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Modular Transverse Matrix (MQB): A new level of flexibility, efficiency and model variety

MQB networks development and production across brands

Modular matrix strategy assures Volkswagen AG a global competitive advantage

Wolfsburg, January / February 2012. The global automotive industry is facing enormous challenges. First: Fossil fuels must be used more carefully and efficiently than ever before. Second: Alternative renewable energy sources need to be increasingly used for mobility in parallel with petrol, natural gas and diesel. Third: A higher level goal is to reduce further the emissions generated by mobility. Fourth: Just as in industrial nations, developing countries and emerging markets must be able to access automobiles whose drive systems are sustainable. These challenges present three specific areas of action for the development of future drive concepts: 1. Strategic optimisation of the efficiencies of the drive systems. 2. Use of alternative and in particular renewable energy sources. 3. Development of CO_2-neutral mobility concepts.

Volkswagen AG is addressing these three areas of action and thereby the challenges of today and the future with a powertrain and fuel strategy that – simultaneously – mandates the optimisation of conventional drives, the use of alternative energy sources, the breakthrough of electro-traction and mobility that, as a whole, is as CO_2-neutral as possible.

To the point – MQB changes everything. In a positive way!

New modular matrix from Polo to Passat. To implement this powertrain and fuel strategy effectively, Volkswagen AG has developed different modular component sets. The most recent of these is the Modular Transverse Matrix (MQB). Another objective of the cross-brand MQB is to protect the Group's high level of competitiveness over the long term and extend it in the especially high-volume segments A0 to B. At the Volkswagen brand this covers the range from the Polo to the Golf and up to the Passat.

MQB considers all drive versions. In configuring the modular transverse matrix, the growing diversity of drive versions was taken into account. In very concrete terms, the MQB enables the integration of drive systems – in an identical mounting location – that range from two entirely newly developed, modularly constructed engine series (petrol engines: EA211 / diesel: EA288) and alternative drives such as CNG (natural gas), hybrid or drive components for electric vehicles without limitations or compromises.

MQB closes a circle. Within the Volkswagen Group, the new MQB supplements the Modular Longitudinal Platform (MLB) for which Audi is responsible, the Modular Standard Car Matrix (MSB) with Porsche as the competence centre and the "New Small Family" consisting of the Volkswagen up!, SEAT Mii and Škoda Citigo, which currently represents the Group's most compact vehicle model series.

Core alignment for present and future. The fact is that modular component systems are of crucial importance to Volkswagen AG in the engineering and production of new vehicle lines. With over 220 Group models and over 90 production sites worldwide with 448,000 employees, comprehensive standardisation of components and production processes inherently plays a key role. A high volume of identical parts leverages large scaling effects in production costs and therefore – globally – the realisation of market-aligned automobile prices and a significantly more extensive product line-up. And this will make sustainable technologies affordable to new car buyers in emerging markets as well. In addition, thanks to the high flexibility of intelligent modular systems, it is easier to implement modifications for region-specific needs. All of these aspects help to safeguard the success of the Group under all economic and environmental perspectives and overcome current and future challenges.

Changes and advantages – cars that are more beautiful, variable and safe

Dimensions standardised. One of the most crucial prerequisites for the successful implementation of the idea of modular component sets is uniform engineering dimensions – e.g. the distance between the accelerator pedal and the centre of the front wheel. But it is just as important to also offer variable parameters. They include, for example, the wheelbase, track widths and wheel sizes, as only then can different vehicle architectures be implemented from one component set.

Engine position standardised. As a result, a prominent characteristic of the new modular transverse matrix is the uniform mounting position of all engines. To make this feasible, Volkswagen fundamentally revised its petrol engine series. The cylinder head was rotated, and the layout of key connections and the tilt of the engine were adapted to match that of other engines. Now, the induction side of the engine is always at the front, and the exhaust system at the rear. This now enables a uniform engine-gearbox flange pattern, which permits the use of the same gearbox for all engine series in every torque class.

A key role in the MQB strategy is assumed here by the modular petrol engine system (MOB) with the newly developed EA211 engine series – this engine series includes the world's first four-cylinder engine with cylinder deactivation (ACT) – and the modular diesel engine system (MDB) also with the newly developed engines of the EA288 series.

Greater flexibility. In one fell swoop, the Group was able to reduce engine and gearbox variants in the new MQB system by 88 per cent. This reduced complexity increases flexibility. As noted, the MQB makes it possible to implement, along with conventional internal combustion engines, all current alternative drives in an identical mounting position without limitations – from natural gas (CNG) to hybrid versions and the pure electric drive. Volkswagen has announced the use of the MQB for the latter drive system as soon as 2013 in the new Golf Blue-e-motion.

