Edition 1/2008

Porsche Engineering Magazine

The 911 GT2
Performance redefined

The Hardware Lab
The highest standard for customers

The engine of the Porsche 917
A complete work of art with 1,100 bhp

Testing, measuring, analyzing
Optimization of vehicle drivetrains

Dear Readers:

Coming up with good ideas is one thing. But what is just as important is finding new ways to implement them. That's what we do well. With innovative approaches and a passion for our work, Porsche Engineering achieves peak performance every day.

As times change, not only do the expectations of customer development change, but the demands on the vehicles increase as well. You know that these demands are coupled with performance. But you might not know the high-performance technology behind them. Less fuel consumption, lighter-weight materials, fast implementation – the demands are ever-growing.

In this issue, you can read all about our work on improving performance.

Enter the fascinating world of the GT2, the 911 series production vehicle with the most powerful engine of its time. 530 bhp – a mix of aerodynamic design, innovative technology, and incredible power. Let your mind travel in a Porsche Cayenne S Transsyberia. And remember last issue's cover photo? The legendary engine of the Porsche 917. In 1973, its whopping 1,100 bhp provided enough thrust to leave the competition in the dust.

Our computers have to be just as powerful. Today, vehicle drivetrains can be optimized to customer specifications using proven measurement and analysis methods. Whether you are steering your Porsche through the urban jungle of Tokyo or cruising the frozen expanses of Alaska – no problem for your engine and transmission. Also, advanced computer technologies enable us to shorten engine development times significantly. We will present the development of the intake port as an example.

Qualified networks of technicians and engineers for the right ideas form the basis for the development work of Porsche Engineering. Take a peek behind the scenes of a specialty department: our Hardware Lab.

Did you ever hear, by the way, about the "zero" hour of the 911? Wait and see.

Follow us on a journey through our development work and experience our idea of performance close-up.

We wish you a pleasant read.

The Editorial Staff

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About Porsche Engineering

At Porsche Engineering, engineers work for you meticulously on new, unusual ideas for vehicles and industrial products. Upon request from automotive manufacturers and suppliers, we develop a variety of solutions – ranging from the design of individual components, through the layout of complex modules, to the planning and implementation of complete vehicle developments including management of the run-up to production. What makes it special is that all this is done with the expertise of a series manufacturer.

Does your company need an experienced automotive developer for your project? Or would you prefer a specialized system developer? We offer our customers both – because Porsche Engineering works where these two areas meet.

The joint knowledge of Porsche Engineering converges in Weissach – and yet it is globally available. Of course, also directly at your site. Regardless of where we work, we always bring a piece of Porsche Engineering with us. If you would like to learn more about us, please request our image brochure by email:

info@porsche-engineering.com

Porsche honors graduates of Czech Technical University, Prague.

Stuttgart

Dr. Ing. h.c. F. Porsche AG, Stuttgart, and Czech Technical University in Prague (CTU) have presented the “Porsche Engineering Award” for the third time. At the Development Center in Weissach, Wolfgang Dürheimer, Development Director of Porsche, presented awards to three graduates of CTU for their outstanding final theses. The first prize went to Thomas Dynybyl (24), who investigated the subjects of cylinder cut-off systems and downsizing in particular in his work “Reversible Engines”. In explaining its choice, the jury, which was composed of representatives of Porsche and of CTU, referred to the special importance of innovative engine concepts to the automobile industry in order to be able to meet future legal requirements. Other prizewinners were Denis Waraus (25) and Lukas Sojka (25). All three winners receive a cash prize and an invitation to visit the Development Center. In addition, the winner of the first place is being offered a doctorate position at Porsche Engineering Services s.r.o. in Prague.

Porsche and CTU have been working together in the field of technical calculation and simulation since 1996. The Porsche Engineering Award has been presented each year since 2006 for the three best final theses of the students of the Czech Technical University in Prague. The prize is intended to further cement the relationship between CTU and Porsche AG.

Performance redefined – the new 911 GT2

With a power boost of 50 bhp compared with the engine of the 911 Turbo, the new 911 GT2 is the most powerful 911 production vehicle of its time. Impressive precision work quickens the heartbeat of any engineer. Striving for efficient performance has always been the goal of the development work of Porsche. But how can an almost perfect sports car be even further optimized?

Resistance is futile. Highlights that make history.

The sophisticated aerodynamics in combination with the extremely sporty suspension and an engine output of 390 kW (530 bhp) give the 911 GT2 driving performance that is second to none. With a power-to-weight ratio of 3.69 kilograms (8 lb) per kilowatt, the rear-drive GT2 rockets from 0 to 100 km/h (63 mph) in 3.7 seconds.

The increase in power compared with the current Porsche 911 Turbo is achieved mainly by a revised turbocharger with flow-optimized turbine and a larger compressor, as well as a complete redesign of the expansion intake system. The newly designed titanium rear silencer with reduced flow resistance also adds to this.

Turn the page for our detailed description of the special features of the expansion intake system.

The expansion intake system

The expansion intake system of the new 911 GT2 is an enhancement of the existing turbo engines. The unique and special feature is its operating principle, which has revolutionized existing processes. Like a traditional intake manifold for 6-cylinder Boxer engines, the expansion intake system consists of a distributor pipe, two accumulators and six individual intake ports. The decisive and revolutionary approach is reflected in the new geometric dimensions of the distributor pipe and the individual intake ports. Compared to a conventional intake manifold, the distributor pipe of the expansion intake system is longer and has a smaller diameter, while the individual intake manifolds are shorter.

Existing intake manifolds, such as the resonance intake manifold, use the air vibrations in the intake system to fill the cylinders with as much fuel-air mixture as possible. The compression effect (compression of air) achieved during the air vibrations is used for this purpose. The disadvantage of a resonance intake manifold, especially in turbo engines, is that the air is heated up when it is compressed. This means that the fuel-air mixture in the combustion chamber cannot be ignited with the best possible efficiency.

For this reason, the current 911 Turbo uses a resonance intake manifold that is designed so that, unlike naturally aspirated engines, this effect only occurs in the higher rpm range. This effect is neutralized at maximum power in the highest rpm range. The expansion intake system of the new 911 GT2 turns the resonance charge effect around completely at higher engine speeds: the principle of expansion (expansion of air) is used instead of compression.

