



REASONS TO IMPROVE: THE EVOLUTION OF THE US TANK FROM 1945-1991



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Although in most cases we have retained the Author's original spelling and grammar to authentically reproduce the work of the Author and the original intent of such material, some additional notes and clarifications have been added for the modern reader's benefit.

We have also made every effort to include all maps and illustrations of the original edition the limitations of formatting do not allow of including larger maps we will upload as many of these maps as possible.

**Reasons to Improve: The Evolution of the U.S. Tank from
1945-1991**

by

Major Anthony I Bailey United States Army

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Abstract

The American primary tank in the Second World War was inferior to its German counterpart for a but the final months of the war. The U.S. tank evolved and demonstrated its superiority to the world Operation DESERT STORM in 1991. This monograph examines the evolution of America's primary tank in the years between 1945 and 1991 focusing on three periods: the Second World War, the Korean War, and the 1973 Arab Israeli War. Each period examines the adversary, America's industrial capabilities, and the combat environment. Describing the adversary highlights there is a tangible threat to U.S. armored forces. In the face of this threat, the United States remained capable of building new more complicated and more expensive tanks, which demonstrates the industrial endowment required to meet the demands of the threat. An examination of the combat environment reveals why the U.S. Army and its armor force seemed so fixated on Europe as the next war's first battlefield.

Ultimately, this paper serves to demonstrate that a tank series, such as the M1 Abrams family, is a required component in the U.S. Army's combined arms arsenal. As such, it is important that the aging Abrams, having served the Army in Operation Desert Storm and the Global War on Terror, continue to evolve in preparation for the next war.

Introduction

The U.S. Army's first armored encounter against Germany during the Second World War in North Africa was disastrous. During the winter of 1942, Allied forces landed in Algeria for Operation TORCH.^[1] The American 1st Armored Division maneuvered across the Algerian desert and east into Tunisia racing southwest to seize the vital Tunisian mountain passes which the Germans would contest.^[2] The 1st Armored Division, one of America's premier units, was fully equipped with the M2 Lee and M3/5 Stuart light tanks from the 1930s, and a few of the new M4 Sherman tanks. In January 1943, a Sherman tank platoon from Combat Command B operating near Kasserine Pass in Tunisia attacked Nazi armor to relieve a friendly unit under fire. The platoon rushed into contact, immediately exchanging fire with the enemy. The German tanks withdrew and the Sherman platoon pursued them. Unfortunately, the German Panzers were merely maneuvering to superior defensive positions. The M4s charged directly into an ambush—annihilating the American five-tank platoon in minutes. German tanks and veteran crews outclassed the Americans in terms of gunnery, armor protection, and tactics. Regrettably, for the Americans, their first lesson in armored combat against the enemy was deadly.^[3]

Almost fifty years later, American armored forces deployed for a different conflict in the desert. It was a pitch-black night on February 26, 1991. The 1st Battalion, 37th Armored Regiment, as part of the 3rd Brigade, 1st Armored Division was in the Middle East to expel Saddam Hussein's forces from Kuwait. The battalion maneuvered into the Iraqi desert, approximately twenty miles north from the Kuwaiti border, preparing to attack. An American tank platoon sergeant from Delta Company complained that he could not see more than twenty feet in any direction.^[4] The company commander radioed to load sabot and hold fire.^[5] The platoon of M1A1 tanks slowly advanced in line formation across the undulating desert as part of the battalion attack on an Iraqi armored unit.^[6] The targeted Iraqi mechanized brigade was one of Saddam Hussein's highly trained units, the Tawakalna Mechanized Division. The brigade was located on the northern end of the division's defensive belt. Aided by night vision devices, the American tank gunners identified Iraqi targets in their sights. The 1/37 Armor Battalion commander ordered his Soldiers to open fire. The opening salvo destroyed several Iraqi tanks and armored personnel carriers. As the American battalion made their way across the desert, slowing near the crest of a ridgeline to adjust their formation, M1A1s lurched forward over the ridgeline and into more Iraqi tanks and personnel carriers. The proximity of the Iraqis negated the Abrams superior range capabilities rendering the Americans vulnerable.^[7] The Iraqis fought hard in short-range tank-on-tank engagement, scoring hits on American tanks, but none lethal.^[8] By midnight the Iraqi defenders along with most of their vehicles were devastated. American forces came out of the battle with minimal damage and four disabled M1A1 tanks.^[9] During the Second World War, there were deficiencies in training, equipment, and experience, however, the U.S. Army's armored

performance in Operation DESERT STORM was exceptional.^{10} proving the M1 Abrams and the crews excellent. These vignettes demonstrate how American armored capabilities evolved over fifty years.

