

## ARSENAL™: Heavy Metal

In this high-tech age of precision guided missiles, modern tanks appear to be relics of a dinosaur age of land warfare. But the thick armor of today's tanks conceals their very own space-age ballistic computers, laser rangefinders and sophisticated electronics. This episode of ARSENAL examines the main battle tanks of four of the world's most prominent tank developers: Britain, France the United States and Germany, tracing their designs from the earliest roots to the latest in heavy metal.

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The ultimate test of tank technology is the battlefield. American tanks formed the sharp end of the sword in Operation Desert Storm. The US Marine Corps was still using the older M60 tank, although with some modifications compared to earlier versions of this vehicle. To better protect the tank against Iraqi anti-tank missiles, some of the M60s had a new reactive armor layered on top of their existing steel armor. When struck by an enemy missile, this armor exploded outward to weaken the impact of the enemy warhead.

Army tank battalions in the Gulf were equipped with the new M1 Abrams tank, which had first entered service a decade before. The latest model, called the M1A1 Heavy Armor, enjoyed many advantages over the older M60. The Abrams' night fighting equipment allowed American tankers to engage and destroy Iraqi tanks long before the Iraqi tankers could even see the Americans. The relentless speed of the attack, made possible by the Abrams' new turbine engine, made it impossible for the Iraqi commanders to react quickly enough to American maneuvers. And the new armor, bolstered by an added layer of dense uranium metal, proved very effective.

The stunning victory of American tankers against the Iraqi Army was a vindication of the new tank technology. But it was also a proving ground for the tankers, their training and their tactics.

Across the hot dusty training areas of the prairies of Texas, sleek tanks hunt out their quarry. Tankers of the US Army's 1st Cavalry Division wage mock combat using one of NATO's newest and finest tanks, the M1 Abrams. The Abrams is the latest in a long lineage of American heavy metal.

The first American tank units were formed in France in 1917, commanded by a little known colonel, George Patton. Their tanks were the hardy French Renault FT.

The Renault was the first modern tank, fitted with a rotating turret like all succeeding tanks. It was very unlike the more ponderous landships of the British Army, though the American Army had a battalion of these as well. The Renaults and their American built copies were necessary, as American industry had little success manufacturing its own tanks before the end of the war. In the 1920s, American inventors tackled the challenge of tank design with considerable enthusiasm, though not always with great success. The early tanks, such as this Cunningham light tank, were little changed from their World War 1 ancestors. They were not very fast, not well protected, and not well armed. But then neither were those of most European armies of the time.

American tank design in the 1930s suffered from both a small army budget and the presumption that America would never again become involved in another European land war. Tanks seemed irrelevant to traditional Army missions — patrolling the Mexican border or policing actions in the distant Philippines.

Some of the tank designs of the 1930s showed considerable imagination. One designer, Walter Christie, developed a series of fast tanks that could be driven cross-country on their tracks, or much faster on roads with their tracks removed. The US Army bought a handful of Christies and played with the concept for some years. But it was in Europe that Christie's designs had their greatest impact. The Soviet Union built a derivative of the Christie tank called the BT. This led to the T-34 tank, the finest tank at the beginning of World War 2. And Britain used the Christie suspension on some of its tanks, such as the Crusader.

As war clouds brewed in Europe, the US Army paid greater attention to tank design. Its designs in the late 1930s were uninspiring, compared to many European designs. When Europe went to war in 1939, the US

Army's tank force was about the same size as that of the smaller European powers — Italy, Poland, Romania. Urgently, work was begun.

The US Army entered World War 2 with two principal tank types, light tanks, such as the M2A4 and M3, and medium tanks, such as the M3. The M3 medium tank used an unusual configuration, with its main 75mm gun in the hull, and a smaller 37mm gun in a separate turret. This peculiar arrangement was due to the fact that American industry could not yet cast turrets large enough to accommodate the powerful 75mm gun. The idea for the M3 medium tank's gun arrangement came from the French Char B tank, one of the most powerful tanks in the world in 1940. The M3 medium tank, and its smaller companion, the M3 light tank saw their combat debut in the hands of the British, provided through Lend-Lease. American tanks developed a reputation for automotive excellence and durability, even though their armor protection and firepower often fell short compared to German tanks. A new tank was on the drawing boards, the M4, better known as the Sherman. The Sherman tank was the mainstay of the US tank force in World War 2.