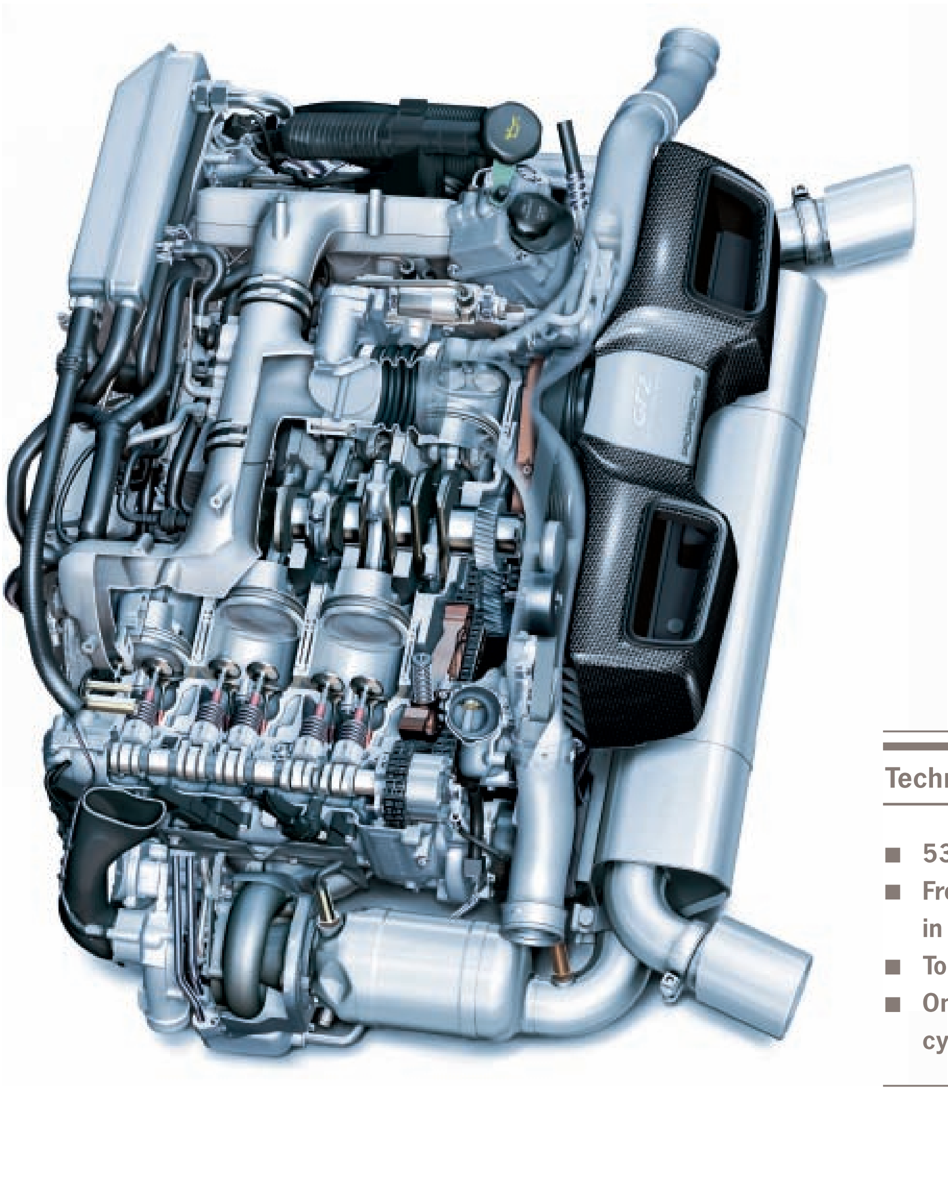
During expansion, the air is cooled rather than heated as in compression. This effect results in a lower fuel-air mixture temperature in the combustion chamber, which means it can be ignited in a more efficient manner. This improves engine efficiency and gives a higher engine output with low fuel con-

For the first time, the Porsche expansion intake system has been installed in the GT2 sumption at high loads and engine speeds. The name of the expansion intake system is derived from the physical effect of expansion. The principle of the expansion intake system can only be applied in turbo engines. The cylinders are filled with slightly less air during expansion than during compression. This effect is compensated in the new 911 GT2 by a slightly increased boost pressure. The increased boost pressure increases the temperature of the air downstream of the compressor.

This effect may seem to be a disadvantage, but the raised temperature level means that more heat is discharged in the charge-air coolers, which in turn means that the air temperature downstream of the charge-air coolers is only slightly higher than with conventional charging.

This increase in thermal energy is accommodated by using the expansion intake system which, through the expansion of the air in the subsequent intake system, causes noticeably lower temperatures of the fuel-air mixture in the cylinders at a practically equal air flow rate. As described above, these functional interactions, with the help of more effective ignition, improve engine efficiency and give a higher engine output with low fuel consumption at high loads and engine speeds.

The environment has also been taken into account. At maximum power output, fuel consumption using this intake system is up to 15% lower than for turbocharging with a conventional intake manifold.



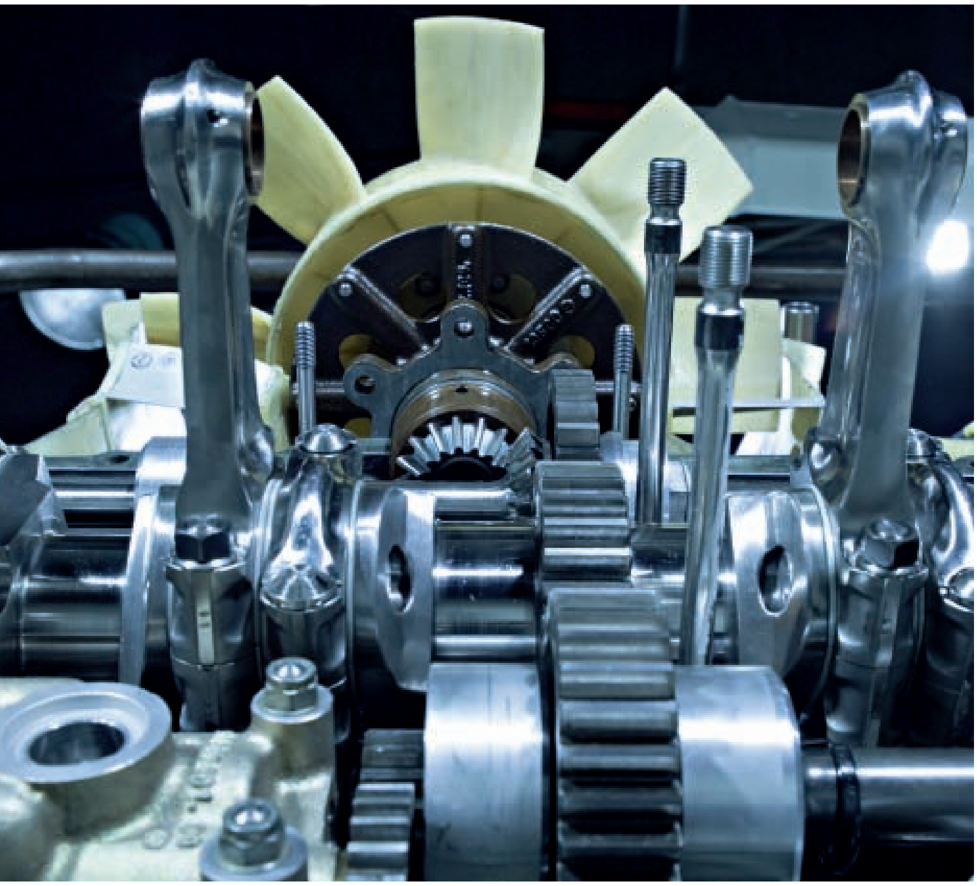
Technical data

- **530 bhp**
- **From zero to 100 km/h (63 mph) in 3.7 seconds**
- **Top speed 204 mph**
- **One-gallon (3.6-liter) six-cylinder turbocharged engine**

1,100 bhp – the engine of the legendary Porsche 917

As the most powerful racecar in the world and with the “Greatest Sports Car in History” award under its belt, the reputation of the Porsche 917 is legendary. This prestige is largely thanks to the most powerful air-cooled engine of all time.

In the spring of 1968, the FIA (Fédération Internationale de l’Automobile) imposed a new regulation for the World Championship of Makes, which starting in 1969 allowed both 0.8-gallon (3-liter) prototype race cars and 1.3-gallon (5-liter) “production sports cars” (with the requirement to build at least 25 identical vehicles) to participate in the long-distance race. Porsche figured they had good chances of finally winning the world championship title with a vehicle in the 1.3-gallon production sports car category, as well as scoring the victory in the prestigious 24 Hours of Le Mans race. In record time, the engineers developed an air-cooled, 12-cylinder naturally aspirated engine, which impressively reached the set goals. In 1969, 1970, and 1971, Porsche won the World Championship of Makes; in 1970 and 1971, the 917 vehicles triumphed with double wins in the 24 Hours of Le Mans. But this dominance almost proved to be the brand’s undoing. For 1972, FIA changed the rules again and 1.3-gallon sports cars – and thus the 917 – were no longer allowed to compete in the Championship of Makes races. But Porsche did not want to send the outstanding racecar to a museum just yet. The decision was made to compete in the CanAm series, which knew neither displacement nor weight limits. For Porsche to hold its own against the established CanAm competition, whose racecars were equipped with large 1.8- to 2.1-gallon (seven- to eight-liter) V8 engines, the twelve-cylinder engine of the 917 would have to be turbocharged.



