The new BMW M5.
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1. World premiere of the new BMW M5. (Short story)

The ultimate in sports sedan motoring has got a name: M5. This finest 5 Series vehicle is the most powerful of all time: five liters of cubic capacity, ten cylinders, a maximum output of 507 bhp (DIN), a peak torque of 384 lb-ft and engine speeds redlining at 8,000 rpm, these are figures that speak for themselves. In an unprecedented way, these figures blur the lines between a car for everyday use and a vehicle for ambitious motor sport racing.

A successful recipe for two decades: power without overstatement.
With its performance figures, the fourth-generation M5 once again sets the benchmark in the segment of powerful sports sedans, a niche which the first M5 carved for itself back in 1984. During the last 20 years, this first M5 and all its successors have made their mark, always setting the standard as a perfect symbiosis of a comfortable, elegant sedan for everyday use, abundant output delivered by a powerful engine and ultimate sportiness. With sales figures of approximately 35,000, the M5 has proved to be an economically successful concept which combines prodigious performance with understatement, a basic feature of all M automobiles.

This principle reaches its culmination in the new M5: this “extreme athlete” with its subtle appearance and the seemingly endless power of its ten-cylinder high-revving engine, which interacts perfectly with the seven-speed SMG gearbox, introduces the driver to completely new dimensions of effortlessness. To put it in a nutshell: in its class, which it shares with top-class competitors, the M5 excels due to the most innovative drive concept, the best power-to-weight ratio, supreme handling and excellent everyday driving qualities. It is a fully roadworthy sedan with the heart of an athlete, a sports car which is perfectly suited for everyday motoring. The new M5 skilfully combines these two virtues.

First high-revving V10 engine to be featured in a regular-production sedan.

The V10 is the only high-revving power unit to be featured in a series-production car. Featured in the most powerful production car within the BMW model family, this new engine once again sets the benchmark in its class.

There is, however, more to it than pure performance. What is important for M automobiles is acceleration and driving dynamics, the latter which is dependent on the actual forward thrust and the vehicle's weight. The drive forces at the driven wheels are significantly influenced by the engine torque and the total ratio. The high-revving concept caters for an optimum transmission and rear-axle ratio, thus guaranteeing an impressive forward thrust.

The perfect choice: high-revving concept.

For the BMW M engineers the compact, high-revving normally aspirated engine was the ideal choice. With a red line of 8,250 rpm, the ten-cylinder engine has ventured into terrain which has so far been reserved for red-blooded racing cars. Compared to the previous M5 eight-cylinder engine, performance has increased by more than 25 percent. The M5 has also surpassed the magical 100 bhp per liter limit, its specific output being on par with that of racing cars.

A masterpiece in engine construction.

The two five-cylinder banks of the V10 are arranged at an angle of 90° to achieve a mass balance of the crankshaft drive, which is optimized for low vibration and increased comfort. For reasons of stiffness and due to the high loads resulting from combustion pressure, engine speed and vibrations, a bedplate design has been chosen for the crankcase, the first-ever application in a production V engine by BMW. For an optimum alignment of the crankshaft, grey-cast iron inserts have been integrated into the aluminum bedplate, which also serve to enhance acoustics, increase vibrational comfort and ensure a high oil supply rate. The extremely stiff crankshaft is supported by six bearings.

High-pressure bi-VANOS and individual throttle butterflies.

The bi-VANOS variable valve timing featured in the new M5 engine ensures an optimum charge cycle, thus helping to achieve extremely short adjustment times. This means in practice: increased performance, an improved torque curve, optimum responsiveness, lower consumption and fewer emissions. Each cylinder has its own throttle, a feature typical of racing cars. Throttle control is fully electronic and cylinder bank specific.

Dual exhaust system made of stainless steel.
The exhaust system is made of seamless stainless steel and has a dual-flow design all the way to the silencers. The exhaust gases finally leave the system through four tailpipes which are what make the rear end of the M vehicles so unmistakable. The exhaust system complies with the European EU4 and the US LEV2 emission standards.

The engine control module: the first of its kind in the world.
The MS S65 engine management system is the central factor behind the V10's outstanding performance and emission data. This engine management system is unparalleled in its package density. Its processors are the most powerful ones which are currently approved for use in automobiles, as high engine speeds and comprehensive management and control tasks demand the utmost from this system.

Highlight in engine management: ionic current technology.
The ionic current technology featured by the engine management unit is a technological highlight which serves to detect engine knock, misfiring and combustion misses. Utilizing the spark plug in each cylinder, this system helps to pinpoint engine knock, to check for correct ignition and to detect any ignition misses. Thus, the spark plug has a dual function – as an actuator for the ignition and as a sensor for monitoring the combustion process.

Seven-speed SMG gearbox conveys M power to the tarmac.
The high-revving concept only succeeds in combination with a gearbox which translates the torque available to the engine, by means of a short overall transmission ratio, into optimized forward thrust.

The new seven-speed SMG gearbox is well suited to the V10 engine's power. BMW M is the first manufacturer worldwide to offer a seven-speed sequential gearbox with drivelogic function. The seven-speed SMG gearbox enables manual gear selection with ultra-short shifting times as well as comfortable cruising thanks to automated gear selection. The purpose of the additional seventh gear is to reduce engine speed and torque gaps.

New SMG gearbox's speed up by 20 percent.
With the seven-speed SMG gearbox, gears can be changed using the gearshift lever on the center console or the paddles on the steering wheel. Compared to the previous SMG transmission, changing gears is 20 percent faster with the new generation. Never before has it been quicker to change gears with a transmission of this kind. The advantage for the M5 driver: Gear change is smooth and accomplished at a speed impossible to reach even by the most proficient driver, thus making the inevitable power flow interruptions when changing gears hardly noticeable.

Drivelogic: the driver determines the SMG's characteristics for changing gears.

Thanks to the SMG's drivelogic function, the driver can choose from eleven gear change options, which enable him to adapt the SMG's characteristics to his very own style of motoring.

Six of these programs can be pre-selected in the sequential manual gearbox mode (S mode), the spectrum ranging from balanced dynamic to very sporty. With the gearbox in the S mode, the driver always shifts gears manually. Whenever the driver activates the Launch Control function, the SMG Drivelogic shifts gears shortly before the maximum engine speed is reached at precisely the right moment and with optimum slip until the M5 reaches its top speed.

In the Drive (D mode) automatic gearshift mode, the transmission shifts the seven gears automatically, depending on the program selected, the driving situation, the road speed and the position of the accelerator pedal.

SMG for increased safety and comfort.

The seven-speed SMG gearbox not only supports the driver in achieving motor sports performance, but also offers scores of safety features. In critical situations, when the driver shifts down on a slippery surface, for example, the gearbox opens the clutch in the fraction of a second in order to prevent the M5 from swerving out of control in the event of excessive drag torque at the driven wheels. Further functions are the climbing, which prevents the car from rolling backwards during hill starts as well as the hill detection, which adjusts the shift points on gradients and descents. This prevents gear hunting when going uphill. When driving downhill, the hill detection holds the lower gears for longer in order to make effective use of the engine's braking power.

Maximum driving pleasure.

The interaction of the V10 engine and the seven-speed SMG gearbox results in a level of performance, which has so far been inconceivable for series-production sedans. Above all, there is one thing the M5 gives to its driver: driving pleasure at its best. Compared to the previous M5, the current model comes up trumps in all performance and fun disciplines: it accomplishes the 0 to 62 mph sprint in 4.7 seconds and reaches the 200 km/h (124 mph) mark after a mere 15 seconds to go on to the electronically limited top speed of 250 km/h (155 mph). A glance at the speedometer reveals where this power package would head for if maximum speed was not electronically limited: an awe-inspiring 330 km/h (205 mph).

The Nürburgring serves as a test track.
Compared to all direct competitors, the interaction of actual forward thrust and a low vehicle weight is a strong argument in favour of the new M5. Also in this respect, the M5 sets the benchmark and leaves its competitors far behind.

An undisputed gauge of driving dynamics is the northern loop of the legendary Nürburgring race track. For decades, the world's most demanding race track has been the perfect place of separating the wheat from the chaff. There is no other place where the interaction of vehicle components when taken to the limits can be observed as well as on the Nürburgring's northern loop. With lap times of approximately eight minutes, the M5 can hold its own and is a worthy competitor of thoroughbred sports cars, leaving its competitors far behind. By the way: traditionally, all M vehicles are tested there.

M suspension based on the 5 Series: the icing on the cake.
The aforementioned lap time demonstrates that the M5 can be extremely sporty. Although the suspension of the basic 5 Series model is undoubtedly very good, such a record performance with respect to dynamics would not be possible. This is why the M5 is also totally unique with regard to its suspension.

Many detail solutions and changes turn the 5 Series into an M5.
Consequently, the suspension and its electronic assistants have been either exclusively developed for the new M5, undergone extensive modifications or adapted to the special M performance. For example, the M5's running gear is by no means a lowered 5 Series suspension. Instead, it is an optimized design created from scratch. The suspension assisting systems, some of which have the same name as those of the 5 Series, have been optimized for this vehicle. On the one hand, this suspension contributes greatly to the M5 being the technological culmination of the successful BMW 5 Series. On the other hand, it clearly demonstrates that the M5 is a unique model with a distinctive appearance.

Variable M differential lock.
The M5 has a variable, torque-sensing differential lock bestowing the vehicle with a high level of driving stability and optimum traction, above all when accelerating out of bends. Even in extremely demanding driving situations, i.e. when there are major differences in the coefficients of friction at the driven wheels, it offers a decisive advantage in terms of traction. A further advantage is that it instantly builds up an increasing locking power if the speed difference between the driven wheels rises, thus guaranteeing optimum forward progress at all times.

Only featured in the M5: DSC with two selectable driving dynamics programs.

A new generation of the Dynamic Stability Control (DSC) has been especially developed for the M5. The DSC system can be deactivated by pressing a button on the selector lever cover. The driving dynamics programs are pre-selected in the so-called MDrive and can be called up using the MDrive button on the steering wheel. While the first DSC mode by and large corresponds to that of the 5 Series, the second mode – the M Dynamic Mode – is highly appreciated by sports-minded drivers.

EDC: the spectrum ranges from sportingly firm to comfortable.

The M5's Electronic Damper Control (EDC) enables the driver to choose from three programs (comfort, normal and sport), thereby adjusting the suspension characteristics accordingly. The driver can operate the EDC function via the MDrive button on the steering wheel or the push button next to the SMG selector lever.

High-performance brakes derived from motor sport.