The Sherman was a good tank in 1942 and 1943 when it first entered service. But the US Army was not prepared for how rapidly German tank development was progressing.

The main tank battles were fought on the Eastern Front between Germany and the Soviet Union. New German tanks, like the Panther and the Tiger, were developed to deal with the Soviet tanks like the T-34 with its Christie suspension. The new German tanks were twice as heavy as the Sherman, and their powerful guns could easily punch through the Sherman's thinner armor.

By the time that the US Army faced its greatest challenge after the Normandy invasion in 1944, its Sherman tanks were outgunned by the better armed Panther and Tiger. Even the improved version with its 76mm gun could barely penetrate the German tank's thicker armor. Fortunately, the German tank force was weakened considerably by Allied airpower. Large-scale tank battles of the type seen on the Eastern Front were a rarity on the Western Front. The Sherman, because of its reliability, proved adequate to do the job.

The most powerful American armored vehicle of World War 2 was the T28 superheavy tank. It was not designed to fight other tanks, but to duel with heavy fortifications of the type expected on the German Siegfried line. It was so heavy that it had to have four sets of tracks instead of the usual two. Its thick armor was nearly impervious to any conventional land artillery. But in a war of maneuver, its weight was a major drawback, and none ever saw combat.

The shortcomings of the Sherman led to the development of a new tank to replace it, the M26 Pershing. The Pershing was not as heavy as the T-28. Rather, it was about the same size as the deadly German Panther tank, and armed with a 90mm gun. During the Korean War, the Pershing and the Sherman were used in tank battles with Soviet-supplied T-34 tanks manned by the North Korean and Chinese armies. The appearance of Soviet heavy tanks such as the Joseph Stalin III tank prompted the US Army to design even heavier tanks. But like the T-28, these also faded into obscurity.

Another idea was a super light-weight tank-hunter such as the tiny Ontos tank destroyer. Ontos, a Greek word meaning "The Thing," was designed as a cheap substitute for tanks. It was armed with six recoilless rifles giving it enormous firepower for such a small vehicle. But it lacked the combat endurance of more conventional tanks, and only a small number were used by the Marine Corps.

American tank evolution remained concentrated on medium tanks, which eventually came to be called main battle tanks absorbing the role of light, medium and heavy tanks. The Pershing was followed by evolutionary improvements, the M47 and M48 Patton tanks. These formed the core of the US Army's tank divisions during the Cold War. The final evolutionary development of the M26 Pershing tank was the M60, appearing in 1960 nearly 25 years after its predecessor. The M60 tank has evolved for twenty years into the M60A1, A2 and finally today's M60A3 version.

The M60A3 is fairly typical of the modern main battle tank. Let's take a look at the crew of a modern tank and their functions.

The crew of an M60 tank is four men: the tank commander, the gunner, the loader and the driver. The tank commander is the senior member of the crew.

*The tank commander is responsible basically for everyone in the tank. For the safety and ensure the gunner and you lead a gunner on his target. When the tank commander or a crew member identifies a target, the tank commander just goes ahead and issues his fire command. We all work together to get the target destroyed. [SFC Stroffoleno]*

The tank commander sits in the right rear portion of the tank turret. He operates the .50 caliber machine gun mounted in a small sub-turret, or cupola, located on top of the main turret. Inside the turret, he has a complex set of controls to carry out his tasks.

*This piece of equipment right here is a Tank Commander Override. And he can move the tank turret right, left, elevate the gun, depress the gun, fire the gun and do some lead if he's firing at a moving target. This piece of equipment is the night sight. It's an extension from the gunner's night sight so he can see exactly what the gunner's seeing at night or during the day because sometimes this sight works a lot better than your daylight sight. This piece of equipment here is a laser range finder and what it does is it sends a laser out, reflects off the target, comes back and that will give you your range. This piece of equipment here is your 50 caliber night sight passive elbow; this is your 50 caliber day sight. The passive elbow will gather the ambient light source and it gathers it and makes it that much more brighter. Whereas the thermal sight is based on temperature contrast. A human being is much more, has much more heat than a tree and at night, this system will basically take that and reflect it on, almost like a television screen in there and it's all done with electronics and it's very well defined and that's why the Army's gone now and said that this will be your primary sight from now on even during the day. [SFC Stroffoleno]*

The next crewman in seniority is the gunner. The gunner sits in front of the commander, and operates the main 105mm gun on the tank commander's instructions. He controls the elevation and traverse of the main gun, and operates its many other features including the stabilization system and laser range finder.