Bright prospects: the air-cooled, turbocharged Porsche 917/30 won hands down in 1973

Pioneering work in development

Never before had turbocharged engines been used in road races. The dynamic characteristics were so poor that the turbo engines were not competitive, despite increased power output. But the engineers were able to develop a new technology for controlling the boost pressure, thereby almost completely eliminating the dreaded “turbo lag”. A valve in the exhaust pipe, which is controlled by the boost pressure, opens when the desired boost pressure is reached and, bypassing the turbine of the turbocharger, guides the exhaust gas that is not needed to the outside. This new control technology allowed significantly improved tuning of turbo engines, partly because now smaller turbo units could be used. In addition, it resulted in a reduction of thermal engine loads.

Finally, the new technology paved the way for the triumph of turbocharging. Now it was no longer just motor sports – production car engines were also successfully turbocharged.

The most powerful automobile engine of all time

With 1,000 bhp under the hood of the 1.3-gallon turbocharged engine, Porsche participated in its first CanAm season in 1972, with the main intent of gaining experience. But the Porsche 917 Turbo immediately won six of nine races, thus securing the CanAm championship title.

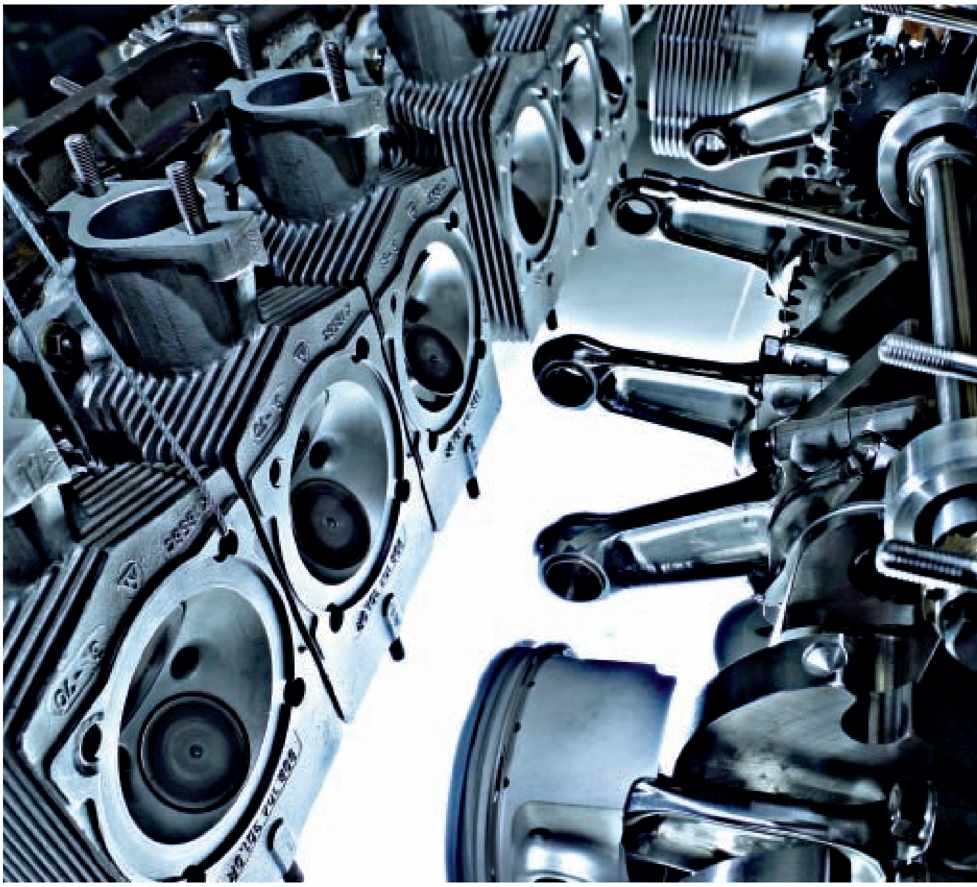
The following season, 1973, Porsche showed up with the most powerful automobile engine of all time. The 1.4-gallon (5.4-liter) version of the twelve-cylinder now delivered 1,100 bhp at 7,800 rpm, and a maximum engine torque of 1,100 Nm at 6,400 rpm. This guaranteed extravagant acceleration values (from zero to 100 km/h – 63 mph – in a mere 2.4 seconds). Porsche then went on to win the 1973 CanAm championship, with eight victories in eight races. After this victorious run, though, the rules were changed again to the disadvantage of the 917, so that Porsche had to retire from CanAm racing. This ended factory-sponsored racing of the 917 for good.

Outstanding performance is nothing without an engine that endures

The heart of the Porsche 917 is an air-cooled twelve-cylinder engine in 180-degree V design with two overhead camshafts per cylinder bank. The center drive is the design highlight of this engine. In this design, the power take-off is through a set of gears in the center rather than at the end of the crankshaft; an intermediate shaft then transmits the power to the transmission. The drive gear in the center of the crankshaft – where there is no torsional vibration – also drives the camshafts and all secondary power take-offs. This offsets the torsional vibrations, makes the engine more robust, thus considerably increasing its life. In addition, it ensures the proper lubricating oil supply for the critical connecting rod bearings through axial feed on both ends of the crankshaft. Thus the 12-cylinder engine owes its proverbial reliability and ruggedness mostly to its center drive design.

A complete work of art in engine development

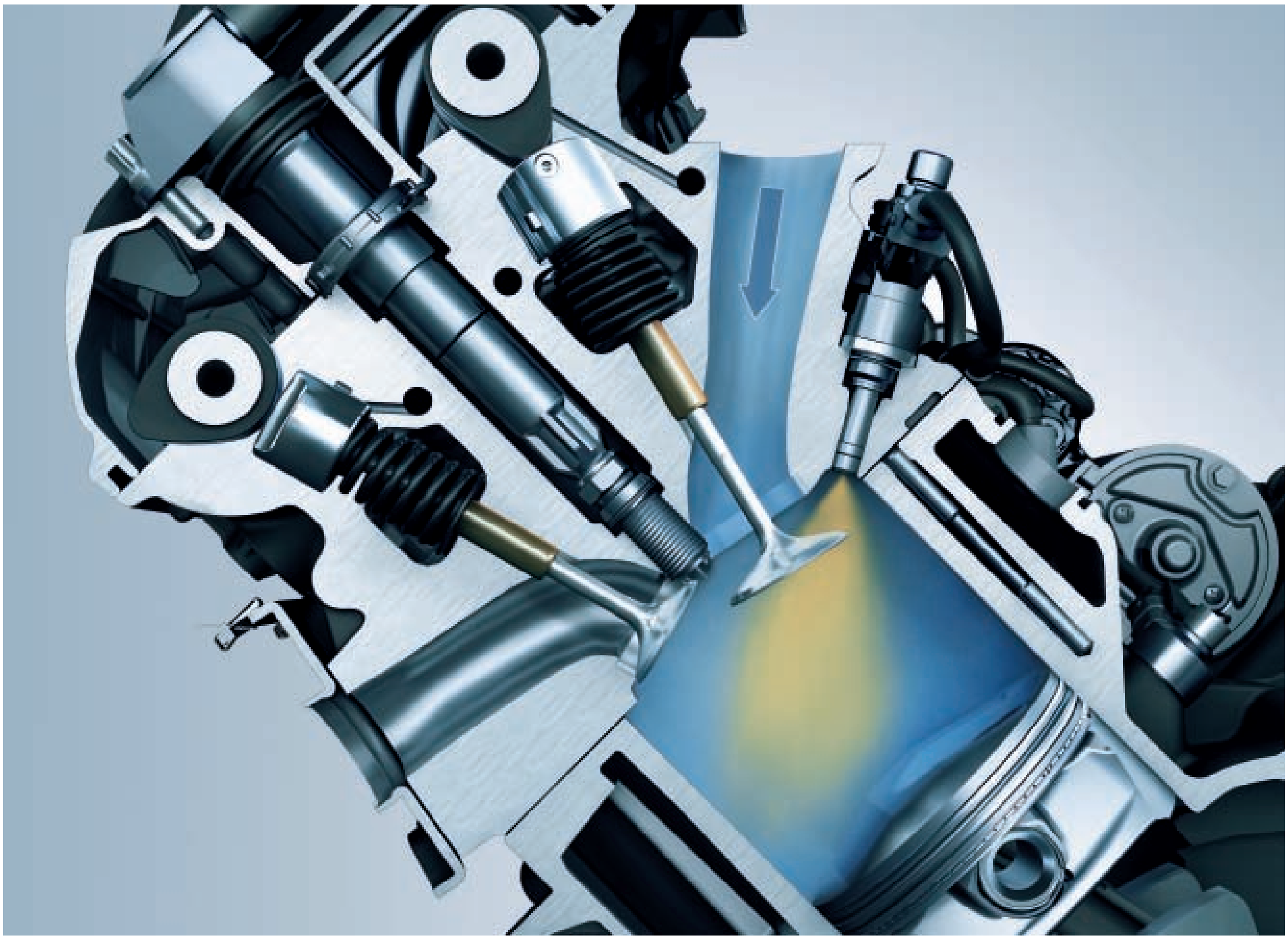
Almost 40 years after its first race, the Porsche 917 is now a legend. The development experience of Porsche and the special construction provided impressive proof that it was smart not to retire the 917 after such a short time in competing in the World Championship of Makes.