To complement its immense power output, the M5 is equipped with a generously sized high-performance braking system with perforated, weight-optimized compound brake discs. The aluminum twin-piston sliding calipers (analogous to the BMW 7 Series), which have been optimized for minimum weight and maximum stiffness, help the M5 to achieve stopping distances similar to those of red-blooded sports cars: deceleration from 62 mph to 0 is accomplished in under 36 meters, the braking distance from 124 mph to a standstill is less than 140 meters.

The high-performance business express.

A wolf in sheep's clothing – this description would fit if the basic 5 Series, and particularly the new M5, looked "tame" when viewed from outside. In fact, the 5 Series already looks sporty, elegant and athletic. It is no coincidence that this 5 Series represents BMW's dynamic business class. The M5 is set apart from the basic model by a host of striking and hidden details, which further add to its powerful, sporty and dynamic looks. An athlete in business attire would be an apt description of the new M5.

Exterior with understatement.

The differences in design versus the basic 5 Series are discreet but consistent, giving the M5 a surprisingly high level of uniqueness in terms of looks, without questioning the common genes with the BMW model series. The modified front and rear aprons are instant eye catchers. Another difference is the modified side sills and

the more prominent wheel arches. Traditionally, the M differs from the “normal” BMW in its exclusive exterior mirror design, the four tailpipes, which have also become an unmistakable feature of all M vehicles, and the exclusive wheel design. For the first time, the M5 sports very attractive gills which are incorporated into the front side panel.

An even sportier interior.

The M5 comes with a leather interior in three different colors, which makes it look even more sophisticated than the lavishly equipped basic model or – for an extra price – with a full leather interior, which looks absolutely stunning. Further important differences versus the 5 Series are the instrument cluster, the optional M-specific head-up display, the steering wheel with MDrive buttons and the redesigned center console.

Business express for everyday use.

All vehicles made by BMW M GmbH are very convenient for everyday motoring. This particularly applies to the M5: despite its awe-inspiring performance which is reminiscent of that of a racing car, it has remained an elegant and comfortable sedan perfectly suitable for longer journeys, an integral characteristic of BMW 5 Series cars. Thus, one can say that the M5’s racing ambitions neither impair driving comfort, active and passive safety, nor do they reduce the space available for passengers and luggage. Even in terms of consumption and environmental compatibility, the M5 is a real paragon – just like all BMW automobiles.

2. The new V10 engine in the BMW M5: A masterpiece in engine construction.

The heart of every BMW is its powerful engine. It is more than obvious that this particularly applies to the models made by BMW M GmbH. This description alone, however, would not do justice to the new engine in the M5: modestly put, this ten-cylinder power unit is a milestone in modern engine construction. It is one of the most fascinating engines the world over ever to be used in a series-production vehicle.

Some automobile aficionados also attach great importance to the sound of the engine. This is also the case with the V10: this technological masterpiece is to the sports vehicle aficionado what a symphony is to the ears of music lovers. Similarities to the sound of the BMW WilliamsF1 racing engine won't go unnoticed. The M5's V10 engine not only has got the same number of cylinders as its Formula 1 counterpart. Both engines also have the high-revving concept in common, a principle which generates enormous forward thrust from high engine speeds and is a characteristic of all high-performance, naturally aspirated BMW M GmbH engines. All this, in conjunction with the ten cylinders, results in an orchestra-like staccato, something that is normally only heard on the race track.

First high-revving V10 engine to be featured in a regular-production sedan.

The new M5's high-revving V10, which has so far been reserved for racing cars and exotic low-volume cars, is the first engine of its kind to be used in a series-production sedan. In order to do justice to the exclusivity of the M family, this high-performance power unit offers a performance which is truly impressive: it has ten cylinders, displaces five liters and produces a maximum output of 507 bhp and a maximum torque of 520 Newton meters (384 lb-ft). Engine speed peaks at 8,250 rpm – a road-going athlete par excellence.

But there is more to the engine than just impressive performance data. At the slightest movement of the gas pedal, the high-revving normally aspirated engine reveals itself to be a typical sports engine. At the same time, it is perfectly suited for use in daily traffic. The M5 is a sedan for everyday use with the heart of an athlete – in other words, a roadworthy sports sedan. The M5 fully lives up to these two demands, opening up a new dimension of effortlessness. 20 years after the presentation of the

first M5 marked the introduction of the segment of powerful sports sedans, this new engine once again points the way forward in this particular class.

Inspired by the Formula 1 engine.
The engine was redesigned from scratch by the BMW M GmbH engineers. When constructing the power unit, the engineers drew inspiration from the BMW WilliamsF1 engine, which is generally regarded as the most powerful engine on the starting grid of the top echelon of motor sport. On the other hand, they transferred all M specific features from series-production automobiles, such as bi-VANOS, individual throttle butterflies and the most powerful engine electronics system currently available, an in-house development, as well as a traverse force regulated oil supply system.

In order to create a worthy successor of the previous M5, which features a 400 bhp V8 engine, it was essential to do one thing: to increase performance even further. In engine construction there are three possibilities for boosting performance: increase the cubic capacity and raise maximum torque in the process, boost performance by using a turbocharger or a compressor or use a high-revving concept to increase power.

Power is more than increased horsepower.
There is more to it than pure output. Acceleration behavior and driving dynamics are further important aspects, which are greatly dependent on the actual forward thrust and the vehicle weight. The forward thrust at the driven wheels is a result of both torque and the total ratio. The high-revving concept contributes greatly to an optimum transmission and rear-axle ratio, which, in turn, helps to unleash impressive drive forces.

If an engine's cubic capacity is increased, one has to put up with – for the benefit of high performance and torque – the problem of additional weight, more space required and higher fuel consumption. Supercharged engines also have drawbacks. Only rarely do they excel due to fuel economy and their spontaneity, i.e. the engine's ultra-fast response to the driver's inputs, fails to meet the high demands made of an M overall concept.

High-revving concept is the perfect solution.
The third option, a compact, high-revving naturally aspirated engine, is the perfect answer. If only for the sake of tradition, for the BMW M engineers the following solution was the ideal choice: boosting performance by increasing engine speed. In this context it must be said that, from a technological viewpoint, the high-revving concept is far more sophisticated, so that it is much more difficult to put this concept into practice. After all, it is no coincidence that BMW's introduction of the new M5

has made them the first manufacturer worldwide to position a high-rpm V10 engine in the segment of powerful final production sports sedans.

Offering a maximum speed of 8,250 rpm, the ten-cylinder engine has ventured into terrain which has up to now been reserved for thoroughbred racing cars. By way of comparison: the previous M5's engine speed is electronically limited to 7,000 rpm. The new ten-cylinder powerplant has broken the 8,000 rpm barrier.

Formula 1 technology takes to the roads.

With this new engine beneath the bonnet, the M5 redefines what is technologically feasible in the manufacture of series-production engines. The higher the torque, the closer the engine gets to the physical limits. The following comparison gives you an idea of the immense stress acting on the material: at 8,000 crankshaft revolutions per minute, each of the ten pistons covers a distance of approximately 20 meters per second. Coming back to the ten-cylinder engine in the BMW WilliamsF1: at 18,000 rpm, the pistons move as much as 25 meters per second. The difference is, however, that a Formula 1 racing engine only has to travel 800 kilometers in one racing weekend, whereas the M engine must last the lifetime of the vehicle, regardless of the climate, traffic situation and style of motoring.

It is evident that the M5 engine has various basic technological principles, production methods and materials in common with the Formula 1 engine and that it is based on technological transfer.

A 25 percent plus in performance – a new dimension of driving dynamics.

The completely redesigned V10 engine, a high-revving ten-cylinder powerplant, is superior to its predecessor, which features 8 cylinders and the same cubic capacity, in all disciplines. Proof of this is provided by its performance which is up by more than 25 percent. The new V10 engine produces a maximum output of 507 bhp (373 kW) at 7,750 rpm (maximum output of the V8 is 400 bhp – 294 kW – at 6,600 rpm). Weighing in at just 240 kilograms, the new ten-cylinder engine is almost identical in weight with its eight-cylinder forebear. Given its awe-inspiring performance, the new ten-cylinder engine is a real lightweight. However, the engine is a heavyweight when it comes to its output per liter: the ten-cylinder M5 exceeds the magical mark of 100 bhp per liter of cubic capacity, its specific output being on par with that of racing cars.

Engine speed has a major influence on performance and torque.
As far as maximum torque (384 lb-ft) is concerned, the ten-cylinder matches the eight-cylinder power unit. Nevertheless, the new M5 beats its predecessor in all disciplines relating to driving dynamics. This phenomenon is also connected to the engine speed. A case in point: if a cyclist changes down when going uphill, he must pedal faster but he will master almost every gradient no matter how steep. If he does not change gears or if he even changes up, he needs a lot more energy or he has to get off the bike. If there are two cyclists with the same amount of stamina, it is always the cyclist who pedals faster that wins the race.

The logical consequence is that the new M5 with its high-revving engine also effortlessly outdoes all direct competitors who exclusively rely on the "torque concept" of an eight-cylinder engine with an increased cubic capacity. In addition, this engine's superiority can be put down to the fact that the concept-related extremely high torque of competing engines has to be transferred via a massively reinforced and heavy drive train – added weight and mass that must also be accelerated. Thanks to the V10's high-revving concept, a considerably lighter drive train can be used and closer gear ratios can be achieved.

By the way, the new M5 also outdoes its competition when it comes to torque: peak torque of 384 lb-ft is reached at 6,100 rpm, a torque of 332 lb-ft is already obtained at 3,500 rpm. And 80 percent of maximum torque is available at up to 5,500 rpm, which is a wide speed range for an engine of this caliber.

Ten cylinders – the sports engine concept.
Its dimensions, number of components and filling quantities make the ten-cylinder engine the perfect choice for a high-performance sports powerplant. The new V10 therefore represents the perfect solution for a car such as the M5. In addition, the ten cylinders with a displacement of 500 cc each, fully live up to the ideals of the most discerning engineers.

Compact design for increased robustness and comfort.
BMW, one of the leaders in engine construction, has made a name for itself primarily as a manufacturer of inline engines. When constructing the new ten-cylinder engine, the engineers arranged the two five-cylinder banks at an angle of 90° (V-configuration) with a 17 mm offset to create a compact aggregate. The 90° angle has been chosen due to its low-vibration and comfort-oriented mass balancing properties. In its geometry the engine solves the conflict between minimum vibrations and maximum component robustness.

The cylinder crankcases are cast utilizing the low-pressure gravity die casting method and are made of hypereutectic aluminum-silicon alloy. This special alloy contains at least 17 percent silicon. The cylinder liners are created by precipitation of the hard

silicon crystals. Additional liners are not necessary – the iron-coated pistons run up and down in the uncoated bores. Stroke is 75.2 mm, bore is 92 mm, overall cubic capacity amounts to 4,999 cc. By the way, the blocks for the M5 engines are cast at the same place as the Formula 1 engines: at the BMW light alloy foundry in Landshut.