Design, package and safety benefit. In general, the advantages of the MQB are multi-layered and specifically benefit the new car customer: for example, the forward shift of the front wheels by 40 mm (compared to Group compact class models today) produces especially well-balanced proportions in styling, supplemented by optimised space utilisation (the so-called 'package') and an improved crash structure.

Less weight, more innovations. Thanks to an intelligent material mix, the MQB also leads to a reversal of the upward weight spiral. Consider the Golf: Despite tremendous progress in convenience features and vehicle safety, the weight of the future generation Golf is about the same as that of the fourth generation (1997 to 2003). At the same time, Volkswagen AG will introduce around 20 innovations in the areas of safety and connectivity/infotainment with the introduction of the first MQB model series – features that have so far been reserved for higher vehicle segments.

Alliance of engineering and production. The strengths of the MQB are inseparably linked to the Volkswagen Group's Modular Production System (MPB) with the result that vehicles and production are thereby networked together more tightly than ever. Comprehensive standardisation of vehicle components, engineering dimensions and production methods can reduce costs and production time. In turn, greater flexibility opens up new possibilities for extending the product line-up – even for niches that the Group could not service to date. In the framework of the modular transverse matrix, the various areas of vehicle and production technologies are interrelated, paving the way to the future.

New efficient petrol and diesel engines

EA211: Petrol engines, more fuel-efficient and agile than ever

EA288: Diesel, clean, torque-strong and Euro-6 compliant

Wolfsburg, January / February 2012. Highly efficient internal combustion engines and new alternative drive solutions have long assumed a key role in the route to the future. To safeguard individual mobility – as we know and value it today – three conditions must be fulfilled:

- Systematic efficiency improvements for the drive systems.
- Use of alternative and in particular renewable energy sources.
- Development of CO_2-neutral mobility concepts.

Volkswagen AG is addressing this challenge – a challenge directed towards all carmakers – by introducing innovations in a wide range of technologies. Consider the Volkswagen brand: pioneering here are the BlueMotion models that were already introduced in 2006. The current frontrunner in this sustainable development is the Polo BlueMotion with a combined fuel consumption of just 3.3 l/100 km (CO_2 emissions: 87 g/km). Overall, the diesel and petrol engines have become increasingly more fuel-efficient in all model series.

In addition, new drive systems are making their way into production, one by one. Another Volkswagen example: presented in 2010 was the Touareg Hybrid, the first Volkswagen with dual power sources from a petrol engine and an electric motor. Now, in 2012 the Jetta Hybrid, shown at the start of January in Detroit, is following as a high-volume model. Its 110 kW / 150 PS TSI engine is supported by a 20-kW E-motor, which is fed from a 1.1 kWh lithium-ion battery. In 2013, Volkswagen will introduce the era of electric mobility with the e-up! and the Golf Blue-e-Motion.

Simultaneously, with the introduction of the new modular transverse matrix, Volkswagen is clearly demonstrating the enormous potential that conventional petrol and diesel engines still possess. The completely newly developed EA211 (petrol) and EA288 (diesel) engine lines serve

up numerous technological innovations. Debuting in the petrol engines, for example, is the world's first active cylinder management (ACT) system to be implemented in a four-cylinder engine for mass production. The engine's efficiency is increased tremendously by activating and deactivating cylinders. Another milestone in Volkswagen powertrain technology!

Overview of the new EA211 series petrol engines

For MQB and New Small Family: Underlying the development code EA211 is a new family of petrol engines. It is made up of both three-cylinder and four-cylinder engines. The engines of the EA211 series made their premiere at Volkswagen with the production launch of the up! (no MQB) as a three-cylinder MPI engine. Now the TSI sixteen-valve, four-cylinder engines of the EA211 series (TSI : direct injection with charging) – at the power levels 63 kW / 85 PS and 77 kW / 105 PS (each 1.2 litre) as well as 90 kW / 122 PS and 103 kW / 140 PS (each 1.4 litre) – are also setting new standards in the Modular Transverse Matrix when it comes to energy efficiency, lightweight construction and high torque performance.

Powerful petrol engines. The top torque values of these engines with a 10.5:1 compression ratio permit both a relaxed shifting style and a dynamic shifting style. That is because the maximum of 165 or 175 Newton metres of the 1.2-litre engines and the 200 or 250 Newton metres of the two 1.4-litre versions can be called up at a low 1,400 rpm; the torque values also stay at their maximum level up to the 4,000 rpm mark.

Fuel-efficient petrol engines. Fuel consumption values of the EA211 engines were reduced by 8 to 10 per cent, in part due to reduced internal friction, lower weight and optimised thermal management; in conjunction with the innovative new ACT cylinder deactivation system, the savings potential can be as much as 20 per cent. Of course, CO_2 emissions are also reduced.

