerful punch. It has defied the world now for almost 45 years. This 911 engine was made for driving full speed ahead. It sits snugly behind the rear axle, where its power enjoys full play and where it propels the 911 forward in compliance with the whims and pleasure of the driver. It is the king of both the road and the racetrack, and a synonym for all the properties that ennoble a machine: robust, reliable, and strong as an ox.

This engine started out in 1963 as a 2.0-liter unit with 130 horsepower. In 1978 it reached 845 hp in the "Moby Dick" racer. In the current version of the 911 GT3, it plays with a capacity of 3.6 liters and 415 horsepower, and 480 in the 911 Turbo. It has swallowed gasoline and methanol, and versions have won Le Mans a hefty 14 times. It has viewed every boost in its capacity as a spur to greater performance, and it has never sputtered in either induction or turbocharged form. It continues to be transformed to this day—having been called RS, GT1, GT2, or GT3, each signifying higher levels of performance. Even in 1997, when the big fan wheel was retired for good and what had previously been an air-cooled boxer engine was now redesigned as a liquid-cooled power pack, it never lost its soul. Nor its sound and certainly not its power. Moreover, this 911 assembly is a classic example of the delicate balance between performance and fuel consumption. At the turn of the millennium, the last air-cooled 911 bi-turbo (Type 993) could be counted among the cleanest cars in the world.

This is a great track record for an engine whose designers actually miscalculated it in a marvelous way. With the Carrera 3.0, they had attained undreamt of capacity levels by the mid-1970s, which subsequently led Ferry Porsche to admit, "Had I known in 1960 that it would be possible to expand an engine to well over three liters, I would have told my engineers to make it smaller. I'm glad I didn't know."

The engineers meant well. In the early 1970s, the new Porsche 911 also needed a new engine. For reasons of space, it was to remain a boxer engine with six cylinders—strong and expandable. Hans Mezger, an engineer and the father of many successful Porsche racing engines, joined the 911 team. He contributed his experience from the Formula One, which had influenced his entire working career. As he explained, "The shape of the combustion chamber is a crucial factor in fuel consumption and performance." And so it was reworked from top to bottom yet again. Other essential technical innovations included the dry-sump lubrication as well as the hydraulic chain tensioner and slide rails. In contrast to a wet-sump system, the dry-sump collects the oil ▸

Chassis meets body: Right after assembly (below) the engine celebrates a "wedding" (right)

Boost-pressure control becomes standard

The first Turbo
With the 911 Turbo 3.0 in 1975, Porsche presented the first standard series 911 with a turbocharged engine. It generated a hefty 260 hp (European spec) at 5,500 rpm. Thanks to the first boost-pressure control system (better known as the wastegate) transferred from race cars to a standard production vehicle, Porsche greatly reduced the dreaded turbo lag.

that always accumulates at the base of the crankcase, extracts it, and feeds it back into the oil tank. This keeps oil quality at a higher level, which in turn benefits sensitive components such as con-rod bearings. And despite engine expansion at high temperatures, the hydraulic chain tensioner ensures that the chain runs without a hitch.

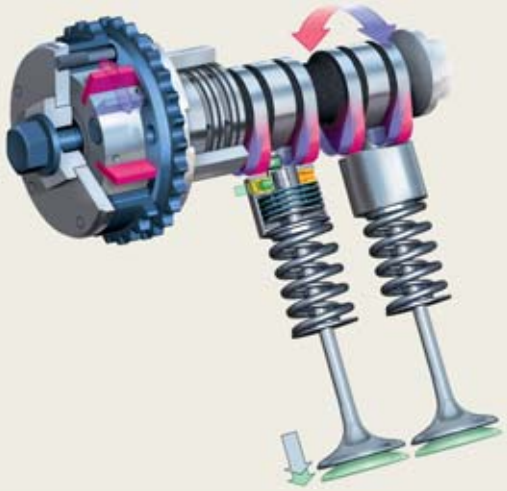
These two factors—technology and experience—were the promising preconditions for coaxing ever greater power from the engine for both the production cars and racers. To quote Mezger again, "It's the easiest thing in the world to change the capacity."