Bedplate derived from racing technology.
High engine speeds, high combustion pressures and high temperatures put an enormous strain on the crankcase. Therefore the engineers have chosen the so-called bedplate design, a compact and extremely stiff configuration which is derived from car racing. The new engine in the BMW M5 is the first series-production V engine to feature such a bedplate design. The aluminum bedplate with integral grey-cast iron inserts ensures high-precision crankshaft alignment, keeping the main bearing clearance over the entire operating temperature range at a minimum. The grey-cast iron inserts help to reduce the thermal expansion of the aluminum casing. To ensure positive coupling with the adjoining aluminum frame, the inserts have been provided with openings. At the same time, this architecture contributes to fulfilling the demands made of the M5's engine acoustics.

The extremely stiff and finely balanced crankshaft made of forged, high-tensile steel is supported by six bearings and weighs a mere 21.8 kilograms. It balances inertia forces and is designed for maximum torsional stiffness. The main bearing diameter measures 60 mm at a bearing width of 28.2 mm. Two conrods connect to each of the five crank pins, which are offset at an angle of 72 degrees. A reduced cylinder spacing of only 98 mm enables the use of a short crankshaft, thus resulting in high flexural strength and torsional stiffness, as well as a very low weight.

Every gram counts in lightweight construction.
The weight-optimized pistons are made of high temperature resistant aluminum alloy and are provided with an iron coating. They weigh a mere 481.7 grams, including piston pins and rings. The compression height is 27.4 mm at a compression ratio of 12.0:1. The pistons are cooled using oil spray jets which are directly connected to the main oil duct. The 140.7 millimeters long, weight-optimized, fracture-split trapezoidal connecting rods are also made of high-strength steel and effectively reduce the oscillating masses. Each of the connecting rods forged from 70MnVS4 has a weight of only 623 grams, including the bearing shells.

The single-piece aluminum cylinder heads of the V10 engine are also produced at the BMW light alloy foundry in Landshut. The cylinder heads feature integrated air ducts for air injection which is important for rapid catalytic converter warm-up. The cylinder heads incorporate four valves per cylinder, a BMW specific engine architecture. The valves are actuated by spherical tappets featuring hydraulic valve

play compensation. The tappet diameter has been reduced to 28 millimeters and its weight is down to 31 grams. Through optimisation of all parts and components of the valve train, the moving mass has been reduced by 17.5 percent in comparison with the predecessor model. The diameter of the intake valve is 35 millimeters, the exhaust valve measures 30.5 millimeters in diameter.

Innovations with attention to the smallest detail reduce maintenance costs.

The intake valves are exclusively manufactured for the M5 engine. With a reduced shaft measuring only 5 mm in diameter, there is hardly any impedance of the flow in the intake tract. Hydraulic valve play compensation units automatically provide for the optimum valve adjustment at all times, which is beneficial to the customer as it lowers maintenance costs.

The higher the engine output, the higher the need for cooling the engine, particularly in the vicinity of the combustion chamber. Compared to conventional systems, the cross flow cooling concept of the M5 engine considerably minimizes pressure losses in the cooling system. It ensures an even temperature distribution in the cylinder head and the reduction of peak temperatures in critical areas of the cylinder head. Every single cylinder is evenly supplied with the optimum amount of coolant which flows from the crankcase at the outlet side through the cylinder head and via the manifold strip at the intake side to the thermostat or cooler.

High-pressure bi-VANOS for an optimum charge cycle.

The bi-VANOS variable camshaft control, which celebrated its world premiere in the M3 back in 1995 and has been further optimized for use in the current M3 model, is also featured in the new M5 engine. It ensures an optimum charge cycle, thus helping to achieve extremely short adjustment times. This means in practice: increased performance, an improved torque curve, optimum responsiveness, lower consumption and fewer emissions.

For example, at the lower end of the load and engine-speed scale the car can be driven with an increased valve overlap, boosting internal exhaust gas recirculation. This, in turn, leads to a reduction in charge cycle losses and fuel consumption.

The adjustment of the angles as a function of the accelerator pedal position and the engine speed is infinite and map-controlled. For this purpose, the sprocket, which connects to the crankshaft via a simplex chain, is linked to the camshaft via a two-speed, helical gearbox. In the event of an axial displacement of the adjusting piston, the helical set of teeth turns the cam relative to the sprocket, which allows for the variation of the angle of the intake camshaft by up to 66° and that of the outlet camshaft by a maximum of 37° in relation to the crankshaft.

The M bi-VANOS technology requires very high oil pressures for ultra-precise, high-speed camshaft adjustment. This is why a radial piston pump in the crank chamber increases engine oil pressure to an operating pressure of 80 bar. The map-controlled high-pressure adjustment ensures reduced adjustment times, allowing for the optimum angle, precisely the right ignition point and injection quantity under all conditions and in accordance with load and engine speed.

Constant lubrication even in hard cornering situations.

Four oil pumps provide the engine with lubricating oil. The reason behind this unusually elaborate oil supply system is the M5's exceptional driving dynamics with extreme acceleration rates. The sports sedan has a cornering capability of over 1 g. During extreme cornering centrifugal forces force the engine oil to the cylinder bank facing the outside of the bend, thereby preventing the natural return of oil from the cylinder head, which might lead to inadequate oil supply in the oil sump. Should worst come to worst, the oil pump sucks air. In order to reliably prevent this situation, the engine features a traverse force regulated oil supply system. This system incorporates two electrically-operated duo-centric pumps which pick up oil from the outer cylinder head and transport it to the main oil sump if lateral acceleration rates exceed 0.6 g. A lateral-g sensor transmits signals to the pumps. The oil pump itself is a continuously variable pump with volume control which delivers exactly the amount of engine oil needed by the engine. This is achieved by the variable eccentricity of the pump's rotor in relation to the pump casing, depending on the oil pressure in the main oil duct.

Proper oil circulation in all conditions.

In extreme braking manoeuvres the M5 might even reach negative acceleration rates of up to 1.3 g. If deceleration rates are that high, it might well be that the amount of oil flowing back to the oil sump, which functions as an intermediate buffer, is not sufficient, particularly since the oil sump is located behind the front-axle support in order to save space. The worst-case scenario is that lubrication is interrupted. In order to prevent this situation, the M5 engine has been fitted with a so-called "quasi-dry sump oil system" which incorporates two oil sumps: a smaller one in front of the crossmember and a bigger one behind. A recirculating pump has been integrated into the housing of the oil pressure pump, which picks up oil from the small front oil sump to convey it to the big rear oil sump, which has been carefully shielded. The return passages and the pickup point of the oil pressure pump are perfectly tuned to ensure proper oil circulation in all conditions.

Ten individual throttle valves are electronically actuated.

Each of the ten cylinders has its own throttle valve, each cylinder bank, in turn, is served by its own actuator, a concept we are familiar with from motor sport. Although this system is very complex from a mechanical viewpoint, there is no better way to achieve spontaneous engine response. In order to attain maximum engine

responsiveness in the lower speed range, and to achieve an immediate vehicle response at the high end of the performance spectrum, all throttle valves are controlled fully electronically. Two contactless Hall potentiometers determine and evaluate the position of the accelerator pedal 200 times per second. The engine management reacts to changes and causes the two actuators to adjust the ten throttle valves. It goes without saying that this process is performed at a lightning-fast speed: it takes just 120 milliseconds to completely open the throttle valves, this is about the time an experienced driver needs to fully depress the accelerator pedal. This gives the driver a feeling of instantaneous response and allows him to "dose" the gas pedal even more precisely. At the same time, the electronic throttle valve actuation keeps transitions from overrun to part load and vice versa smooth and harmonious.

The V10 engine uses ten flow-optimized intake trumpets to "breathe in" air from two intake plenums. The intake plenums and the trumpets are made of a lightweight compound material that contains 30 percent fiberglass.

Dual exhaust system made of stainless steel.
Although the intake system contributes considerably to the remarkable performance of the new M5 engine, the importance of the exhaust system must not be underestimated. Also with respect to the exhaust system, only the best was good enough for the BMW M engineers. The two stainless steel 5-into-1 high-performance tubular headers have been optimized for equal length by using complicated calculating methods. For exact pipe diameters, the seamless stainless steel pipes are formed from the inside using an interior high-pressure forming technique (hydroforming) with a pressure of up to 800 bar. The manifold pipes have a wall thickness of just about 0.8 mm, which is also a sign of the M engineers' incredible attention to detail when designing this masterpiece in engine construction.

Even a sports engine can be a paragon of cleanliness.
When designing the exhaust system, the engineers considered it most important to keep the counterpressure to a minimum and to optimize the gas-dynamic design for impeccable performance and torque behavior. The exhaust system has a dual-flow design all the way to the silencers. The exhaust gases finally leave the system through four tailpipes which are what make the rear end of the M vehicles so unmistakable. As you would expect from a BMW M automobile, two trimetal-coated catalytic converters per exhaust line clean the exhaust gases produced by the ten-cylinder engine in compliance with the demanding European EU4 standard and the American LEV 2 standard. There are two underfloor catalysts. The other two catalytic converters (one for each exhaust line) are located close to the engine. In conjunction with the thin-walled exhaust manifolds, these catalysts quickly reach their optimum operating temperature, which means that they are fully operational quickly after a cold start. They excel due to their low pressure losses and high mechanical strength.

The engine control module: the first of its kind in the world.
The MS S65 engine management system is the central factor behind the V10's outstanding performance and emission data. It enables the optimum coordination of all engine functions with the different vehicle control units, especially with that of the SMG. This innovative control unit is a world-first in a regular-production car: with more than 1,000 individual components, this engine management system is unparalleled in its package density. By the way, hardware, software and functioning are BMW M in-house developments.

High engine speeds call for high-level performance.
Due to the M5 engine's high speeds and the large number of control and regulating tasks, the demands placed on the MS S65 control unit's performance are extremely high. In order to meet these demands, the engine control module has been equipped with three 32-bit processors that perform more than 200 million individual calculations per second. Compared to the M3 control unit presented only four years ago, this represents a performance increase by factor eight. In terms of memory capacity, the latest control unit outdoes the previous one by as much as factor ten. Receiving more than 50 input signals, this system calculates for each individual cylinder and for each individual cycle the optimum ignition point, the ideal cylinder charge, the injection quantity and the injection point. At the same time this system calculates and makes the necessary adjustments for the optimum camshaft angle and the optimum position of the ten individual throttle butterflies.