This successful U.S. armor evolution shows distinct improvement in mobility, firepower, and armor protection. In November and December of 1942, the United States sent its armored force with the new Sherman tank, to fight the Axis armies in Africa. The first encounters between American and German armored forces substantiate American armor shortcomings, as reflected in battle losses, and highlight German armor strengths.^{11} Comparatively the German tanks possessed good mobility, armor protection, and firepower; the American tanks possessed only good mobility. Nearly five decades later, the United States sent its armored force to oust Saddam Hussein's military from Kuwait by confronting his veteran, Soviet-organized, Iraqi army in the Middle East. The encounters between American and Iraqi forces resulting in overwhelming American victories demonstrated the United States' armored strengths. In 1991, American tanks possessed excellent mobility, firepower, and armor protection revealing a fifty-year transformation from an inexperienced force into a superbly trained and proficient one.^{12}

Many events transpired between Operation TORCH in 1942 and Operation DESERT STORM in 1991. They necessitated the transformation of the U.S. Army's tank. Three significant periods in particular affected that progression: the Second World War, the Korean War, and the 1973 Yom Kippur War. The years between 1941 and 1945 are significant in American tank development because they witnessed the improvement of Sherman tank models and, ultimately, introduced a new heavy tank in 1945, the M26 Pershing. The Pershing was comparable to German Panther and Tiger tanks in armor and firepower. The Korean War experience did two things. First, it ushered in the era of limited war when President Harry Truman refused to allow General Douglas MacArthur's request to expand the Korean War into China.^{13} Second, the Korean War energized American research and development budgets improving the atrophied, post Second World War ground forces.^{14} The relevance became clear when the Korean War compelled a conventional military response over that of an atomic one. The U.S. military, and its armored force, was not prepared for a conventional fight. The third significant event, the Arab-Israeli wars, provided the world with a model of the fight predicted to occur in Europe. The Arab-Israeli wars included weapons like American-donated tanks to Israel and Soviet-donated tanks and training to Arab countries such as Egypt, Syria, and Jordan. The 1973 Yom Kippur War included the effective use of anti-tank guided missiles that posed a clear threat to all armored forces on the battlefield. These events form three distinct backdrops from which to shape an answer to the following question: What caused the evolution of the Army's primary tank from the Sherman used in the Second World War to the M1 series Abrams tank that superbly performed in Operation DESERT STORM?

The hypothesis of this monograph is the evolution of the Army's primary tank of the Second World War into today's main battle tank resulted from assessments of the adversary, American industrial capacity, and the combat environment. The adversary refers to the overall enemy of the period, but focuses on armored combat formations considering a tank was determined the best anti-tank weapon.^[15] Discussions throughout the monograph center on enemy tanks and anti-tank systems. The discussion on American industrial capacity is intentionally limited to the nation's ability to manufacture military items, such as tanks. The combat environment refers to the physical environment including terrain, weather, and urban areas affecting the adversary's capabilities and altering the way forces interact in the attempt to defeat one another.^[16]

Defining other commonly used words make the subsequent case studies easier to understand. The words: tank, armor, firepower, mobility, and armored protection appear throughout the monograph. The U.S. Army provided a simple definition of the terms "tank" and "armor" in 1949 and it remains accurate today:

"A full track[ed], armored, fighting vehicle, mounting a major weapon and machine guns, capable of maneuvering both individually and in formation against the enemy. The generic term 'armor' embraces not only the tank and reconnaissance units of the armored cavalry, but also the armored infantry, armored artillery, armored engineers and the service support units required to form an integrated and a balanced fighting force, the nucleus of which is tanks."^[17]

Lessons from the Second World War resulted in a desire to base conventional forces on offensive capabilities from armored formations. The tank provided those capabilities in terms of firepower, armored protection, and mobility.

The term firepower refers to the measure of a tank's main gun destructive capacity. Mobility refers to the measure of movement, both on and off road, and agility afforded a tank from its engine and transmission. An agile tank with longer range is preferred. Armored protection refers to the measure of protection provided to the tank and its crew; more is better. However a heavily armored tank tends to be slow. A slow tank does not provide the mobility, speed, and shock that armored forces must bring to bear against an enemy. For instance, a light tank with a small gun will be very fast, but cannot destroy a heavier armored threat. The dilemma for tank designers remains producing a tank that best combines firepower, mobility, and armored protection through a practical process. The following three case studies evaluate the key events from the Second World War to Operation DESERT STORM appraising the adversary, American industry and the combat environment to answer the research question about causes of the evolution of U.S. tanks and results in implications of further tank evolution beyond current operations in support of the Global War on Terrorism.

The Second World War

German tank superiority forced the United States to evolve tank design during the Second World War. Germany had been at war since 1939 and its armies included armored forces centered on the tank. Although employed during the early stages of the war, Germany replaced its light tanks to provide the armored forces more combat power.^{18} Germany developed powerful tanks such as the Panther and Tiger models before the United States entered the war. These tanks, particularly the Panther tank, possessed a good balance of firepower, mobility, and armor protection in comparison to the American primary tank, the M4 Sherman.

Although disadvantaged in armored capabilities, the United States enjoyed a robust industrial capacity that enabled a triumph over Axis forces.^{19} It was no accident that America possessed such capacity during the war. The United States increased industrial capabilities prior to its entrance in the war as military production increased assisting other armies fighting Germany.^{20} The combat environment through which the United States had to fight was almost worldwide since the Axis threat spread across the globe. President Roosevelt understood the demands of joining a fight that would have American armed forces engaged in combat around the world. Battle experience taught the Army what to develop in tanks and armored forces and America's robust industry produced the newly developed tanks.