The stabilization system automatically compensates for rough terrain and motion, keeping the tank gun aimed precisely at a given point even during movement. Another innovation of the M60A3 is the laser range finder. In spite of the power of modern tank guns, the projectile drops several feet during the course of its flight due to gravity. By accurately determining the range to the target, the tank's ballistic computer can calculate how many degrees the gun must be elevated to compensate for gravity.

The third tanker in the turret is the loader, responsible for loading the main gun. The loader must combine strength and agility. Each of these rounds of ammunition weighs over 50 pounds. They must carefully be loaded into the breech of the gun, even when the tank is bouncing and crashing across rough terrain.

Isolated from the turret crew in the front of the hull is the driver. Driving a modern tank is surprisingly simple. But care must be taken as an M60 weighs over 60 tons and can reach speeds over 30 miles per hour.

The essence of tank tactics is teamwork. Every member of the crew must perform flawlessly for the tank to survive on the modern battlefield. The US Army expects that its tank crews will be able to get off three rounds of accurately aimed fire in the first 15 seconds of combat.

By the early 1970s, the M60 tank was being outclassed by newer Soviet tanks. A new tank entered development, the M1 Abrams. The lessons of the 1973 Mid East War suggested that more attention had to be paid to the threat of guided anti-tank missiles. The Abrams design placed protection of the crew as its primary goal.

Chobham armor, first developed in Britain, provided a major advance in defeating the missile threat. If the tank is penetrated by enemy fire, the greatest risk is posed by the tank's own ammunition. In the Abrams, the ammunition is positioned in a special compartment at the rear of the turret, separated from the crew compartment by special blast doors. If the ammunition is ignited by an enemy projectile, the explosion is vented upwards, away from the crew through blow-out panels. This once secret test footage is a remarkable demonstration of this feature. In spite of the conflagration in the rear of the turret, the blast doors protect the crew from the fire.

The other key aspect of the M1's design is its weapons system. The main gun itself is only one element of the overall weapon package. Tanks appear to be crude cast iron monsters. But their insides are crammed with high tech, solid state electronics designed to operate in the gritty environment of the modern battlefield. Previous generations of tanks had to stop to fire. The M1 and other modern tanks can fire on the move. The turret stabilization system keeps the gun aimed at the same point no matter how much the tank is jostled around by the rough terrain.

*The M1 is real effective with the stabilization system which is built in. Whereas on the older tanks, it took a lot of short halts where you had to stop, moves, stop move. Of course with the M1 you can continue to ride within 30-35 miles per hour and fire and get first round hits. [SGT Mosie]*

The first version of the Abrams, the M1, is armed with a 105mm gun. The newer M1A1 version has a more potent 120mm gun. The Abrams' advanced electronic gun fire control system gives it incredible accuracy at ranges over one mile. A muzzle reference system measures barrel warp caused by the heat of repeated firings. A wind sensor checks for crosswinds that would cause a projectile to go astray. A laser rangefinder accurately measures the distance to the target to within inches to ensure precise aiming.

The data from the tank's advanced sensors are rapidly absorbed by a ballistic computer with little attention from the gunner. The Canadian Army Trophy shoot was held every two years to test the abilities of NATO tank crewmen. In 1987, the M1 demonstrated the effectiveness of its advanced fire control system by beating all previous records for rapidly engaging and destroying its targets.

The advanced electronics are easier to use than the mechanical systems used in previous generations of tanks. Tank crews are now expected to hit their targets much more quickly, and with greater accuracy, than in the older generations of tanks.

Tanks of the new generation also have an advanced sighting system fitted with a thermal imager. The thermal imager senses the minute temperature differences between man-made objects like tanks, and the natural background. This enables them to locate and identify enemy tanks at night, or in the daytime when they are hidden by smoke or camouflage.

Although the Abrams is America's most famous tank, light tanks have been developed for the export market. One of the more successful has been the Cadillac Gage Stingray. The Stingray is armed with a 105mm gun, but it is more lightly armored than the Abrams. The Stingray combines light weight with impressive firepower.