By pressing the power button on the selector lever cover, the driver can activate a sportier program with full performance characteristics. The activation of this program results in a more progressive response of the throttle butterfly to the accelerator pedal with the dynamic transient functions of the electronic engine management system switching over to a more instantaneous response. In the M5, the more comfortable of the two settings is automatically applied as soon as the engine is restarted. The change-over can also be pre-configured and called up in MDrive. In MDrive, there is a further, very sporty program available.

Comprehensive ancillary tasks for the engine management system.
The electronic throttle valve control is based on a so-called power and torque structure which uses a potentiometer on the accelerator pedal to measure the driver's wish for power and performance and converts this to the desired function. The power and torque manager adjusts this request function by adding the power signals from the auxiliary engine units, such as the conditioning compressor or the generator. Functions such as idle-speed control, emission control and knock control are also coordinated and aligned to the maximum and minimum output and torque curves permitted by the Dynamic Stability Control (DSC) and the Engine Drag Force Control (EDFC). The target output and torque calculated in this way is then maintained at the desired level, while taking into account the current ignition angle. In

addition, the engine management system carries out comprehensive tasks for onboard diagnosis with various diagnosis routines to be used by the workshops as well as other functions, and the control of peripheral aggregates.

Highlight in engine management: ionic current technology.
The ionic current technology featured by the engine management unit is a technological highlight which serves to detect engine knock, misfiring and combustion misses. The uncontrolled ignition of the fuel in the cylinder is called engine knock. In order to prevent engine knock, engines without knock control generally feature a lower compression ratio. Furthermore, the ignition point is retarded to prevent the cylinders from reaching or even exceeding the knock limit, which might cause damage to the engine. The “safety distance” to the knock limit resulting from this measure always has an adverse effect on fuel economy, engine output and torque. Active knock control, however, is an efficiency-boosting measure as it ensures optimum ignition timing and protects the engine from damages at the points of operation that are prone to knock.

Conventional systems employ several detectors on the outside of the cylinder to send knock signals to the knock control. In BMW M vehicles, one sensor monitors two cylinders. As the BMW M ten-cylinder engine is based on a multi-cylinder and high-revving concept, the use of those detectors alone is not sufficient in order to reliably detect engine knock. Due to the high engine speeds, evaluation must be very precise for optimum combustion quality in the cylinders, a factor which strongly influences the components’ durability as well as the emission behavior. This is where ionic current measurement comes into play.

The spark plug takes on additional control functions.
This technology utilizes the spark plug in each cylinder to sense and control engine knock. It also helps to check for correct ignition and to identify possible ignition misses. Thus the spark plug has a dual function – as an actuator for the ignition and as a sensor for monitoring the combustion process. Here again, the difference to conventional knock and ignition sensors becomes evident: they are located outside the combustion chamber, while the ionic current measuring is done inside the combustion chamber as spark plug and sensor are combined into one.

Measurement in the heart of the combustion chamber.
Temperatures in a spark-ignition internal combustion engine’s combustion chamber can reach up to 2,500 degrees. These high temperatures and the chemical reactions produced during combustion activity lead to a partial ionization of the fuel-air mixture in the combustion chamber. Particularly in the flame front, the gas becomes conductive through the generation of ions by means of separation or accumulation of electrons (ionization). The spark plug electrode, which is electrically isolated from the cylinder head and linked to a small control unit operating independently from the

engine management system, the so-called ionic current satellite, is supplied with a DC voltage and measures the so-called ionic current between the electrodes, the measured value depending on the degree of the gas flowing between the electrodes. The ionic current measurement technique retrieves information on the combustion process directly from where things are happening, the combustion chamber. The ionic current satellite receives signals from the five spark plugs assigned to each cylinder bank, amplifies them and sends the data to the engine management system for analysis, which then makes the necessary interventions (for each cylinder separately). For example, cylinder engine knock and the ignition point are adjusted for each single cylinder in order to optimize the combustion process. The spark plug, which is both an ignition source and a sensor, facilitates diagnosis when performing service and maintenance.

3. The new sequential M transmission: Shifting gears even faster with the seven-speed SMG gearbox.

The concept of a high-revving engine only proves successful if the engine is combined with a transmission that matches the prodigious performance and translates the torque made available by the engine into optimum forward thrust by means of a short overall transmission ratio.

The seven-speed sequential M gearbox (SMG) is well suited to transfer the power of the V10 engine to the drive train and finally to the wheels. With this gearbox, BMW M is the one and only manufacturer world-wide to market a seven-speed sequential gearbox with drivelogic function. Nonetheless, the new seven-speed gearbox is by no means an extended six-speed transmission. Instead, it is a completely novel gearbox, which has been designed exclusively for use in the new M5. The seven-speed SMG gearbox enables extremely fast manual gear changes as well as comfortable cruising thanks to the automated gearshift mode.

The new transmission is technically designed to handle a torque of 400 lb-ft and engine speeds of up to 8,500 rpm. This gives the transmission sufficient reserves to ensure reliable operation throughout the new M5's entire lifecycle, which is further enhanced by a separate oil cooling system for the high-performance engine.

Even closer speed gaps than with the six-speed gearbox.
Compared to a six-speed gearbox, seven gear steps offer even more reduced engine speed and torque gaps when changing gears. As forward thrust is closely related to high engine speeds, these reduced gaps assist the new M5 in achieving awesome acceleration.

The SMG transmission stands for sublime shifting pleasure.
It goes without saying that the new seven-speed SMG gearbox offers all the advantages inherent in a sequential gearbox concept: gears are changed using the gearshift lever on the center console or the paddles on the steering wheel. The driver does not have to press down the clutch and gear changes are possible even with the throttle foot flat on the floor. As opposed to an automatic transmission, the SMG transmission does not require an energy-consuming and performance-impairing torque converter.

As a matter of principle, all gears of the SMG transmission are shifted electro-hydraulically. The SMG gearbox features shift-by-wire technology, which has its origins in aerospace synergism and by which gears are changed in the fraction of a second without a mechanical link. In contrast to previous six-speed SMG transmission, the new M5's SMG hydraulic unit and the actuators have been integrated into the transmission housing. If a gear change request is made, the control unit actuates the respective magnetic valves which control the overall system's hydraulics. As a next step, the hydraulic oil with a high operating pressure of up to 90 bar flows swiftly via a magnetic valve into the clutch master cylinder to open the clutch. Then, using solenoid valves in the hydraulic unit, four hydraulic cylinders in the actuator are switched, which carry out the actual shifting process by means of four separate gearshift rods. When shifting down, the engine double-declutches automatically.

The new SMG boosts speed by 20 percent.
The previous second-generation SMG transmission was already rapid-shifting, and, to top it all, the new, third SMG generation accelerates the process of shifting gears by another 20 percent: for a gearbox of this kind, the shift speed is unrivalled and the advantages for the M5 driver are as follows: gear changes are extremely smooth and effected at a speed even the most experienced driver could not attain, thus making the inevitable power flow interruptions when changing gears hardly noticeable. The M5 delivers an almost jerk-free performance when accelerating from a standstill to its top speed. The driver gets much enjoyment out of shifting gears as SMG elicits a true "Formula 1 feeling".

Changing gears with an SMG gearbox also makes a valuable contribution to traffic safety: as shifting always involves the same level of speed and precision and is therefore absolutely reproducible, the driver does not have to concentrate that much on the process, meaning that the SMG gearbox promotes precise, safe and relaxed driving.

Drivelogic: the driver determines the SMG's gear change characteristics.
Thanks to the SMG's drivelogic function, the driver can choose from eleven gear change options, which enable him to adapt the SMG's characteristics to his very own style of motoring. These programs differ from each other in the pre-selected gear change time: the higher the selected program, the engine speed and torque, the shorter the shift times.

Six of the eleven gear shift options can be pre-selected in the sequential manual gearbox mode (S mode), the spectrum ranging from balanced dynamic to very sporty. With the gearbox in the S mode, the driver always shifts gears manually, and the transmission does not at any time intervene in the shifting process.

Launch Control: moving up to maximum speed with full performance.
With the gearbox in S mode, the driver can profit from the Launch Control function, which is a complement to the purist, sporty S6 driving program. The Launch Control function enables “rookie racing drivers” to make a perfect standing start in order to maximise the initial acceleration. This function requires the prior deactivation of DSC.

The aim of the Launch Control function is to relieve the driver of shifting gears, giving him more freedom to concentrate on his actual job of driving. When the car is stationary, the only thing the driver has to do is to flip the selector lever forward and keep it in that position. If he now fully depresses the accelerator pedal, the engine is automatically set to its optimum starting speed. If the driver releases the selector lever, the M5 is accelerated with the ideal amount of slip, provided the driver keeps the accelerator pedal fully depressed. The driver does not have to change gears until the M5 reaches its peak speed – the SMG gearbox with drivelogic automatically shifts through the seven gears and changes from one gear to the next gear shortly before maximum engine speed is attained.

As is the case with all driving programs, a telltale in the cockpit informs the driver of the gear currently selected.

Automatic gearbox – one that can hold its own even on the race track.
Five of the eleven gear shift options of the Drivelogic function are available in the so-called automated D mode. If this mode is activated, gears are changed automatically, depending on the driving program selected, the driving situation, the speed and the position of the accelerator pedal. With the D1 driving program selected, for example, the gearbox sets off in second gear and ensures particularly delicate and smooth engagement of the clutch, this being of great help in wintry conditions.

Although having opted for automatic gear changing, the driver can influence the process by, for example, releasing the accelerator pedal slowly, thus determining, also in D mode, the time when the gearbox shifts up. In turn, by depressing the accelerator pedal all the way down to the floor, he is able to effect fast downshifts. In S as well as in D mode, the gearbox automatically shifts down to the first gear as soon as the car is slowed to a halt. All the driver has to do to set the car in motion again is to step on the gas pedal.

Special functions for increased safety and comfort.
The seven-speed SMG gearbox in the M5 not only helps the driver to squeeze the most out of the engine's prodigious performance but also offers a host of safety features. In critical situations, when shifting down on a slippery road for example, the gearbox opens the clutch in a split second in order to prevent the car from suddenly swerving out of control as a result of excessive drag torque at the driven wheels.

A further practical SMG feature is the so-called climbing assistant, which has up to now been featured exclusively in the M3 and allows for hill starts with virtually no roll-back. This effect is achieved by brake system intervention and can be taken advantage of in the sequential as well as the automated mode, irrespective of the direction of travel. The function is activated by applying the foot brake. As soon as the driver releases the brake pedal, the M5 is able to set off without rolling back in an uncontrolled manner.

The intelligent transmission on steep gradients.
The so-called hill detection adjusts the shift points on gradients and descents. This prevents gear hunting when driving uphill. When going downhill, the hill detection holds the lower gears for longer in order to make effective use of the engine's braking power. In addition, with the gearbox in D mode, gear selection is adjusted to the steepness of the gradient.