Adversary

German armored firepower during the Second World War was superior to the United States in one-on-one tank comparison. A 1948 report to the Director of the Second Command Class at Fort Leavenworth recorded common experiences of armored crewmen in combat against German forces throughout the Second World War. The report's author, Colonel H.L. Hillyard, highlights some of those events from 1942 through 1944. One observation described 88-mm. guns destroying or disabling the lead five tanks of G Company, 67th Armored Regiment in Tunisia in December 1942. The Germans were approximately 2000 yards away.^{21} In July 1943, a Tiger tank near Gela, Sicily quickly destroyed four tanks and hit a fifth from G Company, 67th Armored Regiment.^{22} During another engagement in France 1944, a German tank fired seven rounds from a distance of 1500 yards and destroyed five American tanks of the 66th Armored Regiment.^{23} Throughout most of the war German tanks and anti-tank guns regularly engaged U.S. tanks faster and from greater distances putting American tankers at a disadvantage. The Germans reaped the benefits of their weapon system's technical advantages such as muzzle caliber and round velocity.^{24}

In terms of tank main guns, the larger the caliber, the more destructive the round's potential. The German Army experimented with that concept throughout the war years. The best German tanks, the Panther and Tiger, had 75-mm. and 88-mm. main guns.^{25} The German Army entered the Second

World War with the *Panzerkampfwagen I* tank. This weapon system possessed machine guns as its primary weapon and that tank evolved throughout the war.^{26} The *Panzerkampfwagen II* mounted a 20-mm. main gun.^{27} Follow-on models incrementally increased the main gun size from 37-mm. to 50-mm. before manufacturing the 75-mm. and 88 mm. guns.^{28} Additionally, the Germans experimented with 128-mm. main guns mounted on enormous tanks but the most efficient main gun appeared on the Tiger and Panther tanks.^{29}

High velocity ammunition provided advantages in potential armor penetration. If two tank rounds of the same caliber are fired at an armored target, the round with a higher velocity will penetrate more armor than the round with lower velocity. In armored combat, high caliber guns that fire high-velocity ammunition are better than equivalent-sized guns of lower velocity. German 75-mm. guns could shoot high velocity ammunition at approximately 2600 feet per second as compared to the Allied equivalent ammunition that traversed just over 2000 feet per second.^{30} German 88-mm. guns could shoot ammunition approximately 2650 feet per second.^{31} Both the German 75-mm. and 88-mm. guns could fire ammunition at higher velocity than American tank rounds, allowing longer range and armor penetration. That ability provided the Germans an advantage over the United States in tank firepower.

The disadvantage to the United States meant Sherman tanks, with lower velocity ammunition and reduced effective range, required maneuvering well into German tank ranges before the Sherman could threaten enemy tanks. At times, it required American tank commanders maneuvering within five hundred meters to penetrate enough armor to destroy enemy tanks.^{32} The German adversary in the form of Panther and Tiger tanks retained a significant advantage over the U.S. Sherman tank because of its armored protection. Myriad German advantages fed into the U.S. Army desire to develop a better tank to better contend with German forces.

Industry

The United States moved to full industrial mobilization during the Second World War.^{33} There are many indicators supporting this fact. Increased military production is one such indicator. Another indicator is the massive effort made to enlarge the physical size of the American industrial base, an effort that was also potentially costly. Yet another, and more subtle indicator, was pre-war industrial growth that America conducted to assist her yet undeclared British and Soviet allies. Although there is no significant debate challenging America's industrial growth during the Second World War, the following illustrates the extent of America's wartime mobilization. Acknowledging the extent of American military production potential exemplifies that the United States possessed the industrial capacity to simultaneously produce arms and equipment for an ongoing war and retain the production latitude to build improved tanks for later in the war.

The United States increased military production almost two years prior to entering the war

December 1941.^{34} Industrial capacity in the United States increased as early as 1940 to produce equipment and supplies primarily for Great Britain. This two-year advantage in the mobilization process allowed the U.S. Government to mobilize from a peacetime to wartime setting faster than otherwise could.^{35}

“In short, he [President Roosevelt] proposed that America become ‘the arsenal of democracy.’ The job placed before Congress was to provide the country with a law that would meet the situation in spirit and in fact. It required an epoch making decision on policy and the setting up of machinery to provide the needed help in ships, planes, tanks, guns, food, and other supplies.”^{36}

Subsequently, the U.S. Congress made Lend Lease into law on March 11, 1941.^{37} Other recipients of the Lend Lease equipment included the Soviet Union, France, Italy, and China.^{38} Despite the disadvantages in training and experience, the United States entered the Second World War with its industrial capacity already gearing for total military production allowing America to mass-produce the weapons and tanks needed to destroy the Axis armies.

The gross national product from 1941 through 1944 expanded from eleven to forty-five percent.^{39} This figure reflects the expansion within the American industrial base to accommodate the demands required to support the war effort.^{40} The creation of the War Production Board reflected the U.S. Government’s desire to expand its ability to mass-produce war equipment. The Board identified problem areas, such as labor, throughout the years it met and used its authority to mitigate the problems before they became catastrophic.^{41} In March 1942, the board identified the dwindling numbers of skilled laborers that were lost to the growing military. The War Production Board implemented a plan to train less skilled workers to assume the duties of the skilled labor party.^{42} The growth of the American industrial capacity, as evidenced by the expanded gross national product, and industrial oversight, as evidenced by the War Production Board, led to the armored force success in evolving tanks as the need arose.

The U.S. Government built 1600 new industrial plants and expanded others costing nineteen billion dollars.^{43} The increase of America’s industrial capabilities demonstrated the nation’s resolve for winning the war. This expansion of the industrial complex enabled the mass production of Sherman tanks in addition to thousands of other vehicles, airplanes, equipment, and ammunition. Although in one on one comparison to German heavy tanks, the Sherman was inferior, American industry produced almost 60,000 Sherman tanks throughout the war.^{44} Rarely would the Sherman face the Panther or Tiger in a one on one situation. That is not to say that industry alone guarantees a national victory, but it certainly helps. Expanded industrial capacity placed the United States in a position of advantage over Germany throughout the war. That advantage allowed the Army to produce critical munitions and material while retaining capacity to evolve tanks.