Powerhouse: the twelve-cylinder engine achieves a stable 1,100 bhp at 7,800 rpm

It's all in the right mix

Porsche Engineering masters the challenge of optimizing intake ports with flying colors. This describes a method where a number of improvements are implemented during the early stages of development.



The consistent use of state-of-the-art technology and methods can significantly shorten development times for new engines. The intake port geometry in the cylinder head decisively affects the flow quality of the intake air in the cylinder (see diagram, p. 10). Since the development of new combustion processes, such as direct injection systems, called Direct Fuel Injection (DFI) at Porsche, the development of the intake ports has become an even more demanding task.

The right dosage is everything

Depending on the combustion process, intake port development pursues different sub-goals. Here, the large air flow rate that is often desired must be weighed against the targeted tumble or swirl flow indication. In spark-ignition engines, especially in those with direct fuel injection, the incoming air is swirled around the lateral axis of the cylinder to improve mixture formation. During the subsequent compression and fuel injection, this targeted air swirl achieves fast and direct homogenization of the fuel-air mixture. This optimized fuel burning process significantly reduces nitrogen oxide, particulate, and CO_2 emissions while improving fuel economy. At the same time, the flow rate can be improved by minimizing the flow resistance in the intake port. This in turn has positive effects on the engine performance.

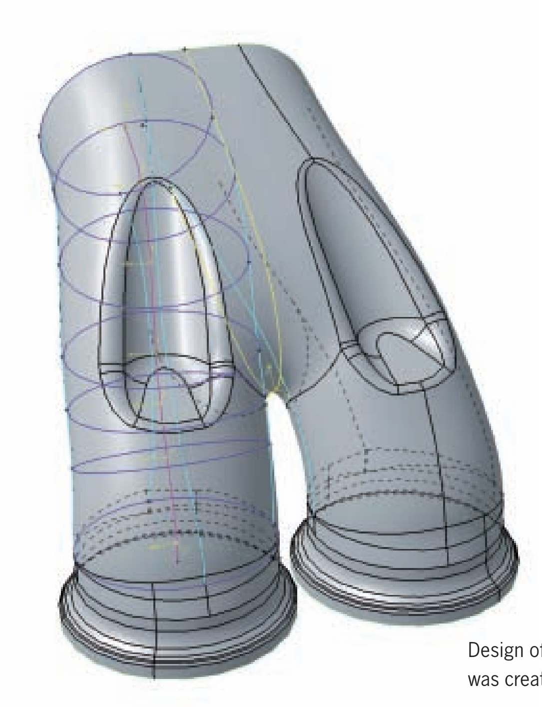
More powerful engines, but eco-friendly, please!

By optimizing the intake ports, Porsche Engineering not only achieves better engine output; with a targeted charge motion in the direct injection processes, CO_2 emissions are lowered at the same time. The flow rate (called the alpha k value) is a general formulation which takes the losses occurring in the intake port flow into consideration. These are caused by friction and the inertia of air masses. High engine power requires a high flow rate. Changing the cross-section of the intake port affects the velocity of the flow, while the port geometry determines the direction of flow. The faster the air enters the cylinder, the more vigorous the swirl.

True, the development of intake ports is not new. What is new, however, is the simulation options Porsche Engineering has available thanks to computer-aided calculations. The geometric influence parameters of intake ports are numerous, since any change in geometry affects the flow.

Intake port development today

Intake port development starts with the specification of different goals, such as the definition of a certain velocity of flow and the flow rate.



Design of an intake port using a CAD model that was created with CATIA V5

For intake port design, Porsche Engineering uses the CAD program CATIA V5, for which our own design method has been developed (see graphic, p. 11). In the CAD models, the designers rely on a highly parameterized geometry, which they control centrally through design spreadsheets in Microsoft Excel. These spreadsheets not only import parameters into a CAD model, but also export measured data from cross-section curves and represent them graphically. In previous versions of CATIA, each cross-section had to be measured and entered "by hand" into a graph. As a whole, the parameters and measured data tell the design engineer whether the specified velocity of flow was reached.

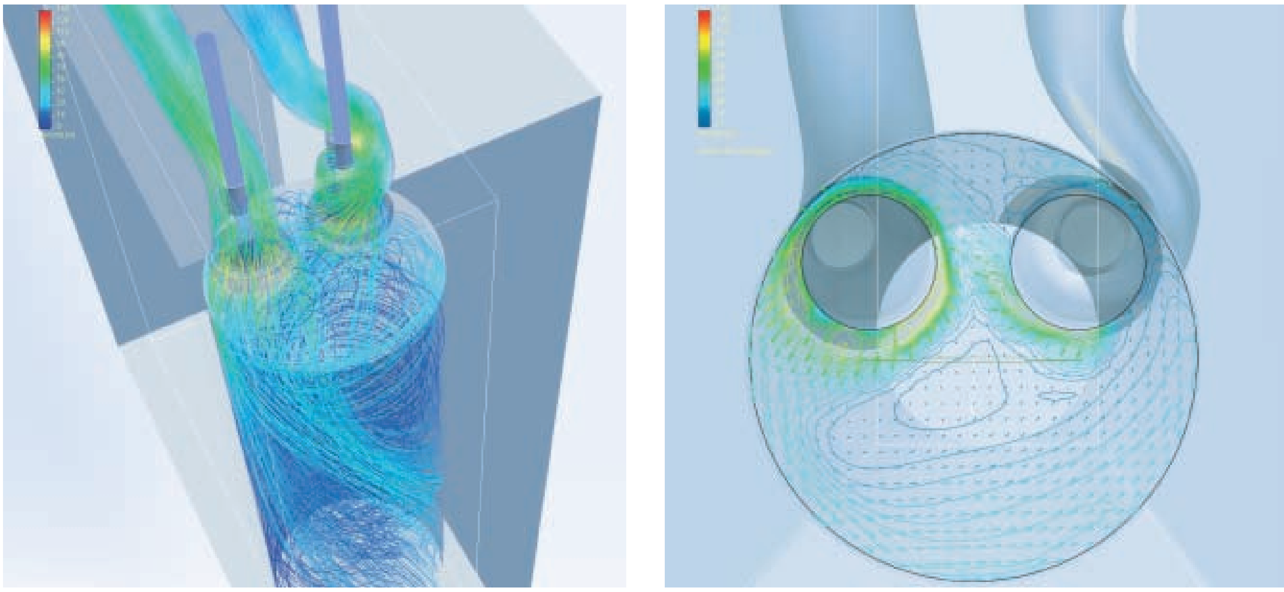
The faster control and evaluation of different models in CATIA V5 is a definite advantage in the designing of variants. A defined number of parameters allows faster and higher-quality design of intake port variants, for example with a different cross-section curve. The use of a CAD program makes the modeling process many times more efficient.