World premiere of cylinder deactivation in the 1.4 TSI. Pioneering here is active cylinder management (ACT). Volkswagen is the first carmaker to introduce this fuel-saving technological innovation in a mass-produced four-cylinder engine. The first engine to feature this system will be the 103 kW / 140 PS TSI. The functional principle of active cylinder management: at low and medium load, two of the cylinders are shut off, which reduces fuel consumption in the EU driving cycle by 0.4 l/100 km. The shut-off is always active when engine speed is between 1,250 and 4,000 rpm and torque is between 25 and about 100 Newton metres.

New angle of inclination. The engines of the EA211 series are also characterised by a new mounting position. In the familiar petrol engines of the previous EA111 series, the ('hot') exhaust side was at the front, and the engines were mounted with a forward tilt. By rotating the cylinder head, the new generation of EA211 engines that is launching with the introduction of MQB is tilted towards the firewall (bulkhead between engine compartment and passenger compartment), just like the diesel engines. From now on, the petrol engines also share this with the diesel engines of the EA288 series: they are now also inclined towards the rear at an identical inclination angle of 12 degrees. Advantages: the exhaust line, driveshafts and gearbox mounting position can be standardised.

BlueMotion Technology. With a BlueMotion Technology pack (Stop/Start system and battery regeneration) that is tailored to the EA211 petrol engines, Volkswagen is further reducing the already low CO_2 emissions of the engines.

Technical details of the new EA211 series petrol engines

Only the cylinder spacing was preserved. The EA211 is a complete redesign; only the cylinder spacing of 82 mm was adopted from Volkswagen's successful EA111 engine series. To ensure a uniform mounting position of all engines in the MQB, engineers rotated the cylinder head of the petrol

engine. At the same time, it is now tilted towards the rear. That it is also built in an especially compact way is reflected in its mounting length that has been shortened by 50 mm. This is an advantage that passengers will experience directly in the form of an even more spacious interior.

Aluminium block reduces weight by up to 16 kg. Thanks to an ultra-rigid crankcase made of die-cast aluminium, the new petrol engines are especially lightweight at 112 and 114 kg – on the 1.4 TSI, the weight advantage compared to the grey cast iron counterpart from the EA111 series is a considerable 22 kg. The lightweight construction that is meticulously observed at Volkswagen extends down to the smallest of details: engine developers reduced the main bearing diameter of the crankshaft on the 1.4 TSI from 54 to 48 mm; the crankshaft itself was lightened by 20 per cent, while the weight of the connecting rods was reduced by an impressive 25 per cent. The rod bearing pins are bored hollow, and the aluminium pistons (now with flat piston crowns) have now also been weight optimised.

Exhaust manifold integrated in cylinder head. Also firmly in the spotlight in the development phase was the topic of thermal management. To utilise exhaust energy optimally in hot operation and, on the other hand, to cool more effectively at high loads, the exhaust manifold of the new EA211 engines was fully integrated in the cylinder head and provided with its own cooling jacket. Not satisfied with that, Volkswagen engineers devised a dual-loop cooling system. The base engine is cooled by a high-temperature loop with a mechanically driven coolant pump, while a low-temperature loop, powered by an electric pump, circulates coolant to the intercooler and turbocharger housing as needed. Passenger compartment heating comes from the cylinder head circulation loop, so that it warms up quickly, like the engine.

Small turbocharger, big effects. By means of innovative construction of the exhaust manifold, Volkswagen was able to use just a very narrow single-scroll compressor in turbocharger selection. The results: this reduced the weight of the cylinder head turbocharger component group.

On the EA211, the intercooler is integrated in the induction pipe which is made of injection-moulded plastic. The advantage: significantly accelerated pressure build-up, which leads to very responsive downsized engines.

Renaissance of the toothed belt in valve actuation. Volkswagen has also significantly reduced internal friction in its new generation of engines. Take the example of overhead camshafts (DOHC): the camshafts are not driven by chain here, rather by a single-stage, low-friction toothed belt design with a 20 mm wide belt and load-reducing profiled belt wheels. Thanks to its high-end material specification, this toothed belt's service life reliably spans the life of the entire vehicle! Actuation of the valve drive via roller cam followers and an anti-friction bearing for the highly loaded first camshaft bearing also lead to reduced friction resistances. To ensure that the engine takes up as little mounting space as possible, ancillary components such as the water pump, air conditioning compressor and alternator are screwed directly to the engine and the oil sump without additional brackets, and they are driven by a single-track toothed belt with a permanent tension roller.