These functions are only possible because the SMG control unit and the engine management system in the M5 closely communicate with each other via a particularly powerful CAN data bus, which connects the MS S65 engine management system with the SMG control unit, which is linked up to twelve redundant SMG sensors. In this way, the SMG control unit receives from the MS S65 the relevant data on the accelerator position, wheel and engine speeds, temperatures, steering angle and key memory. Moreover, the SMG and DSC directly communicate with one another.

4. The BMW M5 engine production: Engine construction at its best.

The highlights:

- Highly flexible production line with a wide range of products at the BMW Plant in Munich,
- Qualified staff and flexible processes,
- Quality assurance by means of data transfer,
- The highest quality standards.

The 507 bhp high-performance powerplant featured in the new BMW M5 perfectly reflects the manufacturing excellence of the BMW specialists. The production of the most powerful production car engine in the company's history is a complex process which requires premium quality.

Core components from the production network.
The cylinder heads and the crankcase for the new V10 engine are produced at the light alloy foundry at BMW's Landshut plant, which also produces parts and components for the BMW Formula 1 engines.

Due to the heavy strain on the high-revving aggregate, demands on the surface quality and the manufacturing tolerances are extremely high in mechanical processing at the BMW plant in Munich. For example, components are processed at an accuracy of up to $^{1}/_{1000}$ millimeters. By comparison: a human hair is 0.05 millimeters in diameter ($^{50}/_{1000}$).

Flexible assembly.
Final assembly, a highly flexible process, is performed in a two-shift pattern in the so-called special-purpose engine department of the Munich plant, where, in addition to the V10 engine, they also produce the six-cylinder aggregate for the M3, the V8 diesel and the twelve-cylinder for the BMW 7 model series.

This diversity calls for a great deal of flexibility, profound product knowledge and excellent skills. This is why the staff responsible for BMW engine construction is all well-trained and experienced.

As this engine is not a high-volume product, full automation of the assembly processes only makes sense to a certain limited extent. This is why operations

carried out manually and automated assembly processes are combined to complement each other perfectly.

An ergonomic work environment, devices for pivoting and swiveling the engine as well as for handling heavy loads ensure optimum working conditions and constitute the basis for supreme product quality.

As part of quality control, both the water chamber and the depressurized oil chamber of every single engine are checked for leakages, followed by hot run testing on the engine test bed.

Quality assurance via data transfer.
The engines are mounted to special devices and to driverless system carriers that house a data unit which stores the most important production data. During the course of the assembly process, the data unit records crucial, quality-related data, such as the tightening torques or valve play and stores this data in a database. The data carriers also ensure that the right program, intended for the engine under construction, is activated at the automated assembly stations. At the assembly stations fitted with integrated tools, data communication ensures that the personnel use the right tools with the correct tightening torques.

Core components such as cylinder heads or connecting rods are provided with a code, which enables the staff to keep track of each component from the very moment it reaches the factory to mechanical processing through to its installation in the engine.

At work stations where complexity is particularly high, the monitors display which of the color-coded crankshaft bearing shells has to be inserted.

Skilful craftsmanship: an absolute must.
Particularly when it comes to the pre-assembly of the valve train and the crankshaft drive, experience, meticulousness and skilful craftsmanship are a must. The work on the kinematics of the VANOS variable camshaft control and the synchronisation of the ten individual throttle butterflies is also very demanding and requires considerable dexterity by the assembly staff.

The two-piece crankcase renders it necessary to use a special sealing technique. A sealant is injected fully automatically into the sealing surface via a circumferential groove. As soon as the sealant comes out at the other end, it is hardened at that particular point by means of UV light. The sealant in the interior hardens as the assembly process continues.

Sophisticated logistics.

The supply of parts and components demands the highest of logistics standards as each of the four engine types with its numerous variants is made of about 400 different parts and components. The associates are an integral part of this complex process as they must use different parts and tools, depending on the type of engine manufactured.

The specialist engines are made to order, meaning that the customer-specific assembly does not start before the receipt of an order from one of the vehicle plants. Depending on the specifications, it takes up to 24 hours for an engine to pass through all stages of the assembly process.

5. The suspension of the BMW M5: Ensuring a high degree of agility.

One of the guiding principles when designing an M vehicle is:
"The suspension must always be faster than the engine." Due to the new M5 engine's high-revving concept, this self-commitment means that suspension designers at BMW M GmbH are faced with an extremely fastidious task.

Basis of the M5 suspension is the all-aluminum suspension of the basic 5 Series, the kinematics of which were adapted to the more powerful M5. The extremely stiff body construction used for the 5 Series and the large proportion of light aluminum axle components and ancillary parts are ideal preconditions for achieving optimum driving pleasure. These features are supplemented by a well-balanced, almost 50:50 weight distribution on the front and rear axles and, of course, the typical BMW rear-wheel drive that keeps the steering entirely free from drive forces.

The basic geometry of the 5 Series suspension was maintained. The track is 1,580 mm at the front and 1,566 mm at the rear, the wheel base measuring 2,889 mm. Having a substantially negative camber, the wheel guidance does full justice to the higher demands placed on driving dynamics and increased loads.

In the interest of sportiness: suspension assisting systems.
The M5's Electronic Damper Control (EDC) allows the driver to adjust the suspension's characteristics from sporty to comfortable by utilizing a choice of three different modes – comfort, normal and sport. The driver operates
EDC via the MDrive button on the steering wheel or by means of a push button adjacent to the SMG selector lever.

The M5's suspension also features optimized DSC Driving Stability Control. Weight-optimized rack-and-pinion steering with two Servotronic control maps was especially adapted for use in the M5.

Intelligent lightweight construction: low masses – high degree of stiffness.
Like on the basic model, the double-joint spring-strut front axle is made entirely of aluminum, with the exception of a few components subject to heavy loads such as the track rod, wheel bearings or pivot pins. The front axle subframe accommodates the steering transmission, anti-roll bar, transverse control arm and tension rods. It is

U-shaped and reinforced by a special thrust plate. As opposed to the basic model, this thrust plate features two so-called NACA air intakes well-known from motor sport or aviation. Thanks to these intakes, cooling air is directed to the gearbox without adversely affecting the aerodynamics of the underbody. The aluminum thrust plate facilitates maximum lateral stiffness of the front axle subframe. This in turn results in particularly precise response behavior. The bearings on the front axle subframe ensure accurate wheel guidance due to employment of separate bearings for suspension and dampers.

Servotronic with two control maps.
Servotronic controls the power assisted steering independently via control maps, depending on the road speed and engine speed. This solves the fundamental problem of obtaining a balance between a high level of assistance for best possible parking comfort and the low level of assistance required for dynamic driving at high speeds. The driver is then in less danger of "tearing" at the steering wheel while suddenly swerving to avoid an obstacle.

The M5 features two different Servotronic mappings, both corresponding with the currently prevailing EDC mode, i.e. either a very sporty or a more comfortable mode. In the sporty mode steering is very direct and the driver receives an immediate, precise response during the high lateral acceleration that occurs when taking fast bends. The comfort mode gives preference to motoring comfort. Both mappings provide the driver with even steering behavior and optimum response.

Rear axle: optimized for the M5.
The rear axle, which is made almost entirely of aluminum, is essentially based on the integral axle featured on the 7 and 5 Series. This design, which is outstanding in terms of road holding and comfort, was adapted to the M5's distinctively higher standards through the utilization of special elastokinematics and reinforcements in all relevant areas such as supports, links and joints. For example, rubber link joints have been replaced by rigid elements. This guarantees an even more accurate guidance and centering of the wheels. The M5's final drive has been entirely reconceived with a view to keeping masses low and conveying power efficiently. By means of cooling fins on the aluminum differential cover, the engineers managed to reduce peak temperatures produced in the rear axle by 15 degrees Celsius compared to a conventional design. This results in substantially reduced thermal load on components. The final drive is connected to the seven-speed SMG gearbox via a two-piece cardan shaft featuring a Hardy disc at the front, a constant-velocity joint at the rear and a center bearing. The output shafts feature a lightweight, torsionally stiff tubular design in order to keep movable masses as low as possible.

Variable M differential lock.
Like the M3, the sportiest member of the family until now, the M5 features a rear axle differential with variable, torque-sensing differential lock developed by the M GmbH. This M differential lock provides the vehicle with both a high level of driving stability and optimum traction, especially when driving out of bends.

M differential lock for more driving fun and enhanced safety.
A differential lock produces locking power when required. This principle takes effect when one of the two driven wheels is about to spin – on a slippery surface for instance. Furthermore, the differential lock is well-appreciated by sports-minded drivers, as it helps enhance the positive qualities of rear-wheel drive when the vehicle is being driven in a sporty manner and on roads with an average to high coefficients of friction.

Providing excellent winter driving characteristics.
In the case of 'standard' torque-sensing differential locks, the overall transferable drive forces correspond to the forces the wheel with the lower coefficient of friction can convey. However, if the frictional coefficient is very low, for example on snow, gravel or ice, the advantages in traction obtained by this conventional differential lock concept are limited.

The variable M differential lock is able to provide a substantial advantage in traction even in extremely demanding driving situations – for instance when the driven wheels are subject to greatly varying coefficients of friction. Therefore, combined with the finely tuned DSC system and the well-balanced distribution of axle load, the variable M differential lock helps the M5 in delivering excellent winter driving characteristics.

Forward progress maintained in any situation.
A further advantage of the variable M differential lock is the fact that an increasing locking power is immediately generated as the differential speed between the driven wheels increases. This prevents the wheel – e.g. the wheel nearest to the inside of a bend while driving over a pass at high speeds for instance – from losing drive forces. Forward progress is maintained
at all times.

100 percent locking power.
The variable M differential lock functions according to the following principle: the differential speed that builds up between the driven wheels when a driven wheel threatens to lose traction or runs on a very slippery surface immediately generates pressure in an integrated shear pump. This pressure is transferred to a multiple-disc clutch by means of a piston, by which drive forces are conveyed to the wheel with the better grip, according to the difference in wheel rotational speed. In extreme cases, the entire drive forces may be transmitted to the wheel with a better frictional

coefficient. If the difference in rotational speed between the two wheels decreases, the pump pressure also inevitably decreases, with locking action diminishing accordingly. This self-regulating pump system is maintenance-free and filled with high viscosity silicone oil.

The driver benefits from the fact that he can drive off far better in his M5 on surfaces on which the drive wheels are provided with greatly varying frictional coefficients, as he then has more traction at his disposal. Moreover, the variable M differential lock also noticeably enhances handling and driving stability – an additional advantage in terms of safety and driving pleasure.