Parallel to the creation of the port models in CAD, critical points, such as the water cooling jacket or the valve spring mounting, are examined for narrowing. In the past, this analysis was also done by hand. Today, the experts at Porsche Engineering use the CATIA V5 DMU (Digital Mock-Up) Navigator for automated narrowing studies, to examine all critical areas more accurately, quickly, and reliably for compliance with the required wall thicknesses and their optimization potential. The narrowing points can be shown in color in the complex cylinder head assembly, thus making them explicit.

Once a large number of intake port variants has been generated in the design phase, the next step is to determine the best variant for the combustion process. Even after the design phase Porsche Engineering relies on advanced, computer-aided analysis methods for determining the flow properties of different intake port variants. In the past, each part was built as an STL (stereolithography) part; that is, an accurate plastic (epoxy resin) prototype of an intake port variant that was subsequently tested on a flow test stand to determine the alpha-k value and the charge motion it produces. Building these prototypes is very time-intensive. Today, a pre-selection is made from all variants, and only the variant with the greatest potential is tested on the flow test stand. The engineers at Porsche Engineering use a CFD (Computer Fluid Dynamics) program that is fully integrated in CATIA V5, allowing more efficient calculations (no reformatting or data exports necessary) and objective evaluation within one day (see diagram, p. 12).

Unsuitable variants can be eliminated beforehand. The preferred variants, where the alpha-k value found in the CFD simulation proves promising, will then be validated on the test stand using stereolithography. With this step, Porsche Engineering can also save development time and costs.

Porsche Engineering sets a standard with this new method for developing intake ports. This achievement by the engineers not only saves resources, development time and costs, but also actually enhances quality and more clearly intermeshes the processes. The development engineers at Porsche Engineering see future areas of application for customers in the layout and optimization of exhaust manifolds, brake disc cooling and intake systems, as well as the flow characteristics of catalytic converters.



CFD simulation to evaluate air swirl, using the example of a port configuration for a diesel engine with direct fuel injection

Making sure the engine and transmission are ready for action

Through various measuring and testing methods, Porsche Engineering makes sure that efficient layout and testing of drivetrains is possible in the early stages of development.

More than ever before, the development process in the automotive sector is characterized by increasingly shorter development cycles for a higher number of vehicle variants. To reach the ambitious goals of the automotive industry regarding CO_2 reduction, coupled with rising demands on vehicle comfort and dynamics, the drivetrain needs to continuously shed weight, despite increases in engine power. Of course, the related rise in weight-specific performance of the vehicles must not compromise component reliability, thereby increasing their failure risk.

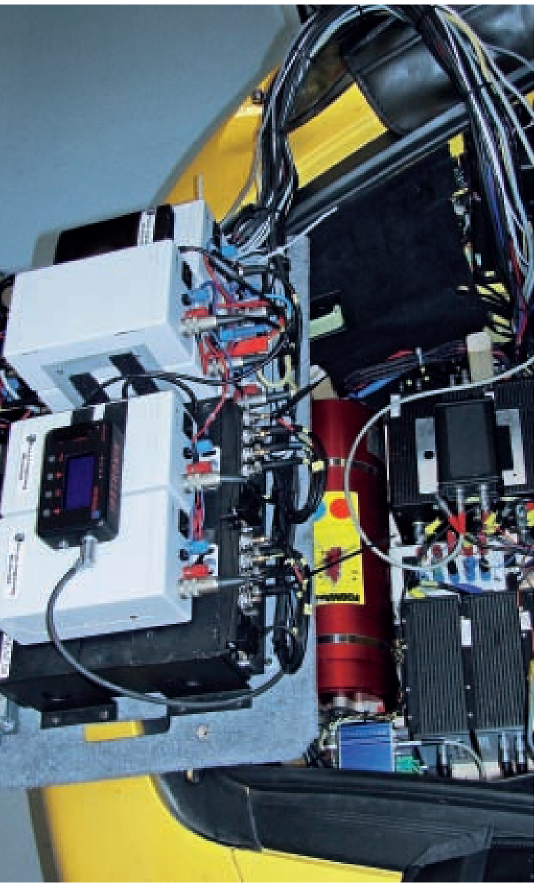
The purpose of testing the components either on the test stand or in the vehicle as part of the development process is to show the failure risk of the vehicle in customer use. A basic requirement of representative testing is that the test specifications accurately describe what the components are to withstand later on, taking into account the permissible failure rate in customer use. If the test programs are too stringent, even slight damage will not be permitted, resulting in reinforcement of components, which may lead to excess component weight and additional costs for measures to extend the life of the vehicle. Too little testing bears the risk of weak spots going unnoticed, resulting in component damage when the vehicle is used by the customer. The consequences can be unpleasant.

Besides the ultimate goal of testing what is important, this must also increasingly be done at minimal cost and time expenditure. We have to test the right things (reasonable component loads) in as little time as possible (high time acceleration) and at minimum cost.

Major goals in component testing:

- **Reasonable component load**
- **High time acceleration**
- **At minimal cost**

To define the test specifications of a drivetrain component, its future worldwide area of application must thus be determined. In addition to the basic requirements of the technical specification, such as engine variants and vehicle segments (SUV, sedan, sports car, lightweight commercial vehicles), transmission testing comprises statistical variables, such as the routes driven, the actual vehicle load, and the very different driving styles to which the vehicle might be exposed in customer use. The term “customer” includes the traditional private person as a car buyer as well as customer groups and commercial users who operate vehicles under special conditions.



Multi-level measuring system configuration in the luggage compartment of a sports car

Vehicle measurement at Porsche Engineering

The objective of the vehicle measurements performed by Porsche Engineering is to measure the characteristic operating loads on the drivetrain that are to be expected in day-to-day operation with sufficient statistical certainty over driving distances of up to 15,000 kilometers (9,321 miles) in a given time range. The measuring conditions have been specified to consider all major influential parameters, such as route composition, driving style, and vehicle load. In subsequent data preparation, load spectrums for precisely defined customer usage potentials are then derived from the measurements. The measuring technology is designed to survive customary “day-to-day” operation as well as extreme loads from abusive maneuvers, such as so-called “idiot starts”, without damage.

To record measured data from a travel distance of more than 15,000 kilometers over three weeks of vehicle operation within the set time range, the measuring system must be characterized by a reliable system start, failure-proof function, and memory capability. The system is started with a central switch that supplies all booster and measuring blocks through a central power supply. False measurements due to system components that were switched on “accidentally” must be avoided. The same applies after conclusion of the measurement: if individual components are mistakenly not switched off, the vehicle battery is discharged before the next round of measurements. The signal scope of the measurement series is usually up to 150 signals, which are measured during the time range between 2,000 Hertz (torques) and one Hertz (temperatures).