Variable camshaft for more torque. To reduce emissions and fuel consumption further, and to improve torque in the lower rev range, the intake camshaft on all EA211 engines is adjustable over a range of 50 degrees crankshaft angle – on the 103 kW / 140 PS 1.4 TSI, an exhaust camshaft adjuster is added. It sets the desired spread of control times and thereby allows even more spontaneous response from low revs; at the same time, torque is improved at high revs.

Five-hole injection nozzles spray at up to 200 bar. The maximum injection pressure of the new TSI version (direct injection engine) was increased to 200 bar; state-of-the-art five-hole injection nozzles deliver up to three individual injections to each of the cylinders via a stainless steel distributor bar – extremely precisely. In designing the combustion chamber, Volkswagen also paid particular attention to achieving minimal wetting of the combustion chamber walls with fuel and to optimised flame propagation.

Modular thinking led the way. The engines of the new EA211 series are also a good example of how systematically the same-parts principle runs like a common thread through the MQB strategy: not only are the cylinder head, the engine block, crankshaft, connector rods and bonnet modules produced uniformly and highly flexibly, but the components for fuel induction (such as the charge air pathway, the air filter, induction pipe, intercooler, throttle valve and control drive) are also identical across all variants. This uniform basic architecture has let Volkswagen AG achieve global network capability in production and assembly as well as global procurement synergies.

World premiere of active cylinder management (ACT) in the 1.4 TSI

Two of the four cylinders take a rest. Volkswagen is the world's first carmaker to implement active cylinder management (ACT) for the TSI four-cylinder – a fuel saving technology that was previously the preserve of large eight or 12 cylinder engines. Active cylinder management will make its debut in the 103 kW / 140 PS 1.4 TSI. Shutting down the second and third cylinders during low and medium load states reduces fuel consumption in the EU driving cycle by about 0.4 l/100 km. In constant speed driving at 50 km/h in third or fourth gear, this saves as much as one litre per 100 km in fuel. Even while driving at 70 km/h in fifth gear, fuel consumption is still reduced by 0.7 litre per 100 km.

Active up to 4,000 rpm and 100 Newton metres. ACT is active over an engine speed range between 1,250 and 4,000 rpm and torque outputs from 25 to approx. 100 Newton metres. This is a broad characteristic map, which covers 70 per cent of all driving states in the EU driving cycle! If the driver presses the accelerator pedal hard, cylinders 2 and 3 begin to work again, without a noticeable transition. The high efficiency of the system does not have any negative effects on smooth running: even with two cylinders the excellently balanced 1.4 TSI runs just as quietly and with low-vibration as with four active combustion chambers. All mechanical switchover processes take place within

one-half camshaft rotation; depending on engine speed this takes just 13 to 36 milliseconds. Accompanying interventions in ignition and throttle valve processes smooth the transitions. What's more, thanks to an accelerator pedal sensor and intelligent monitoring software, the system can also detect irregular driving profiles – such as during a drive through a roundabout or in sporty shifting on a highway. In such cases, cylinder shut-off is deactivated.

ACT components weigh just 3 kg. Altogether, the components of active cylinder management weigh just 3 kg. Their actuators, the camshafts and their bearing frames are integrated in the cylinder head; two low-friction bearings reduce friction of the shafts. Important to know: only with the TSI concept – petrol direct injection plus turbocharging – is cylinder deactivation even conceivable in its form today. In naturally aspirated direct-injection systems there would be complications in fuel induction, combustion and emissions control.

EcoFuel version with 1,300 km driving range.

Natural gas high tech for the compact class too. The 1.4-litre version with 90 kW / 122 PS also serves as the basis for a natural gas version – traditionally known as EcoFuel at Volkswagen. In this case, the engine produces 81 kW / 110 PS. Fuel storage, e.g. on the Golf, is provided in two underfloor natural gas tanks and a 50 litre petrol fuel tank. They extend the range by 420 km to 1,300 km –without imposing any limitations on interior space.

Optimal for the wallet and the environment: The natural gas drive offers an ideal combination of the lowest fuel costs, lowest exhaust emissions and dynamic performance. A positive side effect is the fact that biogas can be used, which is this is one of today's most sustainable alternative fuels.

Minor modifications: Valves and value seat rings are reinforced in the EcoFuel version, to handle the higher loads that occur in natural gas combustion. For the same reason, low-wear spark plugs and a PVD

(PVD: Physical Vapour Deposition) coating of the first piston ring are used. The modifications made for CNG (CNG: Compressed Natural Gas) operation essentially make the EA211 engine suitable for use with bio-ethanol (E85) and pure ethanol (E100) as well. This means that a future-assured EA211 version will now be available for markets in Sweden and Brazil.

Overview of the new EA288 series diesel engines

1.6 to 2.0 litres displacement. The new EA288 generation TDI engines will be available in 1.6 and 2.0 litre displacement versions. The agile four-cylinder develops 66 kW / 90 PS and 140 kW / 190 PS. Maximum torque is extremely impressive in all cases – lying between 250 and 380 Newton metres.