Featured only in the M5: DSC with a choice of two driving dynamics programs.

A new generation of Dynamic Stability Control (DSC) was developed exclusively for the M5: the DSC system can be deactivated via a switch on the center console. Its driving dynamics programs are pre-selected using the so-called MDrive menu and can be called up by pressing the MDrive button on the steering wheel. While the first stage of DSC essentially corresponds to that of the 5 Series, the second stage – the M Dynamic Mode – will appeal to the particularly sport-orientated driver.

M Dynamic Mode – awesome driving dynamics.

M Dynamic Mode (MDM) is a unique feature in the achievement of driving dynamics and an awesome experience for the driver with racing ambitions. Until now a similar feature was found only in the M3 CSL high-end racing machine and was known as M Track Mode. This subfunction of Dynamic Stability Control adapted for deployment in motor sport allows the M5 driver to push the car to the absolute limit of longitudinal and lateral acceleration at the touch of a button located on the steering wheel. Those who choose to use this option can challenge the laws of physics. In this mode DSC is not activated until the absolute limits have been reached, thereby permitting a sideslip angle the driver can just about cope with by means of moderate countersteering. The M Dynamic Mode should, understandably, be reserved for use on the cordoned-off racing track. The driver is informed of the M Dynamic function by a warning lamp on the instrument panel. Finally, the driver is able to completely deactivate the DSC function. He is also informed of this by means of a warning lamp.

A significant increase in safety with DSC.

DSC is a safety feature which cuts in when reaching the boundaries of physics. Through effective intervention in the engine control system and brakes on each individual wheel, the system enhances motoring safety, for example on slippery surfaces, when swerving abruptly or when stability is threatened in bends.

EDC: from sportingly firm to comfortable.
The M5's Electronic Damper Control (EDC) allows the driver to adjust the suspension's characteristics from sportingly firm to comfortable by making a choice between three modes – comfort, normal and sport. The driver operates EDC via the MDrive button on the steering wheel or by pressing the push button located adjacent to the SMG selector lever.

EDC is a continuous and infinitely variable electronic damping control with a wide range of adjustments. In "normal" mode the damping force is automatically adjusted as required. This system is synonymous with optimum motoring comfort and safety. Additionally, the driver can pre-select the damping characteristic using the "comfort" or "sport" mode. In sport mode, the suspension reacts to road surface conditions by employing higher damping forces, thereby reducing the lifting effect, which noticeably improve the limpet-like grip. In the comfort mode EDC produces lower damping forces in favor of greater motoring comfort.

EDC increases motoring safety.
In bends and when braking and accelerating, motoring safety is enhanced in all modes due to a higher level of damping force. This also facilitates an improvement in the vehicle's body roll and swaying characteristics. The vehicle's consistently excellent vibrational properties, irrespective of load and throughout its entire life cycle, are a further advantage.

High-performance brakes also employed in motor racing.
To complement its immense power output, the M5 features an amply dimensioned high-performance braking system with perforated, extremely weight-optimized compound brake discs derived from motor sport. As in motor racing, stringent testing has also determined the optimum arrangement and shape of the perforation for excellent braking properties in both wet and dry conditions. The wheels sport 374 x 36 mm brake discs at the front and 370 x 24 mm brake discs at the rear.

The M5 comes to an "immediate" halt whenever required.
The weight and stiffness-optimized aluminum twin-piston sliding calipers (analogous to the BMW 7 Series) also substantially reduce unsprung weight, thereby contributing towards maximizing agility, safety and motoring comfort. As a result, the M5 achieves stopping distances normally only accomplished by sports cars of the highest caliber. When the brakes are applied at 62 mph, the car comes to a halt after just 36 meters, from 124 mph the braking distance is less than 140 meters.

Diagnostic system for brake pad wear.
The M5 features a diagnostic system for brake pad wear. A wear sensor monitors brake pad wear at specific measuring points and transmits these values to the DSC control unit. The system then calculates, depending on the driving behavior, the current condition of the brake pads and – having this information at hand – forecasts the residual mileage before the brake pads have to be changed. This information is utilized by the Condition Based Servicing (CBS) to calculate adequate proposals for service intervals in order to minimize maintenance work.

The wheels – visually and technically a feast for the eye.
The car has large-diameter brake discs, so the wheels had to be given larger dimensions accordingly. However, the 8½ and 9½ inch wide and 19 inch high cast-aluminum rims supplied as standard also visually emphasize the M5's dynamic appearance, as they complement the well-balanced body proportions.

Special tires designed exclusively for the M5.
The M5's tires are not supplied off the peg. The car boasts 255/40 ZR 19 tires at the front and even 285/35 ZR 19 tires at the rear. They were developed exclusively for the M5 and have undergone stringent testing. The rubber compound and the dimensions were designed for precise transfer of lateral and longitudinal forces in both dry and wet road conditions and offer a relatively high degree of motoring comfort. The tires also possess the respective feedback properties required to provide the driver with an optimum motoring experience reaching the threshold of what is physically possible.

Tire defect indicator (TDI) system renders spare tire unnecessary.
The M5 is equipped as standard with a tire pressure warning system comprising the Tire Defect Indicator (TDI) as well as the second-generation M Mobility System (MMS). This control system warns the driver visually and acoustically in the event of a sudden or gradual pressure loss in one or more tires as soon as tire pressure falls below a certain critical value. Due to so-called hump geometry of the rims, even a completely deflated tire will not jump off of the rim, therefore the driver is still able to safely bring the car to a halt. Following this, MMS is used to seal holes of up to six millimeters in the outer part of the tire, so that the car can still easily be driven to the next garage. This system facilitates the repair of practically any tire puncture, without having to change the wheel on the spot. Consequently, there is no need for a spare wheel. Compared with a complete spare wheel, this results in a saving in weight of more than 20 kg, thereby facilitating an improvement in the power-to-weight ratio and driving dynamics.

6. Bodywork, design, equipment: Safe, challenging, luxurious.

From the very beginning, the M5's power unit and the quality of driving dynamics have set standards in its class. The secret of its success, which has now lasted for 20 years, is, however, just as much the effective synthesis of high-performance technology and an unobtrusive but powerful appearance. Although in terms of driving dynamics the M5 has to be compared with thoroughbred sports cars, it is also a comfortable and spacious sedan car suitable for everyday use and long-distance motoring. The challenge of providing the M5 with a sporting outfit was, therefore, all the more demanding. And it was even more important to avoid excess body weight in favor of outstanding agility and handling. Nevertheless, this was not achieved at the expense of motoring comfort and available interior space.

Innovative bodywork incorporating intelligent lightweight design.
As is the case with the suspension, the bodywork was inspired by the BMW 5 Series. This model's innovative body-in-white sets trends – and this also applies to the M5 high-end sports sedan. The composite construction comprising steel and aluminum does full justice to the term "intelligent lightweight engineering".

At BMW, intelligent lightweight engineering is seen as utilizing the right material in the right place: the weight-reduced aluminum front end reduces overall weight by around 20 kg. A suitable choice of materials has also facilitated a reduction in weight in other areas. The result is a marked increase in the M5's agility through improved weight distribution and center of gravity. Thanks to intelligent lightweight design, the M5 has managed to retain the same weight as its predecessor, its unladen weight being 1,755 kg (according to DIN).

Active and passive safety at high 5 Series level.
With regard to active and passive safety, the M5 achieves without restriction the same high level as the basic 5 Series. A high safety standard in spite of low weight, a sophisticated all-aluminum suspension as well as a light and compact ten-cylinder engine mounted further to the rear, guarantee safe handling of the M5 – whether on the motorway, on country roads, in city traffic or on the racing track.

One particular figure – the so-called power-to- weight ratio – demonstrates just how much BMW engineers have aspired to save weight. This value indicates how much

mass (weight) the engine has to move. Consequently, it informs us more about driving dynamics than just a bhp rating or the maximum torque.

Best power-to-weight ratio in its performance segment.
The new M5's power-to-weight ratio is 3.5 kg/bhp. This is a further superlative figure normally expected of racing cars rather than of a five-seater sports sedan. In comparison: the thoroughbred M3 CSL road racer had a power-to-weight ratio of 3.85 kg/bhp. 3.5 kg/bhp means that the M5 is positioned in the prestigious class of high-performance sports sedans and manages to convince with by far the best power-to-weight ratio.

Cooling – a very special challenge.
Engineers were confronted with a particular challenge with regard to the space available, which was inevitably limited due to the dimensions of the basic 5 Series. The problems that had to be fully solved in this field become evident in the example of cooling air circulation. Compared with the high-end model in this series, the 545i, the M5's engine and cooling systems require double the quantity of air. This cooling air does, of course, have to be diverted away from the vehicle, without negatively affecting aerodynamics. Consequently, the M5 was fitted with an entirely new cooling and air supply system: the fan with increased output, radiator, air conditioning condenser, power steering oil cooling and engine oil cooling systems are located within an extremely confined space directly behind the BMW kidney. For constructional reasons, the engine oil cooler has been placed at an oblique angle in front of the radiator which is divided into two sections. Special air ducts direct the air behind the oil cooler to the underbody where it escapes at the Venturi front end. The specific design of this Venturi front end reduces lift force on the front axle. Despite the confined space, all maintenance-relevant components such as the air filter element, microfilter and oil filter and spark plugs in particular, are easily accessible for servicing purposes.

The large air intakes for cooling and aspiration, which are integrated in the front apron, are a striking feature. The side air vents situated to the left and right of the large front air intakes serve not only to ventilate the brakes, but also as an engine air intake. For the first time, an M5 is equipped with side gills that distinctively enhance the appearance and uniqueness of the new car.

Top athlete in a business suit.
A wolf in sheep's clothing – this image would be fitting if the appearance of the 5 Series were not everything else but timid. In actual fact, the 5 Series already presents itself as a sporty, elegant and powerful car. It is not without good reason that it represents BMW's dynamic business class. The M5 differs from the 5 Series in so far as it features a myriad of visible and concealed details that make it appear more

powerful, superior and dynamic as a whole. In view of this, it would be more appropriate to describe the M5 as a top athlete in a business suit.

Exterior with understatement.
The differences in design are modest but distinctive. Through this, the M5 achieves a surprisingly high level of visual independence, without denying its affinity with the 5 Series. At the same time the design features emphasize its strong, self-confident character. Wherever the M5 appears, it clearly and unambiguously confirms its position as an extremely powerful, high-performance sedan car suitable for everyday use. It is the perfect embodiment of performance, design and driving fun, qualities so crucial to the M philosophy.

More muscular and streamlined than the 5 Series.
The front apron has a muscular appearance and sports large air intakes for supplying air to the high-revving engine. Flaps – these are small spoiler lips on the front apron – reduce lift coefficients. A low lift level results in best possible driving stability even at high speeds.