Rugged and cost-saving new developments

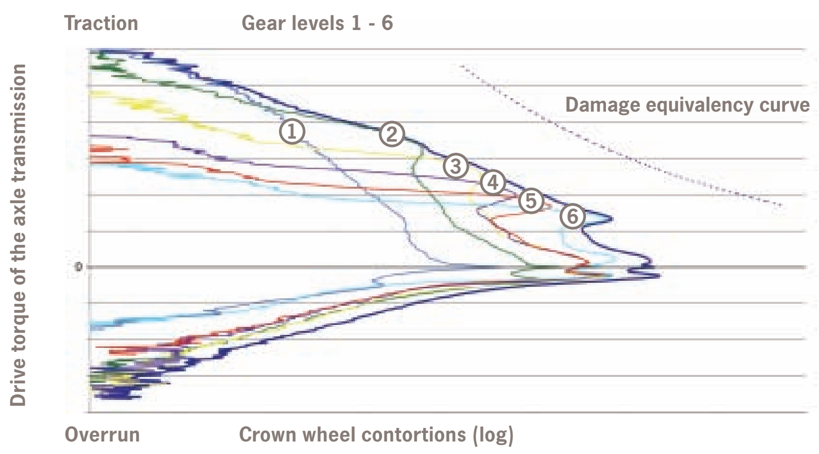
Special challenges for measuring operating loads are posed by driving maneuvers with extreme torque peaks, such as highly dynamic friction value jumps, idiot starts, and traffic light starts. Since torque measurements are based on the elastic deformation of drive components, using conventional side shafts with wire strain gauges applied (so-called measuring shafts) would not achieve the intended goal. After the first abusive maneuver, such shafts are usually so deformed that they exceed the measuring range of the shaft. In an effort to circumvent this problem, Porsche Engineering, together with a system partner, have developed innovative measuring flanges (see diagramm, p.13) that – while comparable with conventional measuring shafts regarding precision and costs – can withstand torque peaks of up to 8,000 Nm, undamaged.

Quantifying load spectrums

The measured data, which are around three terabytes per vehicle and represent around 240 hours of driving in the time range, are used to quantify the loads on the drivetrain, the so-called load spectrum. Its content is defined by mixed operation in cities, on interurban roads, and freeways, dependent on driving style and vehicle load.

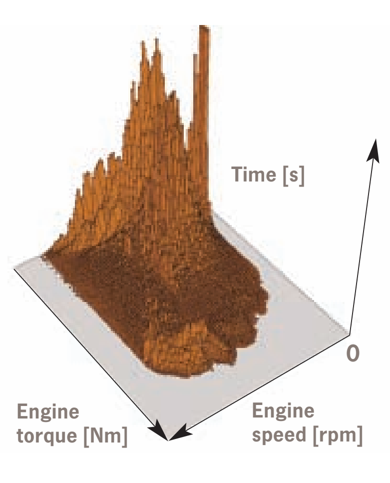
In addition to the torque load, the load spectrums also describe functional interactions or actions in the drivetrain that are of special interest for component layout and testing. For example, how often does a hydraulic valve for valve-lift adjustment switch over a distance of 100,000 kilometers (62,140 miles)? How often does the oxygen sensor measure certain temperature ranges in onroad operation? What is the power take-off of the secondary units of the engine (power-steering pump, air-conditioning compressor, and alternator) in real operation? How often do certain gearshifts occur on a given road section? What are the resulting loads on the gearwheel of the gear in question, and how significant is the influence of driving style on all these parameters?

Damage equivalent torque on the rear axle (all gear levels)



The diagram shows the load spectrum of a rear axle transmission with sub-spectrums from six driving gears in traction and overrun.

Engine dwell time diagram



Engine dwell time diagram for a mid-sized vehicle

On the left is an example of the diagram of a mid-sized car in mixed on-road operation comprising city, interurban, and freeway driving. The right-hand area is defined by the full-load characteristic curve. The maximum engine output range is located in the front of the diagram.

Detailed analysis of testing data sets

After measuring, the data sets are processed in raw data preparation. During the subsequent detailed analysis, load spectrums for all major load parameters (including output, torque, and temperatures) are analyzed. These analyses are performed separately for different customer types as far as they are relevant to the vehicle layout, namely for a defined combination of road type, driving style, and vehicle load. In order to derive test programs, one must either determine damage-equivalent test time/test torque data or subject the data in the time range to various time acceleration methods. After that, they can be represented on the test stand in a time-accelerated simulation test.

This method shows that the subject of load spectrum definition for the drivetrain can be mastered systematically with the right special measuring technology. The benefits that these data provide to development in defining the technical specification undoubtedly justify the high expense.

Off-road dream: the Cayenne S Transsyberia

On the basis of the Cayenne S, Porsche has built a special model for the most extreme outdoor situations. The driver's safety is assured. Even on the most rugged terrain.

With its intelligent all-wheel drive, its powerful and efficient V8 engine with direct fuel injection and height-adjustable air suspension including Porsche Active Suspension Management (PASM), the Porsche Cayenne S is well equipped for any terrain. And to top its sportiness: a car based on the Cayenne S and tailored specifically to the requirements of long-distance rally racing has been developed in the Weissach Development Center. Compared with its urban cousin, the “Cayenne S Transsyberia” features special off-road tires with rougher tread bars, a safety cage, a shorter final-drive ratio, a rear-differential lock, and reinforced, extra-large underbody paneling, as well as reinforced wishbones on the front axle. Another highlight is the new Porsche Dynamic Chassis Control (PDCC), whose two active stabilizers almost completely offset lateral inclination when negotiating curves. Even off-road the PDCC allows the maximum possible wheel articulation, thereby increasing the traction of the electronically controlled all-wheel drive. The Cayenne S Transsyberia is Porsche in its purest form, tailored to the needs of sporty and highly ambitious customers.

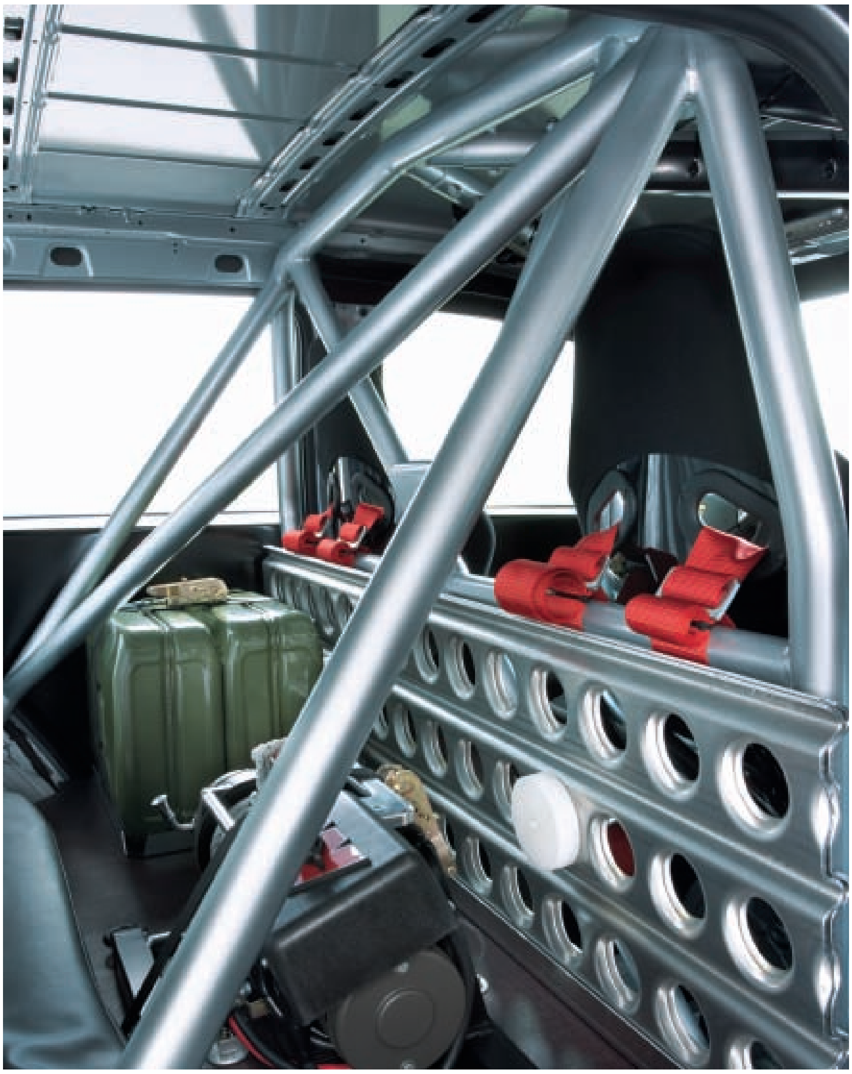
Rally properties with a proven track record

The engine of the Porsche Cayenne S Transsyberia was taken almost without modification from the on-road version of the Cayenne S. The 1.3-gallon (4.8-liter) V8 naturally aspirated engine with direct fuel injection achieves 385 bhp (283 kW) at 6,200 revs per minute. The maximum torque of 500 Nm is attained at speeds as low as 3,500 rpm. VarioCam Plus valve management ensures a smooth and consistent surge of power throughout the entire speed range. Depending on the engine speed, the electronic engine management system switches the intake valve stroke from 0.1 to 0.4 inches (3.6 to 10 millimeters). The length of the intake manifold can also be varied, thus achieving a high torque curve at low rpm. A reduced-weight sports exhaust system on the Cayenne S Transsyberia produces a particularly striking tone. Tiptronic-S transmission, with shortened final drive ratio and transmission control optimized for off-road use, provides increased acceleration power.