More fuel-efficient, powerful and economical. Together with the launch of the EA288 engine line-up, Volkswagen AG is raising its TDI technology – refined over the years – to new levels of sustainability. Compared to the previous EA189 series, the diesel emits up to 7 g/km less CO_2; total emissions were reduced by up to 45 per cent in the Euro-6 version. Individual engines show performance gains of up to 12 per cent; in certain drivetrain configurations the improvement is as much as 26 per cent.

Identical parts wherever possible. Coverage of all legal emissions levels worldwide, the implementation of two engine displacement classes and differentiation of the power range show the variability of the EA288, which is being used as the standardised diesel base engine series in the modular diesel system (MDB). The design of modular components gives engine factories the ability to react flexibly and quickly to changing market conditions and customer wishes. Many key components of the EA288 series TDI engines – such as the valve actuation module, fuel induction and exhaust gas recirculation – enable this on the emissions side due to their modular construction. Later this year, Volkswagen AG will offer a version of the EA288 engine, which already fulfils the Euro-6 standard and will apply to all new vehicles, but will not go into effect until September 2014.

Technical details of the new EA288 series diesel engines

Except for the cylinder spacing and stroke/bore ratio, everything else is new. Just like the new petrol engines (EA211), with the introduction of the modular transverse matrix, the only dimension of the new four-cylinder diesel that is the same as that of the previous model is the cylinder spacing.

Internal engine modifications to reduce emissions. Emissions-relevant components are either implemented in modular construction to conform to the specific emissions standard, or they are prepared in the mechanical design of subassemblies, such as fuel injection, cylinder pressure sensor, turbocharging and intercooling within the fuel induction module. These actions make the TDI, as noted, fit for the upcoming Euro-6 emissions standard today; in addition, they enable compact construction. Compliance with the Euro-6 standard is already built in: the standard requires a further reduction in nitrogen oxides (NO_x) in the exhaust stream from 180 to 80 mg/km in diesel engines. Three different types of exhaust gas recirculation (EGR) are used, depending on emissions requirements:

- Cooled high-pressure EGR without low-pressure EGR.
- Cooled low-pressure EGR without high-pressure EGR.
- Cooled low-pressure EGR and uncooled high-pressure EGR.

Complex emissions control. Just like the internal engine modifications, the emissions control components are modularly constructed. In the MDB, the arrangement of these components close to the engine is new. To fulfil various emissions standards around the world, the following emissions control components are used either individually or in combination:

- Oxidation catalytic converter
- Diesel particulate filter
- NO_x storage catalytic converter or selective catalytic reduction system (SCR)

For vehicles up to the Golf class, a NO_x storage catalytic converter handles the main reduction in NO_x emissions. Meanwhile, in larger and therefore heavier models, Volkswagen utilises SCR (Selective Catalytic Reduction) technology with AdBlue injection, such as is used today in the new Volkswagen CC BlueTDI. Various other design modifications optimise fuel economy and comfort as well:

Low-friction bearings and two-stage oil pump reduce friction. Along with reducing hazardous emissions, Volkswagen has tuned all sub-assemblies of the new TDI for minimal internal friction. These actions include piston rings with less pre-tension, improved rib cooling between the cylinders and the use of low-friction bearings for the camshaft (drive-side) and the balancer shafts. In the oil circulation loop, energy balance was optimised by a two-stage oil pump with volumetric flow control, depending on power demand.

Quickly up to temperature. An innovative thermal management system implements separate cooling circulation loops for the cylinder head and the cylinder crankcase during the hot operating phase. This allows the engine to heat up to its operating temperature faster. A pleasant side effect: the interior also gets warmer quicker in the winter. Another independently controlled cooling loop enables optimal regulation of charge air temperature with additional emissions control benefits.

Balancer shafts for the 2.0 TDI. The new diesels are not only very low in emissions, fuel-efficient and torque strong, they are also very smooth-running and comfortable. Consider the 2.0 TDI: two low-friction bearings are used in its balancer shafts. They eliminate free inertial forces that occur in any piston engine system. Having a positive effect on acoustic comfort are the toothed belt drive of the oil and vacuum pumps operating in the oil sump and the encapsulated injection nozzles.

Upward weight spiral overcome thanks to MQB

Future models will be over 40 kg lighter in the MQB

Less weight despite improved comfort and convenience as well as increased vehicle safety

Wolfsburg, January / February 2012. We know from the past that new generations of vehicles tend to be heavier in weight than previous ones. For good reason: automotive progress – gains in vehicle safety, comfort, convenience and space – has so far usually been tied to increased weight. However, the Modular Transverse Matrix has for the first time developed basic components for many new models that offer further gains in functionality and performance, and yet which are significantly lighter in weight than those of the platform on which today's compact class vehicles from Volkswagen AG are based. This is all the more impressive, because the new MQB enables better comfort properties and greater dynamic performance. In addition, the MQB is already equipped today for all globally known and anticipated safety requirements.