Combat Environment

The combat environment demanded a tank that could handle the physical stresses of a variety of theaters around the world. Tanks were expected to function in climates that were hot, cold, wet, and dry. It was feasible to deploy and fight in one theater one month, only to redeploy to a different theater with its own unique environmental challenges several weeks or months later. The combat environment is also more than just the physical surroundings; it also includes interaction with the adversary. The following examination of the combat environment highlights the challenges that American tank designers must embrace while striving to evolve the tank.

American tanks fought German armor in Africa and across Europe in varying terrain that demanded mechanical reliability.^{45} However, building a reliable tank for a number of extreme environmental conditions can be very difficult. The physical environment of each of the geographic areas where American tanks fought provided unique challenges. Algeria and Tunisia included desert environments that exposed tanks and men to hot, rocky, and extremely dry conditions that wreaked havoc on the armored vehicles. Harsh environments make it difficult to maintain tanks that require pure, uncontaminated petroleum, oils, and lubricants to function. The M4A3 Medium Tank technical manual called for constant inspections while the tank is in operation. It specified mechanical checks before, during, and after operation to prevent any damage that may result in the tank breaking down.^{46}

Other areas of operation included different environmental conditions. Moisture and salt from the Mediterranean Sea characterize the Italian environment; exposure to this is extremely damaging to tanks. Italy's terrain offered a variety of high mountain roads and passes as well as lowland swamps and canals often considered unsuitable for tank combat maneuvers.^{47} American tank crews learned how to maneuver their tanks through "unsuitable" terrain but not without putting stress on the tank's mechanical abilities.^{48}

The European environment proved much more temperate, but harsh winters burdened tanks and especially their crews. The same petroleum, oils, and lubricants that fail when contaminated with dust and dirt performed very differently at near freezing temperatures. Despite the potential extremes of the physical environment, the enemy added additional complexities that further specify the combat environment.

The primary German threat in the combat environment included ground-based, direct-fire systems.^{49} Germany started the war with the ability to fight in combined arms fashion consisting of air and land combat systems. As the war progressed, Germany lost their ability to wage war from the air; the Allies gained air superiority and the *Luftwaffe* became a defensive arm. The German dive bombers that bombed Polish units in 1939 were much less threatening to American tanks during 1944 and 1945 because Allied air coverage disrupted what was left of those formations.^{50} Mass

artillery fires provided by American artillery units surpassed German artillery capabilities. Early in the war, Germany's combined arms approach allowed their formations to use direct and indirect fire from both air and ground platforms. Later in the war, the German threat was primarily ground based and from direct fire weapon systems. It made sense for American tank designers to focus on attaining greater firepower and armored protection because therein laid the immediate threat.

American tank designers, with an understanding of the combat environment through after-action reports, continually improved the Sherman tank throughout the war. In fact, the Sherman tank went through nineteen variations, which accounted for improvements in size, shape, armor, main gun internal configuration, as well as in its engine.^{51} Although each variant of the Sherman tank improved upon the other, the tank ultimately never possessed the proper combination of firepower and armored protection to oppose individual Panther or Tiger tanks. It took an entirely new tank to stand, toe to toe against German tanks.

The M26 Pershing

That new tank, the M26 Pershing, arrived in 1945 in Germany where it hunted German Panther and Tiger tanks.^{52} The Pershing possessed a 90-mm. main gun capable of shooting high velocity armor piercing ammunition. The Pershing held seventy main gun rounds, five hundred fifty .50-caliber heavy machine gun rounds, and five thousand .30-caliber light machine gun rounds.^{53} The main gun ammunition traveled 2800 feet per second, meaning that a Pershing tank firing a sabot round penetrated approximately five inches of armor at 500 meters, four and a half inches of armor at 1000 meters, and just under four inches of armor at 2000 meters.^{54} The M26 weighed only forty-six tons, was lighter than its German counterparts, and boasted frontal armor greater than four inches thick, almost twice that of a Sherman tank. A 500 horsepower Ford V-8 engine powered the Pershing up to thirty miles per hour.^{55} However, the engine, similar to that used in the thirty-five ton Sherman tank, left the Pershing underpowered. In terms of firepower, the M26 Pershing was America's answer to the German heavy tanks.

Summary

The Second World War provided the U.S. Army the impetus to improve its primary tank because of the lethality of German armor. American industrial power supported the country and its Allies, and preserved the ability to develop the tank. The Sherman tank continuously improved throughout the war but it was never able to compete with the best armor Germany produced. The American Army Branch and the Ordnance Department worked together to develop a new tank resulting in the M26 Pershing.^{56} The Pershing possessed the firepower capable of destroying German armor at reasonable ranges and included armor protection that equaled that of the Tiger tank. However, what the M26 gained in firepower and armored protection, it sacrificed in engine power. Despite these shortfalls, the

Pershing was good enough to see the surrender of Germany and the end of the Second World War.^{57}