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Since the birth of the tank in World War I, technological innovation has been a hallmark of French tanks. Let's take a look at why the French armoured force has been at the forefront of armoured technology.

Technological innovations in land warfare - the machine gun and rapid fire artillery - led to the unspeakable horror of trench warfare in World War I. Some far-sighted military officers realized that the best antidotes to these innovations were other technological innovations. Armour was needed to protect the soldier from enemy firepower. Mobility was needed to overcome the stalemate of trench warfare. And guns were needed to overpower enemy defenses. Both Britain and France came up with the idea of an armored trench crossing vehicle at about the same time. These are France's first tanks, the Schneider. However, Britain's land

battleships entered combat first at the battle at Cambrai in 1916. The premature use of British tanks warned the Germans of their potential.

The first French tanks, the Schneiders, entered combat several months after the first British tanks. By the time of the 1917 battle on the Chemin des Dames, the German artillery was ready for them. The results of the first French tank attacks were tragic.

General Estienne had foreseen this problem and was developing a new concept in tanks with the Renault automobile company. Instead of small numbers of large lumbering tanks like the Schneiders, Saint Chamond or the British tanks, he advocated large numbers of very small tanks, the Renault FT.

The FT pioneered the classic layout of all modern tanks. Its most significant innovation was the use of a fully traversing turret. The driver sat in the front of the vehicle, the commander in the turret, and the engine was in the rear. The Renault FT entered combat in 1918 and several thousand were manufactured. It was a highly successful design, and instrumental in the French victories of 1918. The Renault FT became the most widely used tank of the 1920's, also forming the basis of the early tank forces of the United States, Russia, Japan, and China.

In the 1920's, France continued to experiment with innovative tanks including massive breakthrough tanks such as this 70 ton monster. The Char 2C not only had a main gun turret in the front, but a small turret in the rear. There were even experiments with amphibious tanks. But it was the FT that still made up most of the French force through the early 1930s as there was little money for new tanks.

With the rise to power of Nazi Germany in the 1930s, the French Army was forced to re-arm to confront the threat. French commanders saw the need for two distinctly different types of tanks — a more modern version of the small Renault FT infantry tank, and a new, more powerful battle tank. The new infantry tanks were designed to accompany the foot soldiers at a snail's pace. The emphasis was on armor over mobility or firepower. These were to be the most numerous type of tank, built inexpensively in the thousands.

The new Char B battle tank was the most powerful tank of the 1930's far outstripping the tanks of Germany, Russia, or the United States. It was armed with an impressive array of weapons — a 75 mm gun mounted in the front hull, and a 47 mm anti-tank gun mounted in the turret. The 75mm gun was designed to destroy enemy fortifications such as the bunkers on Germany's Siegfried line. The 47mm cannon in the turret was powerful enough to destroy any other tank of its day.

A third major new tank type emerged in the French Army in the late 1930s, the Somua cavalry tank. This tank replaced the horsepower of traditional cavalry with the armor and motor power of the mechanized vehicle. In many ways, it was the best of the French tanks of the period. It was more maneuverable than the cumbersome Char B. And it was far better armed and more mobile than the inexpensive little infantry tanks.

When France and Germany went to war in 1940, the French Army seemed to hold the advantage. France had more tanks, and their technological qualities were much superior — better armour, better guns. But France was defeated in a campaign that shocked the world. The French weakness was doctrine, not technology. The German Army developed a method of mobile warfare, sometimes called blitzkrieg, which made best use of the strong points of tanks. The French doctrine, called methodical battle, could not cope with the German tactics.

French tank design remained influential even after the defeat. The American M3 Lee tank was patterned after the Char B1, with its main gun in the hull and an anti-tank gun in the turret. The layout and configuration of the Somua S.35 helped inspire the M4 Sherman tank, the mainstay of the United States' tank force during World War II.

The 1940 defeat did not signal the end of the French armoured force. The young commander of the 4th Armoured Division, Charles DeGaulle, re-established the Free French forces in Britain. The new French

armoured force was equipped with American armour: the M-4 Sherman tank, the M-10 tank destroyer, the M-8 Greyhound scout car.