Still, it was courageous to bring the first 911 Turbo 3.0 onto the market in 1975, right on the heels of the oil crisis. The engine commanded 260 horsepower (234 in the United States) at the time at an inconceivably modest (for a Porsche) 5,500 rpm. But Porsche had driven to major victories in North America with the turbocharged twelve-cylinder engines in the 917 Spyders, and had mastered the feared "turbo lag" with the help of small turbochargers and a bypass-based, boost-pressure control system (the wastegate). This experience was applied to the 911 Turbo, known as the 930.

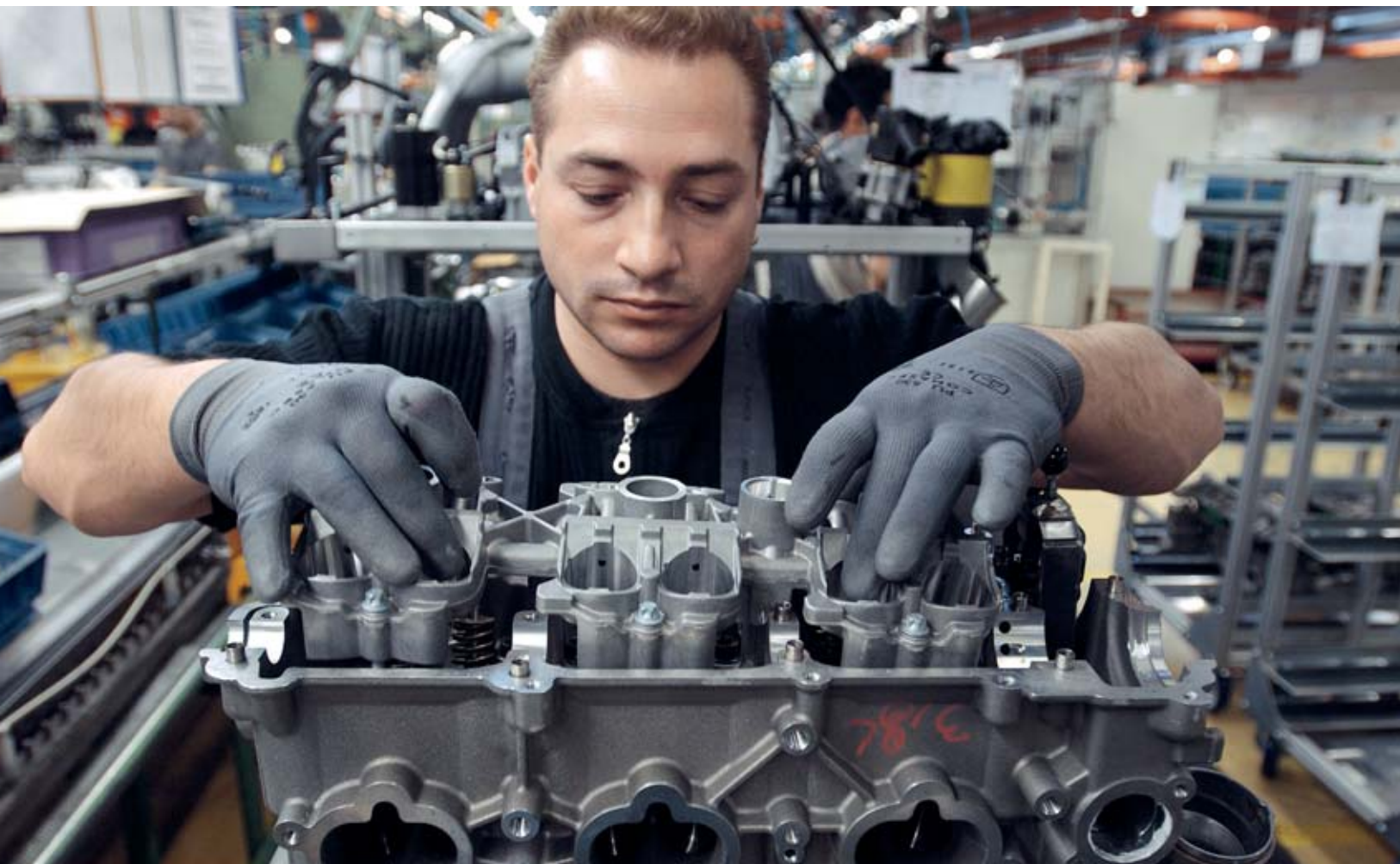
The 911 engine also survived the introduction of catalytic converters with flying colors. Because of its strong presence on the North American market, Porsche started tackling exhaust ▸