Off-road – yes, please!

One fundamental factor in the outstanding driving dynamics of the Cayenne S Transsyberia is its power transmission to all four wheels. In basic mode, the Porsche Traction Management (PTM) permanent all-wheel drive transmits 62% of the engine torque to the rear wheels and 38% to the front wheels. The distribution ratio can be varied in line with the current driving situation using an electrically actuated and controlled multiple-disc clutch. But even 100% of the engine power can be transmitted either to the front or the rear as needed. The map-controlled center-differential lock and the rear-axle limited-slip differential do more than simply respond to insufficient traction at the rear or front axles. Sensors also measure the vehicle speed, the lateral acceleration, the steering angle, and the accelerator pedal's position. Thus the PTM is always able to calculate the required degree of locking for both axles and properly split the drive torque between them. A rear-differential lock has been installed in order to enhance off-road performance.

Offroad performance: for the things you have to do – and the things you just can't leave alone



Solid safety cage in the interior

On difficult terrain in particular, the Porsche Dynamic Chassis Control (PDCC) in conjunction with the air suspension and the Porsche Active Suspension Management (PASM) increase traction. When driving in water, the maximum fording depth at High Level II of the air suspension is approximately 30 inches (75 centimeters). In addition, the body and doors are sealed against water up to side window height. The air intake has been moved to roof height using a flexible air filter snorkel, to ensure that the "bow waves" created when driving through water cannot enter the intake duct. Likewise, the wheels and suspension of this ultimate sporting performer were designed for extreme endurance. The double-arm front axle comes with reinforced wishbones and a track width that is 1.3 inches (34 millimeters) wider. The standard high-speed tires have been replaced with rough-tread off-road tires.

Maximum safety in a crash

When it comes to body rigidity and passive safety, the Porsche Cayenne holds a top position among off-road vehicles. More than 60% of the body-in-white is made of high-strength steel. A three-tier deformation zone absorbs forces during a collision and distributes them to the rigid lower longitudinal members, door sills, and tunnel area. The reinforcements in the A- and B-pillars are manufactured from high-strength steel to protect against roll-over. To protect both driver and passenger in competitive situations even better against the consequences of a collision or roll-over, the Cayenne S Transsyberia has an additional safety cage, which is bolted to the passenger cell and compliant with FIA design regulations.

The bare necessities

To offset the extra weight of the safety cage and rally equipment and to further lower the vehicle's center of gravity, the rear seats, standard interior body panels and soundproofing material have all been removed from the car. The central locking system has been replaced with a manual locking mechanism for the front doors with orange loops. The rear window and the rear side windows are made from lightweight polycarbonate. As in all Cayenne models, the front side windows have a hydrophobic coating. Water is repelled and runs off, which make the glass less prone to soiling than conventional windows. Both the driver and front passenger enjoy the benefits of lightweight sports seats with Alcantara covers.

The ultimate sporting performer with technical highlights

The Cayenne is equipped with a navigation system as standard; it allows off-road trip planning and can be operated by the passenger. The glove compartment has been replaced with a Tripmaster computer, helping the copilot find routes between the various navigation points. Most of the control units are installed in the interior and all electrics cables have been rerouted. The on-board electrics can be quickly switched on and off with a central switch on the lower right of the driver's seat, making it possible to reset the electronics while driving.

Reinforced, extra-large underfloor paneling made of aluminum and an additional cover made of stainless steel for the exhaust tailpipes protect the Cayenne S Transsyberia from damage caused by the enormous stresses of a rally. The typical foot-operated brake on the Cayenne S has been replaced with a handbrake, which can be used to oversteer the car in tight curves. Four auxiliary high-beam lights are mounted on the roof.

The large tailgate conceals complete rally equipment

Equipped for any situation

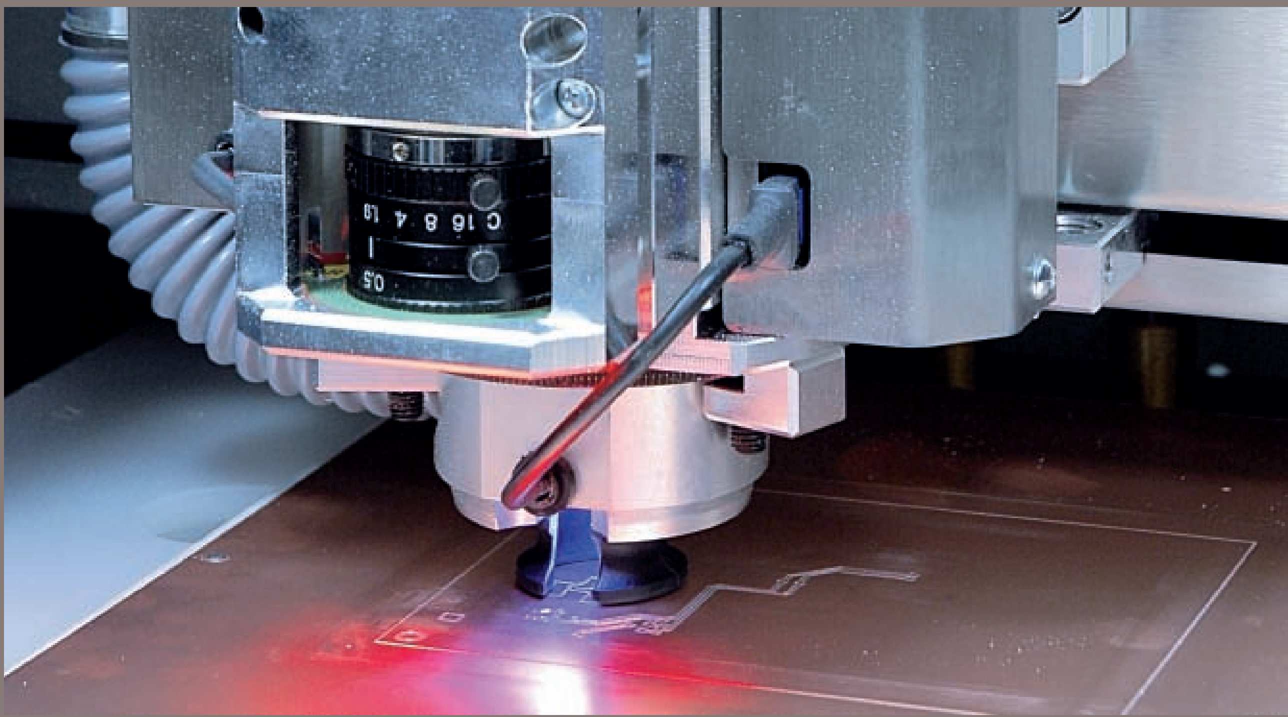
City driving is not exactly a favorite of the Transsyberia. It is built for extreme outdoor situations. To successfully master particularly difficult and demanding terrain, as well as to salvage other vehicles, the Cayenne S Transsyberia comes with a winch that is easy to fit if necessary and is stored in the luggage compartment.