In the years immediately after the war, the French Army relied on American armoured vehicles until French industries could be rebuilt. The M-47 Patton tank was the mainstay of the French tank force through much of the 1950's.

In the 1950's, French designers attempted to re-establish their reputation as innovators in armoured vehicle design. The most impressive and successful light tank of the 1950's was the AMX-13. The designers mated the powerful gun used on the wartime 45 ton German Panther tank on a much lighter 15 ton tank. To keep the tank small, the designers fitted it with an automatic loader for the gun. The AMX-13 was the first tank to use such a system, and they are only now becoming common on other tanks.

The first successful French battle tank of the post-war years was the AMX-30. The AMX-30 design pioneered the smooth bore tank gun. Conventional tank guns are rifled, imparting a spin to the projectile as it is fired down the tube. This presented a problem with new anti-tank munitions such as shaped charge rounds. The French designers were the first to surmount technical problems with smoothbore guns, resulting in the 105 mm gun on the AMX-30. In recent years, smoothbore guns have become standard on main battle tanks around the world, including the German Leopard II and the American M1A1 Abrams.

The AMX-30 still serves with the French tank force in an improved version, the AMX-30B2, which incorporates many new features including a highly effective thermal imaging night sight. The thermal sight allows the gunner to rapidly locate enemy tanks in complete darkness, or even when the target is obscured by smoke. Here we see what the tank gunner in the AMX-30B2 sees when he engages targets at night.

The AMX-30 has proven to be a versatile vehicle, suitable for other roles. A self-propelled artillery version has been built on the chassis, called the GCT-155mm. This vehicle substitutes a high powered 155mm artillery piece for the normal tank gun. The GCT's new gun can hit targets over 20 miles away.

During the Gulf crisis of 1991, the AMX-30 figured prominently in the fighting. The AMX-30 formed the basis of many tank units in the Gulf, including Saudi Arabian and Qatari tank units. During the January Iraqi offensive against the Saudi town of Khafji, Qatari units played a critical role in repulsing their attacks. The rapid and bloody riposte of this attack was the last offensive action by the Iraqi forces during the war.

In western Saudi Arabia, French troops of the Daguet force, prepared to assist the multi-national coalition in the liberation of Kuwait. Among the armoured units in Saudi Arabia was the 4th Dragoon Regiment, equipped with the AMX-30B2 tank. Here, the 4th Regiment conducts desert training maneuvers a few days before the Desert Storm offensive against Iraq.

The French role in the Desert Storm offensive was to serve as the left flank of the multi-national forces, rapidly sweeping north into Iraq. The French forces protected other Coalition units from Iraqi units located further to the north and west. The French objective was to capture the key airfields such as As Salman, and the eventual blocking of Iraqi routes of escape. The French mission was entirely successful. The 4th Regiment encountered Iraqi tank units on the outskirts of As Salman air base, and a short, but violent battle ensued.

While the AMX-30 proved to be more than capable of dealing with its Iraqi adversaries, by the 1990s, its design was a bit long in the tooth. It's armor was not up to the standard of the new American, British and German tanks. But a new design was already underway, the AMX Leclerc.

The AMX Leclerc is the latest and greatest of French tanks, entering service in 1991, nearly a decade after its recent counterparts, the Abrams and the German Leopard 2.

Its designers investigated a number of novel turret and gun configurations, finally settling on a conventional turret, but with many advances in the gun fire control system and a computerized system for command and control.

To incorporate advances in armor technology, the Leclerc is designed to use modular armor packages which can be replaced by updated packages when new technology is developed.

When the conceptual design was completed, the fabrication of test bed vehicles began. These are automotive test-bed prototypes, used to examine the engine and suspension. The turret is not fitted, and instead, special instrumentation is used in its place, to monitor the performance of the vehicle. Once problems are resolved, the production model begins to take shape.

Battle tanks are becoming increasingly computerized to assist their crew in combat. The Leclerc was the first tank to be built around a centralized digital electronics architecture. Its crews no longer communicate solely by voice over radio, but also exchange critical information through advanced data systems. With the assistance of advanced sensors, digitally obscured in this once-sensitive test footage, a digital on-board computer allows the Leclerc to communicate automatically with other tanks in the unit, and its headquarters. Each tank can send or receive digital data. For example, to receive its battle orders or other information, the Leclerc continuously sends data on its location to upper echelons making it possible for the headquarters to plan and conduct the battle, while getting the best use of each tank's capabilities.