The Korean War

The Korean War highlighted the strengths and deficiencies of the M26 and created an opportunity to improve the tank. The United States possessing a monopoly in atomic weapons reduced industrial war production. Not only did the war-making industries shrink, but so too did the military forces. The actual strength of the 1950 Army was 40,000 men less than the authorized strength. Finances and plans early in 1950 urged further reductions of 20,000 men.^{58} The reduction in force affected the 8th Army in Japan because the priority of replacements went first to Europe.^{59} Early American defeats in the Korean War, such as that of Task Force Smith, caused President Truman to recognize the obligation to bolster military strength.^{60} Although initially lacking, American armor performance in Korea demonstrated the M26s strengths in firepower and weaknesses in mechanical reliability. The United States planned to correct conventional military weakness using legislation to re-mobilize industry and to reverse the post Second World War downsizing in an effort to stem the North Korean invaders.^{61}

Adversary

In the late 1940s the Soviet Union trained, armed, and equipped the North Korean People's Army with modern weaponry including the T34/85 medium tank. The North Korean Army grew stronger than the American-backed South Korean Army, which was a light infantry force. In an effort to unify the Korean peninsula under Communist rule, the North Korean Army invaded South Korea in June 1950. Massive amounts of artillery and the T34/85 tank led the invasion.^{62}

Armed with a 76-mm. main gun, the T34/76 of the Second World War evolved into the T34/85 through internal upgrades to the fire control system and an improved 85-mm. gun.^{63} The T34/85 secondary armament included two 7.62-mm. machine guns, one in the hull and the other coaxial mounted next to the main gun.^{64} The tank weighed just over thirty-one tons and possessed sloped frontal armor near three and one half inches thick.^{65} A 512 horsepower V-12 diesel engine powered the tank enabling speeds over thirty miles per hour.^{66} Comparatively the T34/85 neared the German Panther tank's capabilities in terms of firepower, armor protection, and mobility.

The T34/85 proved more than a match for the South Korean Army, which possessed no tanks and only ineffective bazooka anti-tank weapons. The T34/85 also proved adept in countering the United States Army's M24 light tanks that deployed from Japan.^{67} The T34/85 in North Korean hands proved devastating in the Korean War until the United States could adequately respond. That response included close air support from Japan, 3.5in bazookas and the Pershing family of tanks, most of which had to be refurbished and deployed from the United States. Just as the Pershing proved lethal against German Panther and Tiger tanks, in Korea, they were just as were lethal against the T34/85.

Despite sufficient firepower, the Pershing had mechanical issues that made it difficult to maintain operational readiness within armored units. In fact, there was an ongoing M26 upgrade program addressing the underpowered engine and transmission.^{68} The M26 had an inefficient drive train and power plant given the weight of the vehicle, which the upgrades resolved.^{69} The new engine increased the horsepower by approximately forty percent and was smaller thus providing an upgrade of the transmission.^{70} The upgrade program also installed improvements on the 90-mm. gun adding a bore evacuator as well as modernizing the fire control system, making it more efficient.^{71} The improvements altered the M26 enough that it was ultimately re-designated the M46 Patton tank. The M46, like the M26, was effective in combat against the T34/85. The Korean War experience highlighted the strength of firepower in the M26 and its weakness in mobility that served to speed the evolution of America's tank.

Industry

In 1950, the U.S. industrial manufacturers were not prepared for war. Machine tool capacity in 1950 was approximately one third of the Second World War capacity.^{72} The reduction in the capacity decreased the wartime industrial capacity of the United States in the years between 1945 and 1950.^{73} The reduced wartime industrial capacity allowed the military to atrophy into a depleted organization incapable of responding to emergencies other than those that required the use of atomic or hydrogen bombs. Professionals, strategists, and the national leadership recognized the degradation of national security capabilities by the Korean War and enacted legislation increasing military budget and war industry production.^{74}

The National Security Council Report number 68 identified the necessity to —“make ourselves strong,” through the development of military and economic strength.^{75} This report identified a number of shortcomings within the nation's defense policies such as poor coordination between the military and civilian manufacturers.^{76} More than simply improving the nation's military and economic power, the U.S. Government created governing agencies to supervise the strengthening of industry and the military. Although the post Second World War era demonstrated a downsizing and weakening of the American military and industrial power, the national command authority identified these shortcomings and established measures to mitigate them. What legislation could not do, the Korean War experience accomplished, showing the need to more rapidly evolve the flawed Pershing tank.

The Defense Production Act of 1950 aimed at developing and maintaining military and economic strength allowed the United States to “oppose aggression and promote peace” with minimal strain on the civilian economy.^{77} The Defense Production Act had three sections and each section had provisions to support industrial war production. The first section authorized the President to require businesses

fulfill national defense orders. The next section established regulatory mechanisms to fulfill the intent of the Defense Production Act. The last section authorized Presidential control of the civilian economy to make available any scarce or critical materials. The greatest benefit gained through the passage of this act occurred after the Korean War in that the Act required industry to maintain a constant and enduring level of war production, in order to provide for strengthened military. This was known as limited mobilization.^{78}

The Office of Defense Mobilization managed the stated objectives of the Defense Production Act of 1950.^{79} That office possessed a number of powers to mobilize civilians, as well as various industries and government agencies to meet any national security demands in a crisis.^{80} In response to the Korean War, President Truman requested the expansion of the armed forces and an expansion of defense spending. Truman also appointed a mobilization director charged with managing the breadth of war production on behalf of the President.^{81} The level of legislative foresight allowed military production to meet the needs of the Korean War as well as to maintain the armed forces after the war. This program provided finances giving tank designers resources that allowed faster tank evolution than that which occurred after the Second World War.^{82}

The Combat Environment

Europe provided the basis on which tank designers deduced future combat conditions because the Soviet Union constantly strengthened itself and the militaries of Soviet Bloc countries after the Second World War.^{83} American strategists derived certain goals in response to the Soviet Union and the National Security Council elaborated them in April 1950.^{84} It became alarmingly clear that the ultimate security of the United States rested in the defense of Europe.^{85} The resultant focus on Europe as the next major battleground in a future conflict played an enduring role in the development of the American main battle tank. Designers produced a tank that could defeat the Soviet Union in Europe to prevent an attack on American soil.