Athletic proportions when viewed from the side.
The width and shape of the front aluminum side panels have been adapted to the wheel size. The very low, wide side sills emphasize the length of the car through the play of light and shadow, this resulting in an even more dynamic appearance. This deviation from the basic 5 Series was made not only for optical reasons. The sills optimize air routing in the underbody and upgrade the dynamic qualities of the vehicle. Likewise, the exclusive 19-inch wheels in traditional M double-spoke design underline the M5's well-balanced and muscular proportions.

Exterior mirrors following the M tradition.
In keeping with the M tradition, the exterior mirrors have their own unique design. Their bold styling and the play of light achieved by this underline the M5's sporting and dynamic appearance. Their shape, which was designed in a wind tunnel, contributes towards a reduction of lift on the front axle.

An extremely muscular rear end.
At the rear apron, the inwards-pointing rear wheel arches intensify the optical effect of the 285 wide tires by signaling an even more dominant track width. Thanks to a rear diffuser and flaps to the left and right of it, the rear has an extremely muscular look. Like all other M models, the M5 boasts four typical round tailpipes.

The rear diffuser fulfils a central function in underbody air routing. Together with the unobtrusive spoiler integrated into the rear lid and the almost entirely smooth, flat underbody, it accomplishes an improvement in airflow across the underbody, resulting in an excellent drag coefficient and a reduction in lift forces. Customers with

particularly sporting ambitions have the option of a rear spoiler that reduces rear axle lift by a half. A new registration plate trim gives the M5 a unique and superior appearance.

Battery in the boot.
The luggage compartment floor was redesigned to accommodate the dual exhaust system. The AGM battery is located there to help facilitate an improvement in distribution of axle load. This type of battery offers advantages in charging behavior. The number of charging cycles is three times higher than in the case of conventional car batteries. This has a positive effect on the lifespan.

The 70-liter plastic fuel tank is located in front of the rear axle. Combined with the sucking jet pump, the requirement and pressure-controlled dual pump permanently ensures a reliable fuel supply even under high longitudinal and lateral acceleration.

Three exclusive body colors for the M5.
The M5's paintwork also emphasizes the fact that it is an independent model parallel to the BMW 5 Series. The metallic paints Sepang Bronze, Silverstone II and Interlagos Blue are available exclusively for this car. Further available colors are Alpine White, Black Sapphire metallic and Silver-grey metallic. The gills in the side panels, the rear lid and the doorsill trims bear the M5 logo.

The interior: sports car characteristics with a touch of comfort.
The M5 has everything a thoroughbred sports car should have. But it also has everything other sports cars do not have. This becomes evident when viewing the interior and its features, because the M5 offers its passengers the space and comfort of a modern sedan car of the premium segment. Passengers inside the four-door M5, for instance, will be able to enjoy first-class seats and ample space, as well as active and passive safety features on par with the high standard of the BMW 5 Series.

A total of six airbags, belt force limiters, intelligent safety electronics and the automatic or manual emergency call via the BMW Assist function, all coming as standard, are at the driver's disposal in the event of an emergency. Even with regard to luggage space, the car stands comparison with the 5 Series. The boot has a capacity of approximately 500 liters. That is sufficient for two large and three small hard-top suitcases or four 9-inch golf bags.

Sporting luxury instead of focusing solely on essentials.
The flair inside the car is a result of a clever choice of highly exclusive materials and a sporting design. An immediately noticeable difference to well-known sports cars: instead of focusing solely on essentials, the M5 provides a sportingly luxurious ambience that offers almost unlimited scope for the customer's individual preferences.

The M5 features extended leather trimming in the exclusive leather quality Merino. It is available in three color options – Black, Silverstone and Light Sepang Bronze and comprises leather trim in the center area of the instrument panel, on the center console and handbrake lever gaiter as well as the door mirror and armrests. The even more sophisticated all-leather trim Merino in five colors (additionally Indianapolis Red and Portland Natural Brown) is available as an option.

It should be emphasized that this option includes the all-leather covering of the instrument panel and an alcantara-anthracite roof lining. A further special option is the 'Climate Leather' version featuring active ventilation of the driver's and the front seat passenger's seat.

The M5 is highly geared to the needs of the driver.
Behind the M5's steering wheel, the driver will find the optimum conditions for safe handling of the vehicle. The precisely contoured M seat with passive backrest width adjustment offers best possible side support. This seat was redesigned exclusively for the M5. Due to the diverse possibilities of adjustment, the driver is able to find the optimum seat position, from very sporty to comfortable – entirely according to his own preferences. This range of equipment includes the memory function and seat heating for driver and front seat passenger. Additionally, an electrically adjustable lumbar support can be ordered at extra cost.

Perfectly designed seats are a prerequisite for sports motoring.
Sports-minded drivers in particular can order the optional M multifunction seat featuring active backrest width adjustment. The foam part geometry for this seat has also been reconceived for optimum comfort and perfect side support: both backrest width and side support adjust independently in each driving situation, the automatic adjustment being effected according to lateral acceleration and steering angle. The customer decides at the press of a button or by MDrive which of the three modes – comfort, normal or sport – is to be activated. Also included in the optional equipment are the active headrest, memory function, seat heating and electrically-operated lumbar support. The active headrest protects the cervical spine above all in the event of a bumper-to-bumper collision. Active seat ventilation is also available as an optional extra.

Room for five persons and a great deal of luggage space.
At the rear two passengers are offered a center armrest with storage compartment and cupholder. If needed, it functions as a backrest for the middle seat, which provides seating for a third passenger during short journeys. A 60:40 split through-loading backrest as well as a ski bag and seat heating are available as options.

New round instruments provide sporting flair.
The combined speedometer and rev counter have been completely redesigned. Both round instruments have chrome ring surrounds. The new design features black dials with white numerals and the needles are in traditional M red. The white corona-ring illumination is permanently switched on, thereby also underlining the impression of high quality during the day. The representation of the engine speed band on the rev counter is unique: the yellow pre-warning field and the red warning field limit the currently permitted engine speed range according to the present engine oil temperature. With increasing engine oil temperature the useful speed range increases, this permitting the driver to observe the temperature intuitively. Control lamps, oil gauge, mileage counters and SMG display with gear and Drivelogic information are located between the speedometer and rev counter.

Head-up display with M-specific information.
The optional head-up display now shows additional information, providing the driver with crucial driving information directly at eye level. This head-up display has been designed in such a way as to allow the driver to decide for himself at the touch of a button whether he wishes to receive standard information or specific M information projected into his line of vision.

The M-specific display highlights the dynamic engine speed range, this signaling to the driver by means of shift-light function when the optimum shift point has been reached. This function has been derived directly from Formula 1 racing. The display also gives information pertaining to the gear currently engaged and vehicle speed.

The newly designed M leather steering wheel is ergonomically dimensioned. Reshaped and relocated SMG shift paddles facilitate fingertip gear shifting –down on the left and up on the right. While shifting gears, the driver keeps his hands firmly on the steering wheel, enhancing road safety at high speeds or on winding roads.

MDrive for even more comfort.
The so-called MDrive is a new function that is activated via the MDrive button on the steering wheel. This function allows the driver to turn the comfortable sedan car into a thoroughbred sports car at the push of a button and vice versa. This entails calling up the settings and drive modes previously configured in the MDrive menu of the iDrive. The preset values can be stored in the key memory system.

The following individual functions are pre-selected or activated via MDrive:
– The power button with which the engine characteristics – i.e. output and response – are affected in three stages;
– SMG Drivelogic with which one of six sequential or five automatic shift modes are pre-selected – the driver once again benefits from the direct selection of each desired drive or shift mode;

- DSC Dynamic Stability Control featuring two modes of driving dynamics;
- EDC Electronic Damper Control with the three modes – comfort, normal and sport;
- Head-up-Display and
- Active backrest width adjustment.

SMG selector lever with illuminated selector lever position indicator.
The selector lever illumination and gear position indicator is activated as soon as the ignition is switched on. Adjacent to the SMG selector lever, there are four buttons that facilitate direct operation of the driving dynamics functions Power, DSC, EDC and Drivelogic.

Barring just a few exceptions, the M5 client can choose from the myriad of equipment and options for individualisation offered by the BMW 5 Series. These include in particular adaptive cornering lights – headlights that follow the course of a bend as if guided by magic – as well as cruise control.

Finally, automatic climate control incorporating Automatic Air Recirculation, which can be set to the personally desired consistent temperature in the front and rear compartment. This air conditioning system also includes the comfort functions integrated solar sensor and anti-mist sensor as well as filters for outside air and recirculated air.

7. Production of the BMW M5: Exclusivity off the Line.

The BMW M5 is built at the Dingolfing Plant, the largest production plant within the BMW Group's production network comprising no less than 23 production facilities worldwide. Highly flexible in all its operations, the Dingolfing Plant employs a workforce of approximately 23,000 BMW associates – thereof more than 80 per cent skilled workers – and builds some 1,300 BMW 5, 6, and 7 Series every day.

A sophisticated logistics system – BMW's **C**ustomer-**O**riented **S**ales and **P**roduction Process (COSP) – ensures that each car is built exactly on time to its specific national specifications and, of course, in line with the customer's personal order and requests.

Quality management systems consistently optimized and upgraded, together with numerous function and reliability tests in all areas of production, guarantee optimum fulfillment of BMW's strict quality requirements.

Production of the body-in-white together with other models in the 5 Series.

The body-in-white of the new M5 is built by highly flexible robots on the same lines and facilities which also produce the bodyshells of the BMW 5 Series Sedan and the BMW 5 Series Touring in the regular production process. This course of production takes place in any random order and combination in accordance with instructions from production management. Naturally, the bodyshell of the M5 also benefits from all the innovative bonding and joining technologies used in series production of the BMW 5 Series. This also applies to the application of stamp rivet technology on the lightweight aluminum front end of the car.

Production of specific parts and components exclusive to the M5 is integrated in the production processes and production areas as such. The floorpan, for example, fitted at the rear of the car is modified to provide space for the double-chamber exhaust system. Reinforcements around the rear axle subframe, in turn, serve to accommodate the extra power and performance of the M5. To provide adequate space for the rear wheels, the side-frames have been modified around the rear wheel arches. And, finally, suitably moulded body panels specially made in the press shop are fitted on the side walls.

The joining technologies used in production of the lightweight aluminum front end are bonding, riveting, MIG and laser welding.

In all, BMW uses some 1,000 robots in production of the 5 Series (Sedan, Touring, M5) body-in-white. The bodyshell consists of approximately 500 steel and aluminum parts weighing approximately 350 kg.