The Leclerc has tremendous firepower and fighting capability. Its powerful 120mm gun is bolstered by a sophisticated autoloading system, allowing rapid firing even under hostile conditions. France pioneered the autoloader, and the Leclerc was the first western European main battle tank to include this feature. The autoloader allows the Leclerc to engage an enemy continuously, in all conditions, without demanding the attention of a crewman for reloading. The autoloader is not affected by the movement of the tank, and so it can be used without having to halt the vehicle. The Leclerc is also aided by a sophisticated fire control system, and an electric turret drive, which allows very precise stabilization and rapid accurate firepower.

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The calm of an early December morning along the inter-German border is disturbed by the growl of tank diesels. A German panzer battalion churns the fresh snow in a sleepy pine forest. From the woods appears a platoon of one of NATO's most modern battle tanks, the vaunted Leopard II. With the harvest gathered and the fields bare, the modern German Army, the Bundeswehr, exercises its armored shield.

Tanks were the spearhead of the German blitzkrieg in World War 2. The legendary Tiger and Panther were among the most powerful tanks to roam the European battlefields during the final years of the war. Today, they stand as silent reminders of the great armored clashes such as Kursk, Normandy and the Battle of the Bulge. Their place has been taken in the modern Bundeswehr by tanks of the Leopard family, the Leopard I and the Leopard 2.

The Leopard 1 was the first German tank built after the Second World War. It entered service with the Bundeswehr in 1965. Compared to its wartime antecedents, even the monstrous Royal Tiger, it is much better armed. The Leopard 1's main weapon is the standard NATO rifled 105mm gun. It is capable of hitting enemy tanks at ranges of over a mile and half. The Leopard 1 is considerably more mobile than the tanks of World War 2, with road speeds up to 35 miles per hour. This highly regarded design is the most widely distributed tank type in NATO service with over four thousand produced. The Leopard 1 also forms the basis for the Gepard, an anti-aircraft vehicle armed with a radar directed twin 35mm cannon system.

In the 1970s, the German Army began development of a new generation tank, called the Leopard 2. Though sharing a common name with its predecessor, the Leopard 2 is in fact a whole new design. Like the M1 Abrams and British Challenger, the Leopard 2 is protected by a thick hide of advanced armor. Its frontal area is nearly impervious to the deadly threat of anti-tank guided missiles.

A 120mm smoothbore gun forms the sharp teeth of the Leopard 2. This gun spits out a twenty pound metal dart projectile at speeds of over a mile per second. This same gun was later adopted on the American M1A1 Abrams tank. Precision is ensured by a laser rangefinder. To keep the gun pointed accurately during high speed travel, it is stabilized by a high performance system. The effectiveness of this sophisticated network of gun and sensors has been demonstrated time and time again by success at the Canadian Army Trophy shoot. This competition pits NATO's best tank crews against a challenging array of targets. Dutch and German Leopard 2 units have often emerged on top.

The Leopard 2's rough exterior appearance belies its internal complexity. The turret is manned by three crewmen. The loader is responsible for handling the tank's ammunition.

The gunner aims the 120mm gun and operates the sophisticated, computer-aided fire controls. The commander acquires targets and directs the rest of the crew in their duties.

In spite of the technical improvements of modern tanks, the life of a tank crewman is arduous. There is ammunition to be loaded. And there are a host of other chores to keep a sophisticated machine like the Leopard 2 in good operating condition. Tanks are expensive to operate in peacetime. A tank will wear out a set of tracks every two thousand miles and they cost over fifty thousand dollars for a new set.

Electronic simulators can help reduce the cost of training of tank crews by as much as 60 percent. The Leopard series uses a simulator to train new drivers. Driving a 65 ton tank at 40 miles per hour requires special skills. The simulator is linked to a scale terrain model, and the computer provides the trainee with a realistic image of the countryside. Future systems will use computer-generated images. Once the driver completes basic training on the simulator, he transfers to special training tanks for hands-on experience. Special training tanks reduce the wear and tear on actual combat tanks and are less expensive to operate.