Weight of every component scrutinised. Together with the producing factories and the supplier industry, Volkswagen has scrutinised the weight of all components, and they were optimised for their specific functionality. This systematic approach has succeeded in reducing weight in nearly all subassemblies of the modular transverse matrix.

Floor structure is 18 kg lighter. The modularly constructed underbody structure of the MQB has around 85 per cent high-strength steel content. Extensive use of extremely strong, hot-formed steels, whose strength is over four times greater than that of conventional body steels, has reduced vehicle weight by approx. 18 kg, and this was achieved while improving crash properties. To further exploit weight-saving potentials in the future, preparations were made in the MQB to replace steel panels by aluminium. The component system also includes the underbody structures for electrically powered vehicles and hybrid models.

Components were weight-optimised in the interior as well. Examples of this are the front and rear seating systems, the load-bearing structure of the dashboard and the air conditioning system. The total weight of interior components on future models will be more than 10 kg lighter than in previous models. Nonetheless, comfort and convenience will show further improvement. Also made lighter in weight are the electrical system components of the MQB; around 3 kg was saved here as a result of detailed optimisations.

Up to 21 kg lower engine weight. In the powertrain, the weight of all engine/gearbox versions was further optimised, and the 1.4 litre petrol engine with 90 kW / 122 PS illustrates this especially well. In production, it will be over 21 kg lighter; the lion's share of savings was realised by the use of aluminium in the cylinder crankcase.

Driving properties and comfort improved. Thanks to further optimised designs and intelligent material selection, the weight of the running gear can be reduced too – by over 6 kg. Driving and comfort properties are improved at the same time, because of reductions in moving masses.

Upward weight spiral overcome. All vehicles that are based on the MQB will be at least 40 kg lighter than their immediate predecessors. So the MQB succeeds in sustainably overcoming the upward weight spiral and indeed reverses it. This, in turn, improves the fuel economy of all MQB-based models, which preserves resources and the environment.

Modular Production System (MPB) makes factories more flexible

Production of Golf, Tiguan and Passat will be possible on one line in the future

To be implemented in existing plants and used as foundation for new plants

Wolfsburg, January / February 2012. The strengths of the MQB are inextricably linked with those of the new Modular Production System (MPB) of the Volkswagen Group. Vehicles and production will be networked closer than ever. The advantage: comprehensive standardisation of vehicle components, technology measures and production flows reduces costs and production time. In return, the system creates greater flexibility and new freedom for extending the product line-up – even for niches that could not be served until now. In general, MPB will permit massive growth in the breadth of versions; a wide variety of vehicle types of one or more brands that are produced based on the Modular Transverse Matrix will grow immensely.

Perfected production. Based on the large variety of versions and growing requirements for flexibility and economy, Volkswagen AG will introduce the modular production system worldwide in parallel with the MQB. The core theme of MPB is also ‘standardisation’: From production materials to systems to production areas and finally to the total factory. The MPB strategy begins in the manufacture of individual parts: production tools will in future be constructed in such a way that they can produce a wide variety of parts.

Golf, Tiguan and Passat on one assembly line. In body construction, the MPB enables a level of flexibility that never existed before. A good illustration of this principle is provided by the example of the framing station: in the framing station, the underbody structure is welded to the side members and roof frame. Key elements of this station are the placement surface, clamping frame, clamping frame fixture, robot and clamping frame changeover system. The precision of the finished body is determined to a great extent by the precision and stability of the fixturing of the individual body substructures in relation to one another. Today’s clamping frames are precision tools that are specially computed and optimised by advanced

methods for each vehicle type to be built. Uniform fixturing across brands makes it possible to use clamping frames in every production line of the Volkswagen Group. Thanks to a newly developed mobile technology, a wide variety of modules and wheelbases can be implemented – e.g. from the Golf to the Tiguan and up to the Passat.

This is also true: wherever it makes sense, work steps are standardised. Two examples: until now there have been body structures with one- and two-part side shells in the corporate Group, but in the MQB/MPB system there will only be two-part shells. And, while previously there were up to three different delivery points on the assembly line for cockpit assembly, in the new modular era all MQB vehicles will be equipped with one identical fixed point; therefore, one delivery point will be sufficient in the future.