United States objectives and programs for national security, as addressed in National Security Council 68 in April 1950, specified the fears of Soviet expansion westward through Europe by stating

“Two complex sets of factors have now basically altered this historic distribution of power. First, the defeat of Germany and Japan and the decline of the British and French Empires have interacted with the development of the United States and the Soviet Union in such a way that power increasingly gravitated to these two centers. Second, the Soviet Union, unlike previous aspirants to hegemony, is animated by a new fanatic faith, antithetical to our own, and seeks to impose its absolute authority over the rest of the world. Conflict has, therefore, become endemic and is waged, on the part of the Soviet Union, by violent or non-violent methods in accordance with the dictates of expediency. With the development of increasingly terrifying weapons of mass destruction, every individual faces the ever-present possibility of annihilation should the conflict enter the phase of total war.”^{86}

The document goes on to identify the goals of the Soviet Union to first overrun Europe, then defeat Britain through air attacks, and finally to attack the United States through a choice of atomic

conventional weapons.^[87] Armed with this understanding of Soviet intentions and observing the strengthening of Soviet Bloc countries, it is easy to see why American politicians and strategists clung to the forecast of a European battlefield. That is why American tank designers focused on conceiving a tank to win on European soil.

American analysts, aware of Soviet military organization from the Second World War, knew the Soviet Union was organized and equipped to use direct and indirect fires delivered from both ground and air platforms.^[88] American tanks required a reasonable chance of survival under those three conditions meaning that armored formations must withstand the effects of direct and indirect fire while remaining combat effective.^[89] American intelligence on the composition of Soviet forces was predicated on both clandestine and open source observation.^[90] The observation primarily occurred through Soviet military parades and through proxy armies. The North Korean and Chinese armies were equipped with arms from the Soviet Union, including tanks. However, American strategists could predict to a reasonable degree of certainty the composition of the Soviet forces. Tank designers predicted that Soviet forces were more numerous and their tank capabilities at least equivalent to the United States.^[91] Given the future European battlefield, future tanks were designed for that combat environment.

Designers evaluated environmental conditions against Soviet capabilities to produce a viable tank. Knowing the physical environment of Europe, particularly central Germany, and the assumed capabilities of the Soviet Union allowed tank designers a standard against which to make tank improvements. Tank designers developed tanks that could handle four seasons, both hot and cold temperatures in wet and dry conditions throughout a year. Tanks had to be able to ford the rivers and streams found in the European countryside in the event of destroyed bridges. Other considerations for tank design included the necessity for cross-country maneuver and the desired ability to have long cruising ranges before requiring refuel. The ability to operate long times between refuel enhanced the tanks overall mobility which lends itself to exploitation in the offense. The M48 Patton tank resulted from such a design process but was hurried by experiences from the Soviet backed Korean War.

The M48 Patton

The M48 maintained the 90-mm. gun from its predecessors, and it incorporated a more powerful engine and transmission yielding better mobility and agility.^[92] It retained the .50-caliber heavy machine gun on top of the turret but included only one .30-caliber machine gun, coaxially mounted next to the main gun. The fifth crewman and the second .30-caliber, hull mounted in previous models was gone. The M48 carried sixty main gun rounds, five hundred .50-caliber rounds, and fifty-nine hundred .30-caliber rounds. The tank weighed forty-eight tons with over four inches of rounded front armor. A Continental twelve-cylinder engine powered the tank with 704 horsepower achieving a top

speed near thirty miles per hour.^{93} The first M48 Patton tank rolled off Chrysler's Delaware Tank Plant and was christened by Mrs. George S. Patton Jr. in 1952.^{94} The M48 Patton tank replaced both the M26 and M46 as the U.S. main battle tank through the early years of the Cold War.^{95} The Army recognized the M48 as superior to its predecessors. The Army also recognized that the M48 was rushed into service because of the Korean War experience and tank evolution continued.

The M60 Patton

The M60 Patton tank is the product of a more methodical evolution process that was not rushed by immediate combat requirements like the M48 during the Korean War. The M60, maintaining the M48 turret and hull assembly mounted a new high velocity 105-mm. main gun and possessed a General Motors twelve-cylinder air-cooled engine.^{96} The 750 horsepower power plant rendered a top speed near thirty miles per hour.^{97} Secondary weapon systems on the fifty-five ton tank included a .50-caliber heavy machine gun and a 7.62-mm. coaxially mounted light machine gun.^{98} The new Patton carried fifty-seven main gun rounds, nine-hundred .50-caliber rounds, and six thousand light machine gun rounds.^{99} The M60 also incorporated night vision equipment and a nuclear, biological and chemical protective system.^{100} Subsequent models, the M60A1 and A2 weighed almost sixty tons and included a larger turret, additional main gun ammunition, and a main gun stabilizer.^{101} The M60A2 was capable of firing missiles as well as standard ammunition.^{102}