Ever more power, ever lower fuel consumption

VarioCam Plus
VarioCam Plus, which was first used in 2000 in the 911 Turbo, is an electrohydraulic timing adjustment system for the input camshafts, combined with valve lift adjustment. With the help of new technology, Porsche is consistently able to increase power while still reducing fuel consumption.



Hands-on: Engine assembly requires just the right touch



Exclusive: The engines for all Porsche models are made only at the main factory in Zuffenhausen

emissions and was experimenting with thermal reactors in the collector before catalytic converters became mandatory in the United States. Exhaust was combusted several times before being emitted. And catalytic converters were used in the early 1980s at the 944 Cup. So Porsche learned to handle the exhaust back-pressure arising from these converters. It optimized the honeycomb structures in the converter monolith accordingly. With its 3.6-liter capacity and 285 horsepower, the last air-cooled 911 was a pièce de résistance. And it was the last of its type.

The fan community might have mourned briefly—only to be promptly thrilled in 1997 with the first water-cooled 911. The engineers didn't let the emotional attachment dip even slightly. Thomas Krickelberg, a pupil of Mezger and a power-train project director for the 911 Carrera series, recalls that "the engine continued to sit in the rear, and we built yet another six-cylinder boxer. This meant that the firing order and the charge cycle were predetermined—and thus the air-induction noises and the exhaust sounds were practically identical to those of its predecessor." But the engineers still redid the design, following the credo of Ferry Porsche and Mezger. Because greater capacity also means higher fuel consumption, Porsche was increasingly harnessing new technology to achieve greater engine speed while reducing fuel consumption. The 911 of 1997 therefore had only a 3.4-liter capacity, but 300 horsepower. This was followed by the introduction of VarioCam Plus, which uses oil pressure to achieve continuously variable electrohydraulic timing control of the intake camshafts. VarioCam Plus also enabled two-step electrohydraulic adjustment of the intake valves, which ensured optimum combustion and a parallel reduction in fuel consumption.

The development of the turbo would be interesting for environmental reasons alone. In addition to boost-pressure control, charge-air coolers had long become standard and the turbo became a bi-turbo (with two smaller compressors). Another ground-breaking effort was the introduction of variable turbine geometry. It optimizes exhaust flow to the turbine blades, resulting in better low-rpm response without sacrificing high-speed power. Drivers can enjoy impressive torque and response even in lower rpm ranges, and their cars also need considerably less fuel. The current turbo has 480 hp for a 3.6-liter capacity. To achieve comparable performance levels, a naturally aspirated engine would need a capacity of 5.4 liters, which would also require substantially more fuel. Even next to these high-tech assemblies, the original 911 makes a respectable showing. The heart of the current 911 Turbo continues to beat in a crankcase like that of the old engine, and the cylinder heads and housing resemble those of the legendary "super 911," the Porsche 959. History continues to be written—and the legend lives. ◂

Low rpm levels, full power

Variable turbine geometry
Turbo innovation in 2006: Variable turbine geometry applies materials that were previously used only for space travel. The advantage of this technology: it optimizes exhaust flow to the turbine blades, resulting in better low-rpm response without sacrificing high-speed power.