Offering the customer a wide range of – sometimes quite unusual – paintwork colors.
In the Paintshop the body-in-white of the M5 goes through all the systematic processes already applied in the regular paintwork process. First there is the RoDip (Rotation and Dipping) pre-treatment process allowing a share of up to 30 per cent aluminum. Then anti-corrosion paint is applied on to the phosphated bodyshells in the cathodic dip bath (CDB) both inside and outside, extending all the way into the smallest nooks and crannies. Following application of the filler by means of all-new robot paint-application technologies, the body of the car is finished in BMW's new, exclusive M colors on a special paint application line. This ensures a perfect finish in the four M colors as well as a wide range of some 250 individual colors all naturally applied in top quality to fulfil all of the customer's requests very flexibly and efficiently. The powder-based clear paint applied as the final layer gives the surface an appropriate gloss and protects it from both ultra-violet radiation as well as other elements in the environment.

A particular challenge in the Paintshop is to ensure perfect balance and harmony of colors between the body and individual components such as the bumpers, sills and rear-view mirrors. This efficient process of perfect color-matching is ensured by new, automatic online measurement of each and every color shade.

Human performance – the No 1 factor on the assembly line.
Contrary to job requirements and working conditions in the Press Shop, Bodyshop or Paintshop, where processes are largely automated, human performance is the fundamental factor in Assembly. The reason, quite simply, is that the human being is able to work in almost 30 different modes and levels with his hands, while even the most sophisticated and advanced industrial robot is not able to operate on more than 7 levels or planes.

High qualification and motivation of all associates ensure perfect production of customized cars of the highest quality. After all, each and every M5 is tailored to its proud owner – from the drivetrain through the suspension and paintwork all the way to the seats and interior equipment.

Wherever possible the workers on the line are assisted by handling devices picking up and transporting heavy components and thus avoiding heavy physical labour. As a

result, the workers are able to concentrate entirely on the process of fitting the parts and components smoothly and with ultimate

precision. In this process they are supported by a special Information System for Associates presenting the parts and components to be fitted in each case on a screen. And considering the large number of different models built in Dingolfing, together with their wide range of specifications, this is indeed essential.

Special components exclusive to the M5 – the power unit, seats, steering wheel, rear axle, etc – are also delivered to the assembly line in sequence, just like all other components of the BMW 5 Series in general. A wide range of tests and inspections as well as a comprehensive test drive on the dynamometer come as the final point in production of every M5 before the car goes to the customer.

8. Market Position of the BMW M5: The Executive Express.

Just like its predecessor, the new BMW M5 is most certainly a genuine Executive Express. Indeed, this exclusive car defined and opened up a new niche in the market exactly 20 years ago, creating the segment of the high-performance sports sedan.

Within BMW's model range, the M5 is clearly positioned as a thoroughbred sports car combined with all the traditional qualities of a luxurious sedan. It ranks distinctly above the other models in the 5 Series – in its small but highly sophisticated market segment, the M5 is the clear leader both in technical terms and in terms of its position and significance in the market: No other competitor in this segment has been able to even get close to the sales volume of the BMW M5.

The typical owner of an M5 uses his – or her – car every day, mainly on lengthy business trips. 75 per cent of all M5s are run as business cars, most of them on a leasing contract. Annual mileage of an M5 often reaches or even exceeds the 100,000-km mark.

The "average" M5 customer is male, married, and has two further cars in his household. At an average age of 45, the typical owner of an M5 is several years younger than the "regular" driver of a 5 Series, has a higher level of training and earns an above-average income.

Owners of a BMW M5 are to be found in all self-supporting professions. They pursue a prestige-oriented and active lifestyle, enjoying sports such as golf, sailing, riding or powerboat cruising, just like exclusive journeys to faraway destinations.

9. The History of the BMW M5: Opening up a New Class.

The story of the BMW M5 now dates back 20 years: Back in 1984 a group of inventive engineers and marketing strategists at BMW Motorsport GmbH, as the Company was still called at the time, had the idea of transplanting a muscular high-performance power unit into a relatively "normal-looking" sedan, in this way creating an entirely new type of car – the high-performance sports sedan.

In the meantime other manufacturers have tried to copy this successful concept created and introduced by BMW. But over the years the BMW M5 has remained by far the most innovative and successful car in its segment.

The first generation of the BMW M5: from 1984–1987.
Back in the mid-80s there were already demanding BMW customers looking for the power and performance of a sports car within the engine bay of a sedan, thus enjoying a superior thrill of motoring in sheep's clothing. And BMW Motorsport GmbH had all the ingredients required for making such a special car reality: First and foremost, the 210 kW (286 bhp) straight-six power unit once featured of BMW's legendary M1 mid-engine sports car, and of course the bodyshell of the then current BMW 5 Series.

An appropriate standard of driving safety was ensured by sports suspension tailored to the superior performance of the car with features such as gas-pressure dampers, special 220/55 VR 390 Michelin tires, extra-large disc brakes, a specially tuned ABS brake system, and a limited-slip differential with 25 per cent locking action fitted as standard.

This very first BMW M5 accelerated from 0–100 km/h in 6.5 seconds and, at a top speed of 245 km/h or 152 mph, was the fastest sedan in its time. Despite this outstanding performance, fuel consumption was a mere 11.3 liters of premium on 100 km, equal to 25.0 mpg Imp.

The customer looking for special interior features on his M5 also received professional treatment from BMW Motorsport GmbH, being able to choose from a wide range of features and outstanding options.

Total production of the first-generation M5 in Munich amounted to some 2,200 units all built by hand.

The second generation of the M5: from 1988–1995.
Developing maximum output of 250 kW or 340 bhp, the successor to the first model featured one of the most powerful straight-six engines ever built by BMW by the end of its lifecycle. And right from the start the second-generation M5 had entered the market with engine output of 232 kW or 315 bhp, obviously creating a tremendous stir in the process.

From outside the second-generation M5 was more muscular and personalised than its predecessor, the body of the new model boasting muscular front and rear air dams, side-sills in contrasting color, and wheels in special design.

The power unit was in principle still the successful engine of the BMW M1 now, however, refined in many respects. One particular highlight was the resonance air chamber adjusting the oscillating pipes for length in the interest of optimum torque as a function of engine load and speed. The control unit used for this purpose was specially developed by BMW M GmbH.

The body of the M5 was lowered by 20 millimeters versus the BMW 535i in the market at the time, and there was an optional Nürburgring suspension package for the particularly sporting driver. A standard feature on the second-generation M5 was self-levelling on the rear axle as well as a differential lock with 25 per cent locking action.

This high-performance sedan cum sports car accelerated to 100 km/h in just 6.3 seconds and had a top speed – electronically limited – of 250 km/h or 155 mph. Together with the M5 Touring launched in 1992, the second M5, accounting for some 12,000 units built by hand in Munich, outsold its predecessor by far.

The third generation of the M5: from 1998–2003.
Introducing this model, BMW made the more reserved design of this high-performance sedan a lot more athletic, muscular and self-confident.
Now powerful front and rear air dams, broad side-sills, aerodynamically contoured M rear-view mirrors, 18-inch wheels in double-spoke design, as well as four tailpipes clearly bore testimony to this outstanding power machine.

These looks were matched by maximum output of 294 kW (400 bhp) developed by a five-liter V8 power unit ensuring supreme performance on the road: The third-generation M5 accelerated from 0–100 km/h in just 5.3 seconds, reaching 160 km/h in a mere 11.6 seconds. Top speed was 250 km/h or 155 mph, again limited electronically.

Not only the sophisticated technology of the third M5 made this car quite different from its predecessors, but also the way it was built. For now, like all other models in the 5 Series, the M5 was built on the series production line in Dingolfing, with its power unit coming from BMW's Special Engine Shop in Munich (and incidentally also featured in the exclusive BMW Z8 Roadster).

Total production of the third-generation M5 was more than 20,000 units.

Technical Specifications. BMW M5.

Body		**M5**
No. of doors/seats		4/5
Length/width/height (unladen)	mm	4,855/1,846/1,469
Wheelbase	mm	2,889
Track, front/rear	mm	1,580/1,566
Turning circle	m	12,4
Fuel tank capacity	approx. ltr	70
Cooling system incl. heating	ltr	15
Engine oil	ltr	13
Transmission fluid	ltr	2,6
Weight, unladen (EU[1])	kg	1,830
Max. load (DIN)	kg	545
Max. permissible weight (DIN)	kg	2,300
Permissible axle load front/rear	kg	1,090/1,270
Luggage comp. Capacity	ltr	500
Drag coefficient	c_X x A	0,701
Engine		
Layout/No. of cylinders/Valves		V/10/4
Engine management		MS S65
Displacement	cc	4,999
Bore/Stroke	mm	92,0/75,2
Compression ratio	:1	12,0:1
Fuel grade	RON	98
Max. output	kW/bhp	373/507
At engine speed	rpm	7,750
Torque	Nm	520
At engine speed	rpm	6,100
Electrics		
Battery/Location	Ah/–	90/boot
Alternator	A/W	170/2,380
Chassis		
Front suspension		Double-joint tension rod spring-strut suspension with displaced camber; small positive steering scrub radius; traverse force compensation; anti-dive
Rear suspension		Integral axle (aluminum), wheel suspension with special effect anti-squat/anti-dive
Brakes, front		Double-piston floating-caliper Compound disc brakes
Diameter	mm	374 x 36, vented and punched
Brakes, rear		Single-piston floating-caliper Compound disc brakes
Diameter	mm	370 x 24, vented and punched
Driving Stability Systems		ABS, CBC, DSC, variable M differencial lock
Steering		rack-and-pinion steering, hydraulically assisted steering and Servotronic
Overall ratio	:1	12.4
Type of transmission		SMG III
Transmission ratio I	:1	3.985
II	:1	2.652
III	:1	1.806
IV	:1	1.392
V	:1	1.159
VI	:1	1
VII	:1	0.833
R	:1	3.985
Final drive ratio	:1	3.620
Tires		255/40 ZR 19/285/35 ZR 19
Wheels		8,5 J x 19 EH 2 IS 12 Alloy/9,5 J x 19 EH 2 IS 28 Alloy
Performance		
Power to weight ratio (DIN)	kg/kW	4.7
Output per liter	kW/ltr	74.6
Acceleration 0–62 mph	sec	4.7
0–1000 m	sec	22.7
Top speed[3]	km/h	250
Fuel consumption (EU cycle)		
In town	ltr/100 km	22.7
Out of town	ltr/100 km	10.2
Overall	ltr/100 km	14.8
CO_2	g/km	357
Miscellaneous		
Emission classification		EU4

[1]Weight of the car in road trim (DIN) plus 75 kg for driver and luggage.
[2]Deviations are possible under certain conditions.
[3]Electronically limited.