Summary

The Soviet threat to Western European countries and the United States after the Second World War permeated the American system. That Soviet threat was both conventional and atomic in nature. Specifics of the conventional threat were often unclear, but occasionally some specifics could be determined. For instance, tank designers agreed that the Soviet Union in the 1950s could deploy a modern mechanized army that both fought in combined arms fashion and was lethal from both ground and air.^{103} The threat provided by this capable military force gave reason for another evolution of the tank. Tank evolution also required money and a vigorous industrial capacity to produce the new tanks. The demobilization of American post-war industry greatly reduced the ability of the United States to maintain and manufacture new tanks. The Communist invasion of South Korea highlighted the problem and corrected it through legislation.^{104} The Soviet threat, primarily observed in Europe, spread across the globe and into Korea. The industrial growth following the Korean War sped the evolution of the M26/46 tanks into the M48 Patton. Years of peace would witness continued tank evolution resulting in the M60, M60A1 and M60A2 tanks.

The United States' assessment of captured material and tanks from the Yom Kippur War resulted in yet another iteration of American tank evolution.^{105} The assessment identified a distinct and evolved threat on the armored battlefield in the form of both anti-tank guided missiles and a new Soviet main battle tank. The United States required the strength of industry in order to neutralize this threat. In contrast to the military industrial inactivity at the beginning of the Korean War, American military industry in the 1970's was very active. The unimpeded access to captured and destroyed Soviet equipment after the Yom Kippur War in 1973 provided numerous benefits for the military community in the struggle to contain the Soviet Union throughout the world. The combat environment witnessed in Israel and the Sinai Desert provided specific information tank designers needed for the continued evolution of the main battle tank.

Adversary

The battlefield introduction of anti-tank guided missiles and the T62 main battle tank altered the way Western armies planned to fight the Soviet Union in Europe.^{106} There were several anti-tank weapons used on the Israeli battlefield including rocket-propelled grenades, and a family of anti-tank guided missiles. Both had advantages and disadvantages, but the families of anti-tank guided missiles concerned the American armored community because of its long-range lethality combined with its relative low cost and ease of use.^{107} The Soviet Union provided modern T62 tanks to Arab forces and their use in battle allowed the United States a very close look at the tank's capabilities. The anti-tank guided missiles and the T62 tank were prevalent in the Soviet Bloc armies that the North Atlantic Treaty Organization forces would presumably meet, particularly in Eastern Europe. Understanding these weapon systems provided an advantage to American tank designers.

Soviet Sagger and Swatter missiles introduced long-range anti-tank munitions to the battlefield.^{108} The U.S. armored community became aware of the characteristics of Soviet short-range rocket-propelled grenades when they encountered them in Vietnam. However, because the war in Vietnam involved relatively little armored maneuver warfare, the United States did not encounter the long-range anti-tank weapons used against Israeli armor in 1973. As intelligence from the Yom Kippur War became available, the Army's Training and Doctrine Command released bulletins exhibiting a deep understanding of enemy equipment. Training and Doctrine Command released a bulletin on anti-tank guided missiles in 1975 focusing on the Soviet Sagger and Swatter missiles. The Sagger missile was thirty-four inches long, weighed almost 25lbs and was effective between 500-3000 meters. A wire-guided missile, the Sagger traveled approximately 120 meters per second, and came armed with a high explosive anti-tank warhead capable of penetrating sixteen inches of armor.^{109} The Swatter anti-tank guided missile resembled a mounted version of the Sagger for placement on a variety of ground and

air platforms. Additionally, the Swatter was not capable of dismounted use. Properly employed, both missiles were deadly for tanks.

Anti-tank guided missiles provided inexpensive anti-armor capability to any army the Soviets supported. On the other hand, building and maintaining an armor-centric army was very expensive. Smart employment of the variety of anti-tank weapons available in the 1970s threatened armor forces. The implication was that second and third world countries could afford to build an army capable of defeating armored formations on the cheap. It was much more difficult to identify an anti-tank Sagger team ambush than to identify platoon of enemy tanks since tanks were bigger and easier to detect. An infantry company, equipped with rocket-propelled grenades and Sagger missiles could now seize terrain and successfully defend it against armored formations. The realization that anti-tank missiles provided a substantial threat to American tanks forced the U.S. armor community to adapt to a new enemy.^{110}

The T62, wielding the fastest main gun round in the world, was the mainstay of the Soviet armor force in the 1970s after it replaced the T54/55 series tank.^{111} Nations with enough money, or the support of the Soviet Union, could purchase T62 as well. The U.S. Army Training and Doctrine Command continued its study of Soviet weapon capabilities and produced, Bulletin Number 10, titled *The Soviet Main Battle Tank: Capabilities and Limitations* in February 1979. The purpose of the bulletin was to familiarize every soldier with the Soviet tank series centered on the T62. The bulletin introduced the T62 as the Soviet's principal battle tank, mounting an accurate and highly lethal main gun, generally comparable to an American M60 series tank.^{112} The primary strengths of the T62 were its 115-mm. main gun and mobility.^{113} The Soviet hypervelocity, armor piercing, fin-stabilized discarding sabot ammunition traveled over one mile per second and penetrated thirty-three centimeters of armor. It had a fifty percent probability of first round hit on a stationary target at 1500 meters with a seventy-one percent probability of killing the target.^{114} The T62 tank proved reliable and deadly on the battlefield.