High flexibility. The MPB standardises the way in which flexibility in body construction is increased with regard to production volume, degree of mechanisation and variety of types. For example, predefined positions are already taken into consideration for other (standardised) welding and part placement robots that would be necessary for higher vehicle volumes. This enables quick adaptation of systems to short-term increases in parts volume and higher degrees of mechanisation. Starting with the base module operating at 30 vehicles per hour, the production systems can be extended to up to 60 vehicles per hour with two vehicle types in a total of four versions. Uniform control and operating technology across brands further simplifies operation and maintenance. The MPB will also increase flexibility in the paint shop and assembly area. The modular production matrix thereby comprehensively standardises a factory's production systems from the presses to assembly. Individual systems and production areas can also be implemented step-by-step in existing factories or serve as a foundation for new factories.

Optimal utilisation. In parallel, entirely new opportunities will be created for Volkswagen to utilise in the best possible way the capacities of its plants in the sense of a turntable concept; in this way, not only is one model produced at a plant, rather other vehicles – even of different

brands – could also be produced. One example of this is the layout for the new manufacturing site in Foshan (South China), in which, starting in mid-2013 the Audi A3 is to be produced alongside the Golf. For the suppliers of the Group, too, MQB and MPB open up exciting opportunities, because the procurement volume will nearly double by 2018 compared to platform concepts to date. For suppliers this development will signify an investment programme representing billions of euros. Thanks to high volumes, suppliers can also optimally automate their production systems and offer their services at extremely competitive costs.

MQB makes cars safer and more convenient

Soon to become standard in the Golf and Audi A3: the multicollision brake

Assistance systems of mid- and luxury classes flow into the Golf class

Wolfsburg, January / February 2012. For the first time, the Modular Transverse Matrix will make it possible for assistance systems that were exclusively available for larger and more expensive vehicles to flow into high-volume models such as the Golf. Some examples:

- Camera-based traffic sign detection
- Fatigue detection
- Adaptive cruise control (ACC).
- Front Assist surroundings monitoring system
- Lane Assist lane-keeping assistant.

Two other innovations are making their debut as driver assistance systems in the MQB:

- The electronically controlled 'VAQ' front-axle transverse differential lock (eliminates traction disadvantages of front-wheel drive cars).
- Progressive steering (produces direct steering behaviour and optimises comfort and driving safety).

Two other new systems in these high-volume segments also have a positive effect on safety: the proactive occupant protection system (which originally debuted in the Touareg) and the new multicollision brake, which the ADAC organisation just recognised with the 'Yellow Angel' award for innovations. The multicollision brake will be implemented as standard in such vehicles as the next generation Golf and Audi A3.

The electronically controlled front-axle transverse differential lock, progressive steering, occupant protection system and the multicollision brake in detail:

Electronically controlled front-axle transverse differential lock (VAQ)

For the vehicles developed in the MQB system – and for the first time in front-wheel drive production vehicles – an electronically controlled front-axle transverse differential lock (VAQ) will be available. VAQ passed grueling endurance tests at the 24-hour race at the Nürburgring in the past two years. The electronically controlled front-axle transverse differential lock is a powerful addition to the familiar ASR, XDS and ESP control systems. The new system is based on a multi-plate coupler that is located between the differential cage and the right drive shaft. The pressure required to actuate the VAQ is produced and regulated by an electrically-powered hydraulic pump. A control unit continually adjusts for the optimal locking power as a function of the driving situation.

For example, this prevents slip of the wheel with the least grip in a split friction (split-μ) situation or slip of the wheel on the inside of the curve in turning situations. In dynamic driving, VAQ applies the drive torque to the wheel on the inside of the curve and the outer wheel on the road according to the different vertical wheel forces. The vehicle remains very neutral right up to its performance limits by this so-called torque vectoring effect. Curves can therefore be driven more precisely and with greater stability than ever before with a front-wheel drive car. The traction disadvantages of front-wheel drive vehicles are essentially eliminated. Significantly more agile driving behaviour and higher speeds through curves also generate even more driving fun and better performance.

Progressive steering

Building upon the newly developed electro-mechanical steering system for the MQB, there will also be a new progressive steering system. Its primary technical differences from the basic steering system are the variable tooth spacing of the steering rack and pinion and a more powerful electric motor. Its functional difference: unlike constant steering ratios, which by necessity always represent a compromise between dynamic performance and comfort, here the toothing of

the steering rack is significantly modified by the steering stroke. The transition between indirect steering behaviour in the middle range (straight line driving) and direct steering behaviour at larger steering wheel angles is designed to be progressive, which enables significantly more agile steering behaviour in dynamic driving situations. There is also a comfort gain when parking the car, because less of a steering angle input is required.