The new generation of main battle tanks is the fastest on record. High combat speeds make the vehicles difficult to hit during fighting. The Leopard 2's fifteen hundred horsepower diesel engine gives the tank very high cross-country speeds, up to 45 miles per hour. Its torsion bar suspension dampens the jostling of rough terrain. Modern tanks are too heavy to be made amphibious, so rivers are a major obstruction to tank movement. To circumvent this problem, the Leopard tanks are designed to snorkel underwater. The crew seals the vehicle, and then employs a special tube device to provide air to the engine and crew.

If you travel along European highways in the autumn months, among the normal traffic along the route, you are likely to encounter hulking green battle tanks. With the harvest in, the tanks begin emerging from their lairs in the forest for their seasonal wargames. NATO wages its wargames through the winter months. The Blue Army and the Orange Army engage in mock combat, practicing for a war they hope will never come. Northern Germany was long home for the British Army of the Rhine, now relocated back to Britain. The mailed fist of the British forces for the past two decades has been their impressive pair of battle tanks, the Chieftain and Challenger.

Britain was the pioneer of tanks. The British Army introduced tanks to the battlefield in 1916 and has played an important role in their development ever since. The Chieftain is the older of the current pair of tanks, and was introduced into service in 1966. At the time of its initial deployment, the Chieftain was the most heavily armed and most heavily armored of all NATO main battle tanks. Most NATO tanks of the 1960s and 1970s were armed with a British designed 105mm gun. In contrast, the Chieftain was armed with a more potent 120mm gun. The Chieftain's design placed great stress on armored protection. The tank's turret was carefully contoured to take best advantage of its thick steel armor.

In the 1970s, a team of engineers at a British Army research center near Chobham, England developed a radically new type of tank armor. The new armor, was codenamed Burlington, but it has become better known as Chobham armor after the location of the research establishment which developed it. The new Challenger is the first British tank to incorporate this highly effective protection. The exact configuration of this armor remains a closely guarded secret, but it is believed to consist of complex layers of metal and advanced ceramics. It



makes tanks nearly invulnerable to frontal attack from deadly anti-tank guided missiles. Besides this enhanced protection, the Challenger is considerably more mobile than its predecessor, the Chieftain. It is powered by a 1200 horsepower Perkins Condor diesel engine which gives it speeds of up to 35 miles per hour. The advanced hydropneumatic suspension gives the tank a smooth ride even over obstructions and rough terrain. One of the most important advances in tank design over the past decade has been in gun fire controls which permit the tank to fire on the move. The heavily armored turret weighs 20 tons. Yet it must be moved with extreme precision to hit targets a mile or more away. These tests on a turntable provide the clearest example of this critical feature.

Currently entering service is a more advanced version of the Challenger, the Challenger 2, with even more sophisticated fire controls. The Challenger is supported by an armored repair and recovery version. This version is capable of recovering a bogged down or battle damaged tank, and its hydraulic crane can be used when carrying out engine repairs.

Britain has always played a prominent role in supplying tanks to armies overseas. But there are often restrictions on the export of the latest tank design due to highly secret technologies involved. Also, many armies in the developing world cannot afford the highly complex and expensive tanks adopted by NATO and desire a less elaborate tank. So besides manufacturing the Challenger for the British Army, Vickers Defense Systems has also designed tanks specifically for export. The Vickers Mark 7 is an example of British-German industrial cooperation, with a Vickers designed turret and Leopard 2 hull supplied from Germany. The Vickers Mark 7 has advanced solid state fire controls, capable of hitting moving targets at long ranges.

The Vickers Mark 3 is the latest evolution of the Vickers Main Battle Tank. Earlier versions serve in the armies of India, Kuwait, Kenya and Nigeria. Some armies desire a lighter and more mobile tank with less armor protection but a high level of firepower. This has led to an interesting British-American venture, the VFM 5 light tank, with a Vickers turret and an FMC hull. Although weighing under 30 tons, it is armed with a 105mm gun.

Britain's strong traditions in modern tank design have provided NATO with critical technological breakthroughs, such as the very effective Chobham armor, a tradition likely to endure for years to come.

The battle tank is an awesome combination of firepower, armored protection, and cross-country mobility. The tank remains the central element in all major armies, from the hot desert sands of Arabia to the snow covered plains of Central Europe. For the foreseeable future, the main battle tank will provide the heavy metal for all modern armies.

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