Industry

American industry was much more prepared for war in the 1970s than it was in the 1950s.^{115} The Korean War found American military industrial readiness severely lacking; the policy of limited mobilization was incorporated after the Korean War to correct this fault. Limited mobilization required the U.S. Government to employ a limited industrial capability for military material, even times of peace.^{116} This kind of mobilization, lacking before the Korean War, allowed continuing military production and provided for industrial oversight. The Industrial Advisory Council had primary responsibility for identifying problems with industrial output during this time. This system worked throughout the 1950s and 1960s, and played an important role in meeting industrial demand.

of the Vietnam War and allowed a regular pace of tank evolution and production.^{117}

The Industrial Advisory Council forecasted turbulence with continued industrial mobilization during the Vietnam War wound down.^{118} The Council found that there was no regular oversight for military production in the 1960s and as industrial demands decreased, the military industrial base lost essential skilled labor.^{119} One issue affecting industrial efficiency stemmed from a lack of formal mobilization by the U.S. Government.^{120} While this was consistent with the idea of limited mobilization, it allowed many civilian companies to ignore unpopular military production orders. Those companies could do so because they treated military production orders as competitive bids against more profitable civilian production bids, and in many instances, the desire to profit exceeded the desire to support national defense requirements.^{121} The Industrial Advisory Council had the authority to propose corrections to identified issues within the military production process. Those corrections benefitted the entire system and allowed efficient production, like that required for evolution of the M48 into the M60 tank.

The Industrial Advisory Council proposed changes within industry focused on improved efficiency. The Industrial Advisory Council ultimately outlined and recommended a planning system managed through the tenets of consistency, relevancy, thoroughness, and credibility.^{122} Problems with consistency stemmed from the difference of planning periods required by the different armed forces services and recommended a common timeline for everyone.^{123} Relevancy was a factor because the Department of Defense planned for too many non-essential items that curtailed planning for items critical for national defense. Credibility improved when programs incorporated incentives for efficient industrial planning. Responsiveness in production, like credibility in planning, improved when the Council included rewards for speedy production.^{124} Actions taken by organizations like the Industrial Advisory Council served to coordinate and streamline industrial planning and production, which in turn saved money and allowed critical military production even in times of limited economic growth. The ultimate result for the United States was adequate access to military production capacity resulting in modern equipment, and vehicles, particularly the M60A1 and A2 series tank.

The Combat Environment

The 1973 Yom Kippur War provided a combat environment that closely resembled what the United States would endure against the Soviet Union in Europe.^{125} A U.S. Training and Doctrine Command Bulletin published the following assessment in 1975:

“While the Arab-Israeli War of October 1973 (The Yom Kippur War) reaffirmed the offensive potential of the tank, it has also dramatized the lethality of modern anti-tank weapons-particularly the high velocity tank cannon and the long-range antitank guided missile (ATGM). The effect of these modern antitank weapons in this war was devastating. Not since the Battle of Kursk between the

German and Russians in World War II has there been a comparable loss of tanks in such a short period of time. If the rate of loss were extrapolated to the European battlefields over a period of 60-90 days the resulting losses would reach levels for which the U.S. Army is totally unprepared.”^{126}

That assessment served as an alert to the armor community. The combat environment changed with the Yom Kippur War through the new weapons employed on the battlefield. Although the terrain differed from that of Europe, the Middle Eastern battlefield allowed the United States an opportunity to evaluate both friendly and enemy weapon systems in combat.

The Israeli Army equipped itself with a variety of Western equipment and the U.S. Government provided the majority of its arms.^{127} The Israelis, fighting on two fronts, used tanks in the northern Golan Heights and the southern front in the Sinai Desert. In the north, the tanks included primarily British Centurion tanks, and in smaller numbers, the upgraded M4 Sherman tank. Some Sherman tanks had 76-mm. guns and others used retrofitted 105-mm. guns.^{128} The Israeli armored forces in the Sinai were comprised primarily of American M48 and M60 tanks with some British Centurion tanks and fewer Sherman tanks.^{129} The M48 and M60 series tanks included Israeli mounted 105-mm. main guns.

The Arab forces reflected the Soviet Army’s organization, just as Israeli forces closely resembled that of the United States.^{130} Syria attacked in northern Israel with armored forces including Soviet T54/55s as well as the T62 tank.^{131} Against Israel’s southern defense zone, the Egyptians attacked with T54/55s and T62s. The T54/55 wielded a 100-mm. main gun and the T62’s main gun measured 115-mm.^{132} After the war, studies on the effects of tank fire provided tremendous clarity about the nature of the modern Soviet combat environment.^{133} There was significant information derived from combat in Israel that applied to a potential war in Europe. Understanding that nature caused multiple events such as the publication of service wide bulletins, the incorporation of new tactics, techniques and procedures, changed doctrine, and provided focus for tank evolution.

One such tactic, technique, and procedure recommended by the U.S. Army’s Training and Doctrine Command incorporated the “Sagger watch” in armored movement.^{134} The Sagger watch was when one element conducts overwatch looking for the signature of a Sagger missile launch. Once identified the overwatching element shoots to suppress the Sagger team and alerts the unit. The targeted element, once alerted, conducts evasive maneuvering to dodge the missile. The Sagger anti-tank guided missile^{135} resulted in not only new tactics, techniques, and procedures, but also supported another evolution of the U.S. tank.

The M60A3

The M60A3 series tank was America’s answer to the Soviet T62 and the anti-tank guided missile threat. It possessed a 105-mm. main gun capable of shooting both super-high velocity and high

explosive anti-tank