Variable ratios have long been known in the area of hydraulic steering systems; however, the tuning of such a steering system is subject to very tight limits, so that the driver is not overtaxed by the transition behaviour. This is completely different with the new progressive steering system; the combination of the progressive steering ratio of the steering rack and the tuning potentials of an electro-mechanical steering system are systematically exploited here to realise optimised steering behaviour that is sporty yet practical in everyday driving

Proactive occupant protection system

Pre-crash protection. Volkswagen AG will use this prevention system to increase significantly the passive safety of its compact vehicles, which is already at a very high level today. When the proactive occupant protection system detects a potential accident situation (such as by the initiation of hard braking via an activated brake assistant), the seatbelts of the driver and front passenger are automatically pretensioned to ensure the best possible protection by the airbag and belt system. When high transverse acceleration is detected in an unstable driving situation such as severe oversteering or understeering with ESP intervention, the side windows and sunroof are closed until there is just a small opening. The reason: when the windows and roof are nearly closed the head and side airbags offer optimal energy absorption and thereby achieve their best possible effectiveness.

Multicollision brake brakes automatically after first impact

Preventing secondary collisions. A newly developed technology, which will immediately make its way into high-volume segments with the MQB, is the multicollision brake. It helps by automatically initiating braking after the first collision to reduce the intensity of secondary collisions. Around 25 per cent of all car accidents with personal injury involve multiple-collision accidents. In this type of crash, the residual kinetic energy of the vehicle after the primary collision can lead to serious secondary collisions. But the multicollision brake can reduce the severity of these collisions or even prevent them.

Reducing kinetic energy. The primary motivation for the development of the multicollision brake was to brake the vehicle involved in the accident automatically to significantly reduce residual kinetic energy. Triggering of the multicollision brake is based on the detection of a primary collision by the airbag sensors. The system evaluates the deceleration value indicated by the accelerometers. In addition, any side intrusions detected by pressure sensors in the doors and the propagation of an acoustic body wave through the vehicle that is detected by special sensors are also incorporated in the evaluation. Vehicle braking by the multicollision brake is limited by the ESP control unit to a max. deceleration rate of 0.6 g. This value is the same as the deceleration level of Front Assist; this also means that driver control of the car is assured when automatic braking is initiated.

Car driver remains 'chief' on board. The multicollision brake can be 'overridden' by the driver at any time. For example, if the system recognises that the driver is pressing the accelerator, the multicollision brake is deactivated. The automatic system is also deactivated if the driver initiates hard braking at an even higher deceleration level. Essentially, the multicollision brake executes braking until a vehicle speed of 10 km/h is reached; this residual speed is suitable for guiding the car to a safe spot.

Standard in the Golf and Audi A3. Starting with the Golf and Audi A3, numerous models will be equipped with the multicollision brake as standard from 2012. The high volume of the MQB suggests that one could expect a significant reduction in secondary collisions in real traffic statistics. By including the multicollision brake in the modular transverse matrix, Volkswagen is once again democratising an important safety feature over many vehicle classes. Volkswagen just recently received ADAC's 'Yellow Angel' innovation award for this new technical innovation.

Touchscreen with proximity sensor in the Golf

Top touchscreen in the future Golf will react to proximity of hand

User control of navigation system and smartphone continue to grow more similar

Wolfsburg, January / February 2012. The Modular Infotainment System (MIB) in the MQB from from Volkswagen AG is providing numerous solutions for the infotainment challenges of tomorrow. The modular approach enables the use of a very wide variety of infotainment functions over a broad range of vehicle classes. Development efforts distributed across brands will optimally exploit Group-wide synergy opportunities and enable quick reaction times to continually changing market requirements and the rapid pace of development progress within the IT industry.

The MIB concept will, for example, give Golf drivers access to functions that until now were only available in higher vehicle classes – if at all. Straight away, Volkswagen will be offering a large range of touchscreen formats, from 5-inch to 8-inch, for radio and radio-navigation systems in the next Golf. Thanks to a new, innovative user interface, it even makes it possible to operate infotainment functions intuitively and simply while driving. The system uses a proximity sensor specially developed for Volkswagen to indicate that the driver or front passenger would like to control device functions; immediately, the touchscreen automatically switches over from a general display mode to the operating mode. In addition, for the first time the driver will be able to adjust easily and read information on all driver assistance systems individually on the large MIB display. The new capacitive touchscreens offer a 'look and feel' that is similar to the familiar leading devices in the market for smartphones and PC tablets.

With the introduction of the MIB, there will also be a high-resolution navigation display of topography in the A-segment, which will enthuse users with a realistic 3D graphic interface on an 8-inch display. Moreover, customers will have the ability to procure and install navigation card updates free-of-charge. Functions such as an internal media memory, SD card slot, USB memory and 'simple pairing' of Bluetooth devices during the drive will also be features of navigation systems in the MIB.