The Cayenne S Transsyberia always cuts a good figure

The luggage compartment also comes with two 5.3-gallon (20-liter) reserve cans, a hydraulic off-road car jack, two fire extinguishers, two sand panels, two full-sized spare wheels, and two transport boxes for tools. Also on board are two two-man tents, two sleeping mats, four tightening straps, a 29-foot (nine-meter) rescue belt with a chain joint, a folding spade, a folding saw, an axe, and a working headlamp, along with four towing lugs, and a HAZET tool set.

Tailored solutions for demanding customers

Typical Porsche: the Hardware Lab of Porsche Engineering develops products that meet the highest standards and customer requirements. Efficiency and intensive customer support go hand in hand.

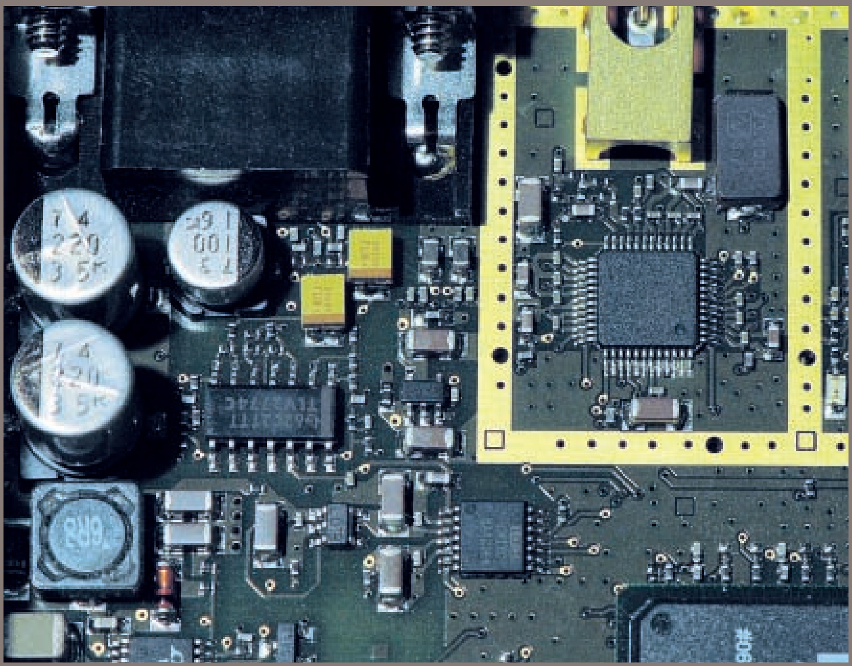


Electronics as the key technology play an increasingly important role in the information and communication age. Ease of operation, multi-functionality, high reliability, and real-time responses are the major requirements of contemporary hardware. This trend applies increasingly to the automotive industry, as more complex and faster hardware finds its way into modern cars.

The Hardware Lab basically follows three trends: the linkage of multimedia and sound systems; the use of state-of-the-art electronics to reduce consumption; and finally, increasing passive and active safety through intelligent integration of assistance systems.

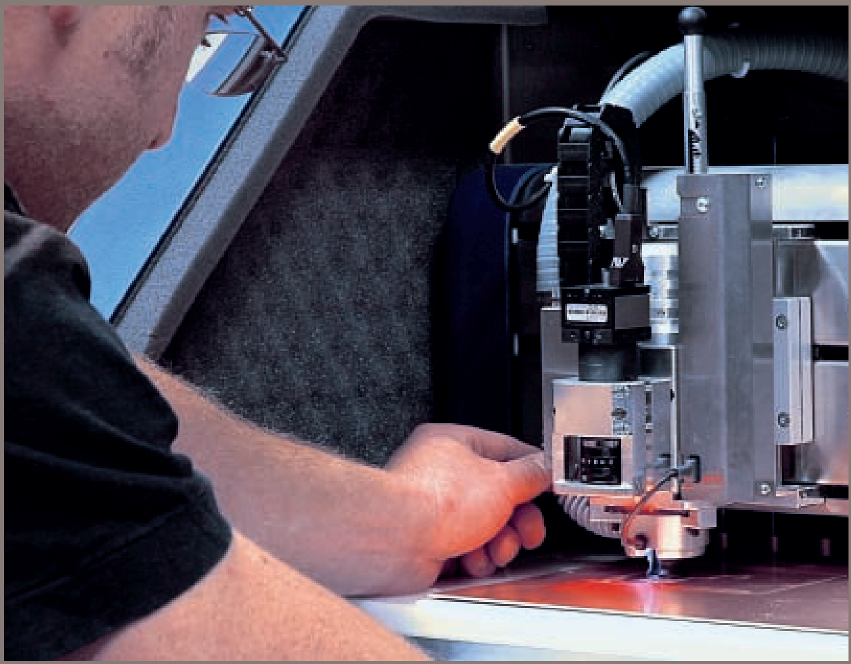
Diligent development process

In all hardware developments of Porsche Engineering, quality is at the top of the list. For this reason, all development processes are aligned with the Porsche standards. Increasingly complex products combined with shorter time-to-market and more demanding quality expectations make it necessary to determine customer requirements early on and to create a realistic test environment for the future product. This is one of the specialty areas of the Porsche developers. Often it takes them only a few days to create an initial sample (A-sample) of complex control units that can be used in integrated systems and that provide fast, real-time feedback regarding the future feasibility of the customer's requirements. The applications on the control units are first modeled, simulated, and then tested extensively in executable code on the target hardware (Rapid Prototyping). This way, specification and development errors can be discovered in a very early phase of a project. If needed, we will support our customers throughout further development with B-, C-, and D-samples, up to three months after the start of production. Veteran experts support the customer on the way to a successful product and help with all development steps, all the way up to approval testing and consultation regarding electromagnetic compatibility (EMC).



Development examples – product portfolio

High-performance audio amplifiers and music player interfaces for vehicles are examples of recent innovative developments by the Hardware Lab. These projects often involve easy-to-operate interfaces between consumer electronics and the audio system of a vehicle. Other projects are in the areas of electric drives, electric drives for sports equipment, and innovative solutions in combination with hybrid drives. Their extensive knowledge of battery technologies, which increasingly contributes to the success of future products, makes the Hardware Lab an attractive partner. After all, the engineers in the Hardware Lab have many years of experience with the integration of vehicle assistance systems into complete vehicles.



911 – a synonym for performance

Historical deciphering of the Porsche success code revealed surprising findings – about the “zero” hour of the 911.

When the new Porsche was presented at the International Motor Show (IAA) in Frankfurt am Main in September 1963, it bore the identification plate “Type 901”. The development department had done diligent preparatory work to exclude possible objections to the type designation, so they had every reason to feel safe. At the Motor Show, the new sports car received a great response and the success of the “Type 901” seemed predestined.

Imagine the development engineers’ surprise when an objection from a French automaker arrived at the end of 1964, claiming that it – and it alone – had the exclusive right to use type designations with a zero in the middle.

The new sports car from Porsche met with a positive response all over the world. Yet, after intensive internal legal investigation, renaming it was unavoidable. Still, the elegance of the vehicle was to be maintained for a new launch. After the Porsche had caused such a furor in such a short time with its 901 number addition, just as the type 356 had in its time, they were adamant about keeping the nine and the one.

The obvious solution was to double the one: 911. This decision was made relatively fast. Without delay, the graphic designers at Porsche tackled the graphic implementation of the change. And their brushstrokes demonstrated taste and confident style. Over time and across model changes, the upright, angular 911 logo morphed into the rounded, slightly italic lettering, the typical “Carrera logo”, as it is called internally.

911 Carrera

This logo has long since become an optical distinguishing feature of this model. It is also legally protected – as a registered trademark. The fact that the Porsche type 901 became the type 911 only a year after its initial launch certainly has not harmed its career.


turbo
0 km/h
SWR3
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