Ninety Years of BMW – the Symbol of Innovation.
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The spirit of innovation has transcended through the history of BMW for no less than 90 years. And indeed, this ongoing innovation of the white-and-blue brand has been borne out and initiated consistently by the creativity, skill, and consistency of the company's employees. The products created in this process have at all times combined proven and new technologies in a most characteristic manner, forming a sophisticated, trendsetting symbiosis at all times.

1. BMW Aircraft Engines.

All this came together as far back as in the year 1917 when, in February, a new Chief Engineer joined Rapp-Motorenwerke: Max Friz came to Munich from Daimler Motoren-Gesellschaft, bringing with him the idea for an aircraft engine he had not been able to turn into reality in his former job. His concept was to build an extra-large, extra-high-compression power unit enabling an aircraft to reach higher altitudes than ever before.

Precisely this was the greatest demand made by the military of engine manufacturers during World War I, since the ability to reach a higher altitude gave pilots a significant strategic benefit.

With air density decreasing as a function of height, conventional engines quite literally ran out of air at altitudes above 3,000 metres or about 10,000 feet. An engine with extra-large capacity and a higher compression ratio, on the other hand, operates in thin air like a “normal” engine on the ground. But on the other hand such an engine must be throttled back in its performance when close to the ground in order to avoid any overload on the components.

Lightweight engineering: pistons and crankcase made of aluminium.
Introducing this concept, Friz took up a proposal Wilhelm Maybach had made a year before, which however had not gone into series production. This, quite simply, was that high performance was important, but far from everything: Because at the same time engines had to be as robust, light and aerodynamic as possible. Friz’ particularly innovative approach, therefore, was to combine Maybach’s new idea with proven technologies. So on 20 May 1917 the Development Department registered the first construction drawing for a new engine conceived by Friz as a straight-six in the interest of optimum mass balance with minimum vibrations.

This concept helped to significantly reduce the structural loads acting on the aircraft, which in those early years was still a relatively fragile construction. The slender frontal area of the engine and the compact arrangement of the ancillaries served in addition to reduce air resistance. On the other hand the substantial engine capacity of 19 litres and the high compression ratio called for relatively large components. So to keep such extra weight within limits, Friz opted for a crankcase and pistons made of aluminium.

In Friz' design the cylinder head and cylinders formed one inseparable unit, with the steel cylinder liners simply being bolted into the cylinder head extending far down into the engine block itself.

In this way Friz was able to do without a cylinder head gasket generally involving a number of critical features, dry sump lubrication and dual ignition serving instead to provide a reliable and consistent supply of oil and keep the engine running reliably at all times.

Just how modern this concept was in practice is borne out clearly by the valve control system, with the valves being driven by rocker arms running on an overhead camshaft which, in turn, was driven not by a chain, but rather by a vertical layshaft.

High-altitude carburettor for enhanced output and fuel economy.
One of the most important components of the innovative power unit designed and built by Friz was the special high-altitude carburettor – a system made up of three mixing chambers, three air and fuel supply nozzles in each chamber and five throttle butterflies interacting with one another to efficiently adjust the fuel/air mixture to the respective altitude. To make the adjustments required, the pilot had two levers for normal and high-altitude gas, that is a fuel/air mixture control system destined to subsequently give the engine an excellent balance of output and fuel economy.

The design and construction drawings had not even been completed when a group of specialists from the German Reichwehr visited Rapp-Motorenwerke in July 1917, seeking to obtain further information on the project. After Friz had presented and explained his construction, the high-brass representatives of the military were so convinced that they ordered 600 engines right away, requesting delivery at the earliest possible time.

The birthday: 21 July 1917.
As a result of this completely surprising success within a company which so far had not exactly enjoyed a great time in the market, Rapp-Motorenwerke soon had to be re-organised: Founder Karl Rapp left the company and only a few days after the Prussian officers had paid their visit, the Meeting of Partners decided to give the company a new name – Bayerische Motoren Werke.

Just one day later, on 21 July 1917, the new name of the company was entered in the trade register, the change then becoming absolutely official another two days later when, on 23 July, the company's Top Management wrote to the Ministry of War: "We hereby inform you that as of today we have changed the name of our company to Bayerische Motoren Werke."

Even so the old name and logo, a horse in the silhouette of a black chess figure, still appeared at the time on the company's letterhead as a symbol for the name Rapp. But now, reflecting the new name of the company, the symbolic knight soon disappeared and was replaced by the white-and-blue colours of Bavaria. And since the new name was too long, it was cut back to three short letters: BMW. Then, on 5 October, the German Imperial Patent Office registered the new logo as the trademark of the company.

Taking off for the first time on 23 December 1917 in the Rumpler C IV biplane, BMW's first engine bore the model designation "IIIa" in accordance with the appropriate military classification and the new logo of the brand. With its output of 185 horsepower, the engine fulfilled all the expectations of the military users, who promptly placed an order for 2,500 units. And while not all of these engines were completed by the end of the war, the engines used at the time quickly gave the BMW brand its great reputation for reliability, power, and economy.

World high-altitude record: 9,760 metres (32,013 feet).
Proceeding from this successful engine, the engineers at BMW built further variants in the last few months of the war, among them the even larger 250-hp BMW IV. This was indeed the engine which on 9 June 1919 took test pilot Zeno Diemer to an unprecedented altitude of 9,760 metres or 32,013 feet. Never before had anybody reached an altitude of this kind – meaning that Max Friz had impressively proven the potential of his innovative engine concept.

Twelve-cylinder with magnesium crankcase for the "Rail Zeppelin".
With the restrictions imposed on German aviation being gradually loosened in the mid-20s, the six-cylinder again provided the starting point for the ongoing development of BMW aircraft engines. What was needed at the time were large engines able to develop a high level of consistent output over a long period. So again, the engineers took an approach characteristic of BMW innovations to this very day, optimising a proven basic design and adding both trendsetting and reliable new concepts.

Taking this approach, the engineers at BMW put together two units of the BMW IV six-cylinder in 1924, creating a 12-cylinder V-engine delivering 580 hp permanent output. And to save weight, they used not only aluminium on the new engine, but in some cases even magnesium on the crankcase.

This powerful engine destined to become famous as the BMW VI quickly became the benchmark of its time, numerous aircraft relying on the BMW V12 on both their maiden and record-breaking flights. And indeed, this unique power unit quickly proved its merits not only in the air, but also in a particularly

spectacular manner in the early '30s in the German "Rail Zeppelin" a high-speed train driven by a compressed air propeller at the rear. The BMW power unit accelerated this streamlined railcar to a speed of no less than 230 km/h or 143 mph, again setting up a new world record.

The final highlight was that the engine was not only delivered from Munich to customers all over the world, but was also built by licensees in Czechoslovakia, Japan and Russia all expressing their great confidence in the BMW VI power unit.

In the late '20s BMW further expanded its leading position as a manufacturer of aircraft engines, now also focusing on the production of air-cooled radial power units. To gain adequate experience with this new technology, the specialists in Munich started building Pratt & Whitney Hornet engines under a licence agreement as of 1929. For while, with its maximum output of 450 hp, the Hornet engine was not as powerful as BMW's best-selling 12-cylinder BMW VI power unit, the radial engine was significantly lighter.

Radial engine with direct gasoline injection.
Once again, BMW's development engineers struck out to optimise proven technology, increasing engine output to 690 hp while leaving engine capacity unchanged and adding only a bit of extra weight. To achieve this improvement, both the crankcase and cylinder heads of the new BMW 132 were made of aluminium, with a turbocharger to provide extra boost at high altitudes being fitted directly on the rear end of the crankshaft.

Becoming a great success, this superior radial engine gained fame particularly as the power unit featured in the three-engined Junkers Ju 52. Indeed, in its process of ongoing development, the BMW 132 quickly became the spearhead for other, innovative technologies: The BMW 132F, for example, was BMW's first power unit with direct gasoline injection. And in the mid-30s, the development engineers converted the nine-cylinder to diesel combustion, added water cooling on certain components, and gave the new engine the designation BMW 114.

Running on special fuel and with multi-stage turbocharging, the radial engine in its last stage of development even broke the 1,000-horsepower "output barrier" at least for short spells and bursts of power.

But soon even this was not enough: In late 1938 the specialists in Munich started developing a double-radial engine with no less than 14 cylinders, that is two radial units with seven cylinders each behind one another. To ensure an adequate flow of air for the cylinders at the rear, the "basic" nine-cylinder was cut back accordingly and the two radial units were slightly

offset from one another. Displacing no less than 42 litres, the BMW 801 aircraft engine weighing approximately one tonne developed continuous output of no less than 1,500 hp.

The command unit: the first mechanical "on-board computer".
Introducing an innovative engine control concept, BMW's engineers significantly facilitated and streamlined the process of operating the engine: The so-called "Command Unit" cut back the conventional array of levers for the pilot to one single control unit, thus making the job of controlling the engine and flying the plane much easier and smoother than before. Ensuring supreme reliability, this miracle in sophisticated mechanics automatically controlled the fuel/air mixture and air charge process as a function of load and height, as well as the ignition timing and setting of the propeller. The result was a reduction of fuel consumption and an increase in operating reliability.

In its basic configuration, the BMW 801 came with direct gasoline injection and a mechanical turbocharger. But then, in the early '40s, the latter was slowly but surely replaced by a more sophisticated alternative, with the turbocharging effect being provided by means of the flow energy in the exhaust emissions. This created a radial engine with turbocharger technology entering series production as the first aircraft engine of its kind in 1944.

VANOS even back then: an 18-cylinder with variable control timing.
To further increase engine output and performance, the engineers at BMW increased the number of cylinders in the BMW 802 aircraft engine to no less than 18. Cooling air plates made sure in this case that despite the small spaces between cylinders, enough cooling air was still able to reach the points subject to high thermal loads and temperatures.

The most particular feature on this 2,500-hp power unit was however the valve timing, with both the intake and outlet valves being masterminded by cam plates able to turn in opposite directions while the engine was running. So it is fair to say that as far back as in 1942, the BMW 802 already came with an early type of VANOS camshaft control now to be admired on modern BMW car engines. Clearly, a significant innovation far ahead of its time.

2. BMW Motorcycles.

With the Treaty of Versailles imposing a ban on the production of aircraft engines in Germany, BMW's spectacular story of success came to an abrupt end. Looking for alternatives, BMW's engineers first focused on the BMW IIIa aircraft engine, creating the M 4 A 12 "Bayern" engine as a stationary power unit or for driving boats, tractors or trucks.

At the same time the Company set out in search of new business opportunities, establishing a worthwhile new option in the early '20s: With the re-construction of Germany calling for appropriate mobility, demand for motorcycles was growing. So in response BMW developed a small power unit, a 500-cc flat-twin – the horizontally-opposed Boxer. Both the pistons and crankcase of the new M 12 B 15, as it was code-named by the company, were made of aluminium, reducing the overall weight of the engine to a mere 31 kg or 68 lb. Initially the company sold this engine to manufacturers of two-wheelers before deciding in 1922 to enter the prosperous motorcycle market with its own machine.

The BMW R 32: the first motorcycle in the world with flat-twin and a drive shaft.

Max Friz's idea was to fit the engine into the new motorcycle with its cylinders facing crosswise to the direction of travel. This, in turn, placed the crankshaft in a longitudinal configuration extending from front to rear. The transmission with its shafts also in lengthwise arrangement was driven directly by a friction clutch, the two housings were bolted to one another. A drive shaft then served to feed drive power from the gearbox to the rear wheel.

While all of these components were already on the market, Max Friz was the first to combine these individual elements to create the innovative concept of the BMW R 32.

The big day came on 28 September 1923, when BMW presented not only its range of modern engines, but also for the first time on an official occasion the company's own motorcycle at the German Motor Show in the Exhibition Halls on Kaiserdamm in Berlin. And this was indeed a bold step into the market, with the company entering into the ring against more than 130 motorcycle manufacturers in Germany alone. What made this step even more courageous was that BMW's 8.5-horsepower motorcycle was one of the most expensive models in the market at its base price of 2,200 Reichsmarks.

Substantial success in the market nevertheless soon proved that BMW had chosen the right concept standing out clearly from the competition not only through the smooth surfaces of the engine/transmission unit, but also through the frame structure with two fully-enclosed steel pipe loops running parallel to one another.

The low position of the flat Boxer engine significantly improved the motorcycle's centre of gravity and, as a result, its riding qualities. And while the front wheel fork allowed only limited spring travel, the use of leaf springs helped to provide a certain inherent damping effect. Deep-black paintwork burnt into the body and elaborately designed white decal lines, finally, clearly set the standard in the motorcycle's quality of finish.

First motorcycle engine with light-alloy pistons.
Setting new standards in terms of the motorcycle's technical components was even more significant. And indeed, the first riders of BMW motorcycles were able to emphasise with pride that they benefited in full from all the experience BMW had already gained as a manufacturer of aircraft engines. This involved both the choice of materials and the use of light alloy in production of the pistons, as well as a level of functional reliability hardly ever seen before on a motorcycle. There was no failure-prone chain drive between the engine and transmission, no chain or belt leading to the rear wheel, and both the valve shafts as well as the springs were fully encapsulated at the top of the cylinders to keep dust out and oil in.

In conjunction with fully enclosed lubricant circulation, this not only kept the motorcycle clean at all times, but also significantly facilitated the process of maintenance and service.

At the time, the best way to promote a new motorcycle and, in particular, a new and "young" brand was to achieve outstanding success in motorsport. Precisely this is why young engineer Rudolf Schleicher decided to enter the hill-climb event on the Mittenwalder Steig in the Bavarian Alps, clocking up the day's fastest time on his BMW on 2 February 1924 and entering the annals of Bayerische Motoren Werke's motorsport history as the first-ever winner bearing the white-and-blue colours.

Schleicher was not only a fast rider, but also a very imaginative engineer: Using a cylinder head cast out of light alloy for the first time in motorcycle construction and featuring overhead-hanging (OHV) valves encapsulated beneath a cover hood, all of which had been designed by Schleicher, three BMW works riders entered the Solitude race in Stuttgart on 18 May 1924 and promptly won three categories at the event.

Before the end of 1924, this new design concept was carried over to the new R 37 sports model which, offering maximum output of 16 hp, almost doubled the engine power of the former R 32.

The pressed-steel frame becomes the "German school".
Very soon BMW started coming along with new concepts and innovations generating growing demand for the brand's machines: Stable pressed-steel running gear replaced the tubular frame, helping to avoid cracks on the soldered connection points and giving the machine a very muscular and powerful look. Indeed, this new concept soon became a great success and was therefore adopted by a number of competitors in Germany, leading to the term "the German school of motorcycle construction" defining this design and engineering concept abroad.

1934: the birth of the telescopic fork.
In 1934 BMW motorcycles made their first appearance on race tracks and off-road courses with a brand-new type of front-wheel fork: slender, smooth, and without any kind of visible spring. This design concept with integrated oil pressure damping quickly proved its merits against the toughest competition and made its market debut just a year later in the new BMW R 12 and R 17. "Apart from the exterior looks – no thin tubes, no springs at the outside, no lubricating nipples, and no components visibly assuming an operating function – the new wheel forks offer a genuinely perfect effect", stated one of the most renowned testers in lauding this milestone in international motorcycle construction.

Innovation in production: protective gas welding for greater frame stability.
A year later the BMW R 5 hailed the advent of a brand-new generation of models. For the first time conically drawn steel tubes with an elliptical cross-section were welded to one another by protective gas welding, a further innovation being the use of adjustable dampers on the telescopic forks. The new 500-cc power unit, in turn, came with two camshafts and a single-piece tunnel-shaped engine block.

In terms of performance, this new BMW was able to match its fastest competitors from Britain, and in terms of riding comfort it was clearly superior to its British competition. In 1938 BMW further increased this leadership, introducing the R 51 with straight-travel rear-wheel suspension.

When in the early '40s the army asked for an off-road machine with power also being transmitted to the sidecar wheel, with a reduction gear for off-road riding and even a reverse gear, BMW responded right away with the introduction of the R 75: An all-new construction from the ground up, the R 75 boasted a

750-cc ohv power unit, a frame in hybrid construction combining its central profile with bolted-on tubular connections, a telescopic fork with double-action hydraulic damping, and appropriate drivetrain technology to meet the army's specific demands. To convey drive power to the sidecar by means of a cross-shaft, there was also a limited-slip differential.

Weighing 420 kg or 926 lb, this sidecar machine was able to carry a substantial load of more than 400 kg or 882 lb, again meeting the army's requirements.

In their off-road qualities, these motorcycles with their driven sidecar wheel were far superior to a car with all-wheel drive, making it no surprise that BMW built more than 18,000 units of the R 75 Army Sidecar Machine between 1941 and 1944.

Entering the post-war era, BMW made a successful new start into the market based on proven design and engineering concepts. And introducing the R 51/3 in 1951, the company also launched a new generation of Boxer engines, focusing even more than before on reliability and the significant improvement of running smoothness. The R 68 then made its appearance in1952 as BMW's first 100-mph machine, a thoroughbred sports machine for the road capable of that magic top speed of 100 mph or just over 160 km/h.

Setting the standard in suspension technology: the all-swinging-arm BMW.

Newly developed suspension and running gear again set the standard in 1955, the "all-swinging-arm" BMW opening up a brand-new dimension in motorcycle engineering through the supreme directional stability and suspension comfort offered by its swinging arm suspension both front and rear. The entire range of models extending from the single-cylinder R 26 through the R 50 and

R 60 touring machines all the way to the high-performance R 69 sports tourer was available with this trendsetting suspension, once again making BMW motorcycles the worldwide epitome of supreme refinement in technology ensuring unparalleled quality and riding characteristics.

With the motorcycle slowly but surely losing its significance in Europe as a means of transport, it started to gain increasing success in the USA in the mid-60s as a leisure-time and sports instrument for the enthusiast. Precisely this prompted BMW to introduce a brand-new range of motorcycles in 1969, development of which had already started when motorcycle sales had slumped to their lowest point: While BMW retained the flat-twin power unit,

the engine now came in brand-new design and with a new concept. The 500 and 600-cc versions were furthermore joined by the top-of-the-range R 75/5, a motorcycle for the 750-cc class now gaining growing significance.

However, not only the engines were new – with the R 75/5 being equipped for the first time with constant-pressure carburettors and an electric starter – but also the light, modern running gear offering appropriate advantages in terms of handling and behaviour.

The R 90 S: the first production motorcycle in the world with cockpit fairing.
BMW Motorrad celebrated its 50th birthday in 1973 with an appropriate highlight – the production of the 500,000th model. In the same year the R 90 S offered even larger engine capacity and a significant increase in power and performance. In particular, however, the R 90 S set the trend for the development of the entire motorcycle market through its looks and appearance, being the first-ever production motorcycle with a cockpit fairing highlighting its sporting character.

Three years later BMW further enhanced this leadership, launching the R 100 RS at the dealership in 1976 with an even larger engine and a fully integrated fairing.

The R 80 G/S with its exciting single-swinging-arm.
Another four years later, BMW again set the trend in the two-wheeler market, introducing the R 80 G/S as the foundation for the brand-new market segment of large-displacement touring enduros. Boasting the largest engine of all enduro machines at the time, the R 80 G/S was equally well-suited for road use and offroad terrain. This was indeed ensured, inter alia, by a truly exciting innovation – the rear single-swinging-arm referred to by BMW as the "Monolever".

Both the R 80 G/S and its successor, the R 100 GS launched in 1987 with its further enhanced "Paralever" rear-wheel swinging arm, very quickly became best sellers within the BMW range. And as yet a further sign of brand distinction, the single-swinging arm soon became a highlight also of other BMW motorcycles.

The K 100: BMW's innovative four-cylinder.
In 1983 four cylinders and liquid cooling were the state-of-the-art for modern high-performance motorcycle engines. But like his colleague Max Friz 60 years before, BMW engineer Josef Fritzenwenger was able, even in this situation, to develop a very special and highly individual technical concept:

Referred to as BMW Compact Drive, this new configuration retained the longitudinal position of the crankshaft and the direct flow of power to the gearbox, but now also featured a counter-rotating interim shaft while boasting the same shaft drive extending to the rear wheel. The four-cylinder power unit displacing 987 cc was arranged in a longitudinal, flat-lying position within the frame, the crankshaft positioned on the right-hand side in the direction of travel, the cylinder head with its two overhead camshafts on the left.

These were however not the only innovations of this trendsetting machine, since the BMW K 100 also entered the market with electronic fuel injection and 90 hp maximum output, while the complete power unit was suspended in a lightweight tubular bridge-type frame.

Over and above the "basic" model, there was also the K 100 RS sports tourer with its innovative and highly effective fairing and the K 100 RT touring model.

More world debuts: ABS and the three-way catalytic converter.
Back in the 1970s, BMW became the world's first motorcycle manufacturer to focus even in the development phase on the complete range of wear and equipment required by the rider, BMW motorcycle helmets with their folding front section setting new standards in the motorcycle world. A very special milestone in 1988 was the introduction of the world's first anti-lock brake system on a motorcycle, BMW's engineers succeeding after thorough testing in preventing the wheels of a motorcycle for the first time from locking and thus helping to rule out the risk of a fall. This significant advantage in safety immediately generated a very positive response among purchasers everywhere.

Various concepts introduced by BMW to reduce harmful emissions from BMW motorcycles proved equally popular, with these breakthrough technologies being introduced throughout the entire model range as of 1991: The Boxer models first came with SAS Secondary Air System exhaust gas afterburning, the K 75 and K 100 soon featured an uncontrolled catalytic converter. As the top model in the range with its special aerodynamic body fairing together with full fairing on the front wheel and rear section, the BMW K 1 soon became the first motorcycle in the world to feature a controlled three-way catalytic converter as standard, the four-valve four-cylinder power unit with digitally controlled electronic engine management offering ideal conditions for such a superior waste management system.

The BMW Boxer with four valves: the R 1100 RS.
With the fundamental principle of the Boxer remaining unchanged – the cylinders sticking out into the wind rushing by at the right and left, the transmission connected directly to the engine, and the drive shaft leading to the rear wheel – everything else was new on the BMW R 1100 RS launched in 1993: The cylinder heads now housed four valves each, operated by short tappets running on the camshafts positioned midship within the engine.

Digital Motor Electronics allowed engine output of 90 hp from 1,085 cc, and, together with the controlled catalytic converter, helped to keep the environment really clean.

The entire drive unit formed a load-bearing element, the BMW R 1100 RS thus no longer requiring a frame in the conventional sense of the word. The front wheel was guided by a Telelever, an innovative combination of the triangular swinging arm and a telescopic fork hinged on the engine block and offering significant benefits in both riding comfort and safety. The rear wheel, in turn, was mounted on the Paralever double-joint single-swinging arm already featured in the K 1 and R 100 GS, with the spring strut supported on a subframe at the rear. The body design of BMW's new sports tourer, finally, was part of the overall technical concept, serving in particular to accentuate the particular looks and features of the Boxer engine.

The BMW C1: a truly innovative concept of mobility.
The advantages of a motorised two-wheeler – agility, compact dimensions on the road and when parking – combined with the safety elements of an automobile – a safety cell with deformation elements calculated in advance, plus shoulder bars and two safety belts: This was the brand-new concept introduced by the BMW C1 in the year 2000.

Far more than just a "motor scooter with a roof", the innovative BMW C1 was a highly developed two-wheeler boasting elaborate technology allowing the rider to enjoy this unique machine without a helmet or protective clothing.

The technical highlights of the BMW C 1 started with the most powerful four-stroke engine in the 125-cc class featuring four-valve technology, electronic engine management with fuel injection and a fully controlled three-way catalytic converter, extended through the Telelever front wheel fork and ABS brake system, the safety-first concept of the frame and body, and continued all the way to a comprehensive range of comfort features and other items of equipment.

A year later BMW launched the third generation of ABS anti-lock brake technology, BMW Integral ABS offering two additional functions: A brand-new electrohydraulic brake servo and integral brake system with the handbrake and footbrake levers acting simultaneously on the front- and rear-wheel brakes, together with adaptive brake force distribution geared to the load the motorcycle was carrying. Reduced brake operating forces and even shorter stopping distances were the significant safety benefits offered by this world-first achievement in motorcycle technology.

The BMW K 1200 S with Electronic Suspension Adjustment.
In May 2004 BMW Motorrad proudly unveiled a brand-new high-performance athlete, the K 1200 S. Conceived exclusively as a sports machine, this motorcycle was radically new from the start, boasting a wide range of innovations. The four-cylinder power unit fitted for the first time in crosswise arrangement and leaning to the front at an extremely low angle, with valve drive derived from BMW's Formula 1 power unit, provided a low centre of gravity right from the start. In combination with the overall geometric configuration of this new machine, this allowed ideal wheel load distribution of 50 : 50. And another feature truly unique on a production motorcycle in this category was the construction of the integrated six-speed gearbox as a fully enclosed box-type, "cassette" transmission.

Technical highlights in the suspension were the new Duolever front-wheel suspension and Electronic Suspension Adjustment. In kinematic terms, the Duolever was a rectangular joint made up of two almost parallel longitudinal arms pivoting within their frame and giving the front wheel precise lift and stroke. The wheel support, a light casting made of a high-strength aluminium alloy, was connected to the longitudinal arms by two ball joints, and was therefore also able to provide a steering motion. A central spring strut pivoting on the lower longitudinal arm, in turn, provided the necessary spring and damping functions. In all, this highly innovative concept combined supreme stiffness with low weight and an ideal wheel response curve.

Available as an option, Electronic Suspension Adjustment (ESA) was yet a further innovation to enter regular production: ESA allows the rider to adjust spring pre-tension and damper forces at the touch of a button straight from the handlebar, using all the advantages of electronic control.

Another progressive feature was the on-board network based on CAN-bus technology to provide a wide range of functions in a relatively simple, uncomplicated system allowing full diagnosis of any deficiencies when necessary.

The BMW F 800 S: parallel-twin with minimum vibration thanks to innovative mass compensation.

The latest highlight in the history of BMW motorcycle innovations entered the market only recently in the first half of 2006 in the guise of the BMW F 800 S: A two-cylinder displacing 800 cc and combined with excellent running gear to provide all the riding qualities so typical of a BMW. The first straight-two in the history of BMW naturally came with four valves, the high compression ratio of 12 : 1 and the special design of the combustion chamber helping to ensure superior fuel economy and emission management.

The final touch, however, was provided from the start by the innovative balance of mass forces: To eliminate undesired vibrations on the parallel-twin, BMW's engineers invented a kind of horizontal connecting rod mounted eccentrically on the crankshaft and serving through its oscillating mass to set off engine forces smoothly and reliably. This system was compact, straightforward in design and construction, and reduced any additional weight to a minimum.

3. BMW Cars.

Purchasing Fahrzeugfabrik Eisenach, the Eisenach Vehicle Manufacturing Plant, in 1928, BMW established a third pillar for the company in addition to the production of aircraft engines and motorcycles: the production of cars. For reasons of time and to avoid any undue risks in the new market, the company started out by continuing licence production of the Austin Seven which began in Eisenach in 1927 under the model designation 3/15 PS DA 2.

Four years later BMW's engineers had gained sufficient experience with their new four-wheel products to introduce the first car into the market developed by BMW itself, the BMW 3/20 PS. And indeed, this new model was full of innovations right from the start, featuring a central box frame and independent wheel suspension both front and rear, and thus offering a driving experience customers had previously only been able to enjoy in far larger and more luxurious cars.

Within just one year, the BMW 3/20 PS was available to customers not only as a new car, but also with a new power unit, the new, 20-hp 782-cc engine featuring overhead hanging valves and running much more quietly than its predecessor. The seats, motoring comfort and lines of the new car were also far more harmonious and modern than on its rather spartan predecessor.

The BMW 303: the first six-cylinder.
In 1933 BMW moved up to the highest realms of technology also in the automobile market: Introducing the BMW 303, the company proudly unveiled its second "home-made" car and the first BMW to feature the kidney radiator grille. Within the engine compartment the new model boasted a 1.2-litre six-cylinder in-line engine developing maximum output of 30 hp. The most outstanding forte of the new car, however, was its excellent driving and motoring qualities quite unprecedented in this part of the market.

BMW had opted for this power unit code-named the M78 after two former designs appeared either too sophisticated or too primitive. The engine was based on a four-cylinder introduced a year before and differed primarily through the combination of the crankcase and cylinder block to form one complete unit.

Further highlights were the camshaft fitted beneath the engine block and the tappets operating the valves in vertical, hanging arrangement via rocker arms. Both the intake and exhaust pipes were on the same side.

A feature quite unusual today was the varying gaps between cylinders: The distance between the second and third, and the fourth and fifth, cylinder were larger than the other gaps between the cylinders, with this extra space being required to accommodate the crankshaft and camshaft bearings. The crankshaft not using any counterweights therefore ran in four bearings, just like the camshaft.

This was however not the main reason for this rather distinctive design. Rather, the crucial factor was that back then the crankshaft was assembled together with the connecting rods and pistons as one completely pre-fabricated unit. And since the pistons thus had to be fitted into position from below, the main bearing supports for the crankshaft were not allowed to extend into the cylinder contours. Hence, the only option was to accommodate the main bearings between cylinders further apart from one another.

Highly inventive: using the exhaust gas to heat up the carburettors.
A similarly unusual feature from today's perspective, but nevertheless quite characteristic of BMW's typical inventiveness, was to be found in the fuel supply system, where the intake manifolds were enclosed by six-centimetre-wide chambers directly above the two updraught carburettors. Using the heat from the exhaust system, these chambers served to warm up the fuel/air mixture, eliminating the risk of icing and improving the distribution of the air/fuel mixture.

In the years to come this engine served as the foundation for developing a number of further six-cylinders, some of them even with an aluminium cylinder head. Engine capacity was increased to two litres, and depending on power requirements either one, two or three carburettors delivered the fuel/air mixture to the combustion chambers.

Such a three-carburettor engine developing 40 hp was to be found in the BMW 315/1, a light sports two-seater launched in 1934 and scoring a wide range of success in numerous races and other contests. Indeed, the sporting character of BMW cars began with this very engine and in this particular model.

The BMW 326: frame and body welded to form one unit.
Two years later, BMW launched a new top-range model immediately acknowledged as one of the most advanced large-scale production cars of its time: the BMW 326. This was in fact the first BMW featuring a bodyshell welded to the frame, doors hinged at the front, a hydraulic brake system and the spare wheel beneath a cover on top.

Proceeding from a newly developed low-bed box frame with a torsion bar-suspended, low noise rear axle, as well as transverse-leaf springs on the front axle moved further down, BMW's engineers had created an all-new midrange model. The engine was also a new two-litre six-cylinder with two carburettors and maximum output of 50 hp conveyed to the wheels by a partly synchronised four-speed transmission even featuring a free-wheel function in first and second gear. Top speed of the BMW 326 was an impressive 115 km/h or 71 mph.

The 326 was not to remain BMW's only sensation in the year 1936. For the next highlight appeared at Nürburgring on 14 June, when the brand-new BMW 328 made its first appearance. This superior sports car was indeed the result of a very fast development process, since the engineers, designers and mechanics in BMW's Development Division in Munich had had only little time and money to make this thoroughbred sports car reality.

But while being forced to restrict themselves to the essential, BMW's specialists still had all their creativity to offer – and they were extremely successful in bringing this creativity to bear: Within a short time, the new BMW 328 dominated its category in motorsport, quite often leaving even far more powerful competitors far behind. And this is understandable, considering that 80 horsepower in the regular production version weighing just 830 kg or 1,830 lb overall gave this elegant roadster truly impressive power and performance – and still does so today.

Elegant lightweight construction: the BMW 328 Mille Miglia.
BMW entered the 1940 Mille Miglia with unique roadster and coupé models built by Carrozzeria Touring in Milan. The thin aluminium skin on these Superleggera bodies was mounted directly on the filigree, load-bearing tubular spaceframe made of steel, reducing overall weight of the coupé in road trim to just 780 kg or 1,720 lb and allowing a top speed of 220 km/h or 136 mph.

The power unit featured in this legendary sports car was BMW's first automobile engine with V-shaped hanging valves operated not by overhead camshafts, but rather by thrust rods and rocker arms. And since the engine block featured thrust rod guides only on the intake side, a mechanism in the cylinder head conveyed the operating forces via pivot bars and levers to the opposite side of the engine.

A revolutionary test: the BMW 328 with fuel injection.
Featuring three downdraught carburettors fitted on the cylinder head, the two-litre six-cylinder developed 80 hp in regular trim, accelerating the lightweight BMW 328 to a top speed of more than 155 km/h or 96 mph and soon becoming the very epitome of the sports engine.

But this was far from the end of the road for the six-cylinder, with engine output being increased to 100 and even 110 hp on competition engines. The limit in the process was set not so much by the engine as such, but rather by the availability of fuel restricted to just 80 octane. This, in turn, limited the compression ratio to a maximum of 9.5 : 1, in order to avoid the risk of the pistons burning through. So it was only the introduction of special racing fuel that enabled BMW's engineers to overcome this limitation, increasing output of the BMW 328 all the way to 136 hp. And in 1941 BMW's engineers even conducted tests with fuel injection on this outstanding engine, using three throttle butterflies instead of the conventional carburettors.

The BMW 501: the "Baroque Angel" full of highlights in technology.
Losing the Eisenach Car Production Plant in the War, BMW found it difficult to make a new start in the post-war years. Hence, the first new model did not appear until the 1951 Frankfurt Motor Show – the BMW 501.

Although relatively "classic" in its design and styling, the "Baroque Angel" was full of highlights in technology: The two half-shafts at the front were each mounted on two triangular track control arms running in needle bearings. This low-friction bearing technology ensured a particularly sensitive response on the part of the progressive springs and suspension made up on each side of a longitudinally arranged, extra-long torsion bar.

The arrangement of the dampers was likewise quite unusual: Fitted at the outside on the lower triangular arms, the dampers extended upwards in an inclined position, coming to rest inside on the upper track control arm. This avoided any contact with the sprung body and prevented even the slightest transmission of noise.

Focusing on the steering, the engineers in Munich introduced a very special idea on the BMW 501, applying the principle of rack-and-pinion steering to a crown wheel segment in the interest of maximum steering precision. The oil reservoir for the steering served at the same time to lubricate all other front axle components, which therefore remained independent of the regular central lubrication. The rear axle, as all testers agreed at the time, was the "ultimate level of perfection in the development of the live axle", torsion bars acting on the axle right at the outside via spring arms serving here, too, to provide the necessary suspension effect and at the same time giving the car its longitudinal guidance.

Even the gearbox with gears being shifted straight from the steering wheel was arranged in a different position: Instead of being bolted directly to the engine, the gearbox with its four all-synchromesh gears was housed beneath the front seats and connected to the engine by a short propeller shaft.
The advantage of this particular arrangement was that the footwells remained largely free, without being impaired or cluttered by a voluminous transmission housing. A further benefit was that the engine mounts did not have to be re-designed for maximum torque from the transmission, meaning that the engine was able to rest on unusually soft and smooth mounts. The bottom line, therefore, was that the 65-hp six-cylinder, a modified version of the engine already featured in the BMW 326, was exceptionally smooth and refined in the BMW 501.

1954: introduction of the world's first light-alloy eight-cylinder.
The BMW 501 nevertheless only paved the way for BMW's most spectacular innovation in the '50s: The first series-production light-alloy engine in the world and the first German eight-cylinder after the end of the War launched in 1954. Weighing in at 210 kg/463 lb, the 2.6-litre power unit in the BMW 502 was just 28 kg or 62 lb heavier than the six-cylinder in the 501.
The pistons with four rings ran in "wet" cylinder liners, that is centrifugal-cast liners surrounded by coolant pipes.

This solution was the obvious choice right from the start because BMW planned from the beginning to build not just the 2.6-litre with its almost square combustion chambers, but also a 3.2-litre with exactly the same stroke but longer bore.

The oil pump on the smaller engine was driven by a divider shaft, the oil pump on the larger engine by a roller chain. Otherwise the higher delivery output of the pump might have overburdened the sensitive gearwheels.

The intelligent method used to fasten the rocker arm shafts in position once again bore testimony to the inventiveness of BMW's engineers, with the inner support bolts on the bearing blocks, like the pushrods, being made of special dura-steel and extending through the entire cylinder head all the way to the housing at the back. As a result, the support bolts maintained the same consistent distance to the crankcase also in the transition from cold to high temperatures, even though the different metals warmed up at a varying rate. The result was excellent valve play compensation between cold and warm running conditions. BMW's advertising experts understandably highlighted this construction at the time as "automatic valve play compensation".

The valves themselves were positioned parallel to one another at a 12° angle to the axis of the cylinders. And so while this was not a crossflow cylinder head of modern design where the valves hanging in V-arrangement are positioned opposite one another, this configuration helped to save space, which was rather limited within the engine compartment of the BMW 502.

To keep the warm-up period as short as possible, the eight-cylinder featured an oil-guiding corrugated pipe within its water shell serving as a heat exchanger: After the engine was started cold this configuration was able to warm up the coolant more quickly to its regular operating temperature, while when driving fast it helped to cool the oil.

Displacing 2.6 litres, the V8 with double downdraught carburettors developed maximum output of 100 hp when it made its debut into the market.

The new Range: technology at its best.
Even back in the mid-50s, BMW's development engineers recognised the urgent need for a modern car in the midrange segment. And while development activities to produce such a model were indeed initiated, the project to build a brand-new midrange car was originally simply too expensive. By the early '60s, however, the situation had changed fundamentally and BMW's new midrange model was eventually developed as a sporting, medium-sized four-door saloon combining sports suspension with a powerful engine – sufficiently comfortable for five passengers, sufficiently agile for dynamic motoring. BMW's marketing strategists therefore gave the car the name "The new Range", the BMW 1500 making its debut at the Frankfurt Motor Show in 1961.

The power unit featured in the new Range was an all-new 1.5-litre straight-four developed under the guidance of Alexander von Falkenhausen, at the time BMW's engine wizard. Maximum output of 80 hp was sufficient for a top speed of almost 150 km/h or 93 mph, quite outstanding compared with the competition at the time.

Once again, therefore, BMW's engineers had made the very best out of contemporary technology and the state back then, creating a concept destined to achieve years of success. Proceeding from the 1.5-litre, the company's engineers soon introduced larger four- and six-cylinder power units in turn serving to set new benchmarks and launch further innovations in engine construction.

In 1966, for example, a patented cooling concept made its debut in the two-litre version: The state of the art at the time was to use a thermostat on the coolant circuit leaving the cylinder head, which opened up as soon as the coolant reached a certain temperature, thus allowing cold water to flow into the engine block. The disadvantage, however, was the excessive change in temperature caused in this way, together with high loads acting on the engine.

BMW's new concept was to move the thermostats to the entry point into the engine block, where, mixing cold water from the radiator and hot coolant supplied by a direct line in the cylinder head, the thermostats helped to maintain the temperature of the coolant flowing in at an appropriate, well-balanced level for the engine. This served, as desired, to increase engine temperature in winter and reduce the temperature of the engine on hot summer days. A further advantage was that it was no longer necessary to switch between a summer and winter thermostat setting.

The first turbo made in Europe.
With its substantial power reserves, the four-cylinder opened the door for a truly enormous increase in performance: Introduced in 1970, the 130-hp BMW 2000 tii became the first BMW with mechanical fuel injection setting a new benchmark in the two-litre class.

The debut of the BMW 2002 turbo three years later was even more spectacular, this 170-hp top performer in the 02 Series reaching a maximum speed of 210 km/h or 130 mph with its 170-hp power unit.

Built for a period of just 10 months, the 2002 turbo was available exclusively in white and silver, the short production life of the fastest and most powerful BMW 02 being a result of global decisions taken in the oil market: In response to threats by the oil-exporting countries, the Western world imposed speed limits and bans on driving, with the price of gasoline in Germany rocketing up from DM 0.70 to DM 0.90 and clearly making life very difficult – if not to say: impossible – for a car as technically sophisticated and progressive as the 2002 turbo. For the turbocharged BMW was once again an outstanding trendsetter, being the first production car in Europe to feature exhaust gas turbocharger technology.

Six-cylinder with innovative combustion chamber design.
As early as in 1968 BMW's engineers had derived a second engine family from the four-cylinder destined to really characterise the image and reputation of the brand: The straight-six power units featured in the BMW 2500 and 2800, once again taking the company back into the market of large saloons and coupés. Fitted at an angle of 30o, these power units featured a crankshaft

running in 7 bearings and controlled by 12 counterweights for superior smoothness free of vibration. A further feature was the overhead camshaft likewise helping to give BMW's six-cylinders the "turbine-like" smoothness for which they subsequently became so famous. Together with the forged crankshaft running in 7 bearings and featuring two counterweights on each crankweb, this was the guarantee for excellent running smoothness.

One of the technical innovations on the two engines boasting the same design concept was the so-called "triple-hemispherical swirl-action combustion chamber" configuration literally cut into the pistons. This special geometry served to generate exactly the right swirl effect, concentrating the fuel/air mixture around the spark plug. The result was a very effective but at the same time soft and smooth combustion process borne out inter alia through the engine's superior power and performance: Maximum output of the 2.5-litre was 150 hp, with the 2.8-litre developing an even more significant 170 hp – enough to catapult the BMW 2800 into the exclusive elite of 200 km/h (125 mph) cars. And reaching a top speed of 190 km/h or 118 mph, the BMW 2500 also far ahead of nearly all its competitors.

This new engine concept stood out from the start as a genuine role model not only on account of its power and performance, but also because the new engines were at the same time economical, robust, and long-living.

The BMW M1: paving the way for four-valve technology.
The BMW M1 clearly proved the great potential of the six-cylinder power unit in 1978: this low-slung mid-engined sports car was powered by a 3.5-litre straight-six delivering 277 hp to the rear axle. Code-named the M88, this truly outstanding power unit was based on the M06 engine built in a large production series and featured the four-valve cylinder head carried over from the racing engines in the BMW CSL lightweight coupé. Offering this kind of technology, BMW took on a leading role in the introduction of four-valve engine concepts

The BMW 524td: setting a milestone in the diesel market.
A genuine revolution in the history of BMW was the decision to enter the fiercely contested market of diesel cars, developing a brand-new generation of engines in the process. The first model produced in this initiative was the BMW 524td launched in June 1983, BMW living up to the challenge to build a diesel engine combining the advantages of diesel technology with the features so typical of BMW such as dynamic performance and supreme motoring culture. The result was the BMW turbodiesel based on the existing straight-six power unit displacing between 2.0 and 2.7 litres.

Featuring turbocharger technology and large cross-sections on the intake and outlet valves of the engine displacing 2.4 litres, the new diesel was able to develop a substantial 115 hp maximum output. The turbulence chamber combustion process enhanced to an even higher standard than before offered ideal conditions for superior fuel economy and low combustion noise. According to the DIN standard, this modern turbodiesel introduced by BMW consumed just 7.1 litres/100 km equal to 39.8 mpg Imp, but nevertheless offered top speed of 180 km/h or 112 mph and accelerated to 100 km/h in 13.5 seconds, setting a new benchmark for dynamism in a diesel.

A truly unique concept: the eta engine.
As an alternative concept, BMW also offered an innovative engine with gasoline technology. This brand-new power unit was featured in the 525e entering the market in 1983, the letter "e" standing for "eta", the symbol for efficiency. This 2.7-litre six-cylinder was optimised without compromises for supreme torque and economy, developing 122 hp maximum output but nevertheless consuming just 8.4 litres regular fuel on 100 kilometres – equal to 33.6 mpg Imp.

Back then fuel economy of this kind on a large six-cylinder was acknowledged as truly sensational, all the more so as the engine hardly consumed any more fuel under practical driving conditions than in standardised fuel consumption tests. This focus on a large power unit with relatively low power was indeed quite unusual in Europe, and remains so to this very day.

The BMW 750i: twelve-cylinder with the most advanced technology.
Three years later BMW came along with the sensation of the decade – the BMW 750i making its debut in 1987 as the first twelve-cylinder saloon built by a German manufacturer since the end of the '30s. This new BMW flagship nevertheless remained relatively modest from outside, standing out from the other models in the BMW 7 Series only through its somewhat wider radiator grille and the wider powerdome on the engine compartment lid as well as square instead of round tailpipes.

The BMW V12 was developed with the objective to provide a perfect symbiosis of superior performance, compact dimensions, all-round economy, and exemplary emission control. And the result was indeed truly unique also in relation to competitors the world over.

These objectives were reached by using the most advanced, state-of-the-art technologies and consistently implementing innovative ideas. Weighing just 240 kg or 529 lb overall, the five-litre V12 set up a new record also in terms of weight and efficiency right from the start. And with its maximum output

of 300 hp, together with peak torque of 450 Nm or 332 lb-ft, the new V12 likewise outperformed comparable engine and vehicle concepts in the market at the time.

The BMW Z1: a spearhead in technology actually available in the market.
In 1988 BMW for the first time made the daring move to offer the market a spearhead in technology built in series production: the BMW Z1.

This unique model was conceived and built by BMW Technik GmbH as a – very successful – example of alternative body engineering, the company taking a brand-new approach in designing and building this new car. As an example, this revolutionary two-seater featured a monocoque-like, unitary frame structure made of corrosion-free steel plate, while the bodyshell was made of thermoplastic segments recyclable individually as required.

A particular highlight of the very modern body design was the side sections retracting electrically into the car and taking the place of conventional doors.

Only the powertrain came from BMW's "regular" production models, the Z1 featuring the 170-hp six-cylinder carried over from the BMW 325i and giving this roadster quite unique to this day a top speed in excess of 220 km/h or 136 mph.

The BMW Z8: a unique combination of spaceframe technology and a high-performance eight-cylinder.
Entering the year 2000, BMW again added further momentum to the company's leasdership in technology for the road, giving its revolutionary new model the name "Z8". And indeed, right from the start the BMW Z8 offered the best technology possible at the time in automotive engineering.

The trendsetting body structure of the Z8 was at least as exciting as the car's design and style, the spaceframe aluminium body in unitary design opening up a new dimension in technology. Built as a kind of truss structure, the spaceframe incorporated high-strength structural aluminium plates filling in the space between generously dimensioned extrusion-pressed profiles serving as a stable "skeleton".

The beautiful aluminium outer skin then came on top of this structure, with each component being fastened and removed with the help of bolts.

Keeping weight to a minimum in comparison with other open-air sports cars, this concept ensured the highest possible standard of body stiffness. The result for the driver was a truly excellent, direct feeling of the road at the same time avoiding the vibration and body "tremble" so typical of an open car. And power was also abundant, a high-performance sports engine displacing five litres and developing 400 hp offering everything the driver required.

BMW X5 defining the new SAV segment in the market.
A year before the introduction of the Z8, BMW had already defined another new segment in the market through the BMW X5, the world's first Sports Activity Vehicle (SAV).

From the very beginning, this all-wheel-drive newcomer supplemented the sporting but comfortable features of a typical BMW saloon by offering a wide range of offroad qualities. Measuring 1.72 metres or 67.7 inches in height, the BMW X5 was a lot higher than all other BMWs. At the same time it was as wide as a BMW 7 Series, but a lot shorter than a BMW 5 Series. And thanks to its unitary body, the BMW X5 offered exceptional driving qualities both off the beaten track and on the road.

This four-door Sports Activity Vehicle was built exclusively at the BMW Spartanburg Plant in South Carolina, featuring both straight-six and V8 power units.

In 2003 BMW added the more compact BMW X3 to its range of Sports Activity Vehicles, for the first time offering a premium vehicle in the market positioned beneath the BMW X5.

Optimum drive technology: BMW xDrive.
The highlight of the BMW X3 was the newly developed, intelligent xDrive all-wheel-drive system allowing infinitely variable distribution of drive forces between the front and rear axles. Immediately recognising the need to change the distribution of power, BMW xDrive responds extremely quickly to driving requirements, generally faster when driving onroad than a wheel is able to lose traction and, as a result, its grip on the surface.

This means that in a dynamic bend, for example, xDrive is able to feed exactly the right drive power to the respective axle at all times, significantly minimising both under- and oversteer in the process.

From VANOS to VALVETRONIC.

In 1992 BMW introduced infinitely variable valve management – double-VANOS – as a world-first achievement in the BMW M3. The particular advantage of this control system is that it adjusts valve timing on both the intake and outlet valves infinitely to the engine's running conditions via precise angle control of the camshafts, regardless of the position of the gas pedal and engine speed. In practice this means substantial torque at low engine speeds and superior power in the high speed range. And keeping the amount of unburnt residual gases to a minimum, double-VANOS also serves to improve the engine's idling qualities.

Special engine management control maps for the warming-up process serve in addition to enhance the effect of the catalytic converter, with all of these functions being masterminded by Digital Motor Electronics (DME).

The efficiency of BMW's power units was further enhanced to an even higher standard by the introduction of VALVETRONIC in 2001. VALVETRONIC is a valve drive system with fully variable lift management of the intake valves, engine output being controlled by infinitely variable intake valve lift without requiring the throttle butterfly previously inevitable on an internal combustion gasoline engine. The intake valve lift function introduced in this way controls the amount of air drawn into the engine, keeping power loss to an absolute minimum (air volume control).

On the road VALVETRONIC technology gives the BMW driver enhanced fuel economy, reduced exhaust emissions and, at the same time, even better response and a higher standard of running smoothness.

The leader in light-alloy casting.

Shortly after the BMW brand was established many years ago, the company opened its own light-alloy foundry because the aluminium components provided by suppliers did not meet the quality standards applied to the IIIa aircraft engine. And in the meantime, over the decades, BMW has acquired unique know-how in the production of light-alloy components. Indeed, this was the prerequisite for innovations such as the light-alloy flat-twin power unit in the early '20s, the world's first aluminium V8 in the BMW 502 in 1954, and the complete changeover in the meantime of BMW's entire range of engines to light-alloy technology.

The BMW six-cylinder: the only engine in the world made of composite light alloys.

Introducing the first production engine with a composite magnesium/aluminium crankcase, BMW hailed yet another pioneering achievement in 2004. Thanks to this unique casting technology developed by BMW in-house and now applied consistently in production, the straight-six weighs a mere 165 kg or 364 lb.

This was followed in February 2006 by the Twin Turbo power unit featuring High Precision Injection, again giving BMW a leading position in turbocharger technology on large-scale production gasoline engines. Together with BMW's straight-six diesel featuring Variable Twin Turbo technology, this power unit ranks right at the top in the international market.

BMW EfficientDynamics: paving the way to sustained mobility.

Oriented to a process of long-term, innovative improvement, BMW's EfficientDynamics drivetrain strategy combines superior performance with minimum consumption of resources. In the year 2007 BMW introduced an all-round concept of intelligent energy management with hybrid functions, features such as Brake Energy Regeneration serving to enhance the level of efficiency, in this case by generating electrical energy for the car's on-board network solely while the engine is in overrun and during application of the brakes. The Auto Start Stop function, in turn, also serves to use fuel with maximum efficiency, optimising fuel economy on the manual-gearbox version of the BMW 1 Series in conjunction with BMW's new four-cylinder gasoline and diesel engines. To benefit from this new function, all the driver has to do is shift to neutral when coming to a halt at the traffic lights or in a traffic jam and let go of the clutch pedal. This automatically switches off the engine, which is immediately activated as soon as the driver presses down the clutch pedal again. Using this Auto Start Stop function, the driver is able to reduce fuel consumption during standstill of the car to zero.

Over and above Brake Energy Regeneration and the Auto Start Stop function, the new four-cylinder power units designed from the start for maximum efficiency help to further optimise fuel economy in general. Precisely this is why BMW offers the discerning customer two versions of new gasoline engines with the latest technology of second-generation direct gasoline injection. The big advantage in this case is that the new technology maintains the lean burn mode with extremely efficient dosage of gasoline in the fuel/air mixture throughout a particularly wide range of engine load and speed. As a result, this new technology appropriately named High Precision Injection allows a reduction in fuel consumption in everyday motoring by up to 14 per cent.

In series development, BMW is already in the process of electrifying the drivetrain all the way to full hybrid technology. So based on an active transmission combined with intelligent energy storage, a full hybrid will be presented to the public within the next three years.

Since even vehicles with this technology will still emit CO_2 while driving, BMW EfficientDynamics focuses in the long term on the use of hydrogen recovered in a regenerating process.

Indeed, BMW has already become the first carmaker in the world to launch a luxury saloon with hydrogen drive built in series production – BMW Hydrogen 7, an absolutely unique car emitting virtually nothing but vapour when running in the hydrogen mode. The particular feature typical of BMW is that BMW Hydrogen 7, benefiting from its supreme 12-cylinder power unit, does not require the driver or passengers to make the slightest concession in terms of motoring comfort, performance and reliability. And since the car is also able to run as an alternative on conventional premium fuel, it guarantees unrestricted mobility also beyond the range of hydrogen filling stations.

Introducing this practical solution, BMW is clearly demonstrating not only its leadership in technology in the area of future drive systems, but also in the integration of hydrogen drive into a vehicle concept clearly proven in practice. This, obviously, sets the foundation for an alternative to conventional drive technology accepted in the market and readily available to the customer.

The launch of BMW Hydrogen 7 is therefore a milestone en route to a new age of mobility independent of fossil fuel not only for BMW, but also for the entire automotive and energy industry. And in this way, BMW is once again clearly proving the unique innovative power and potential of an equally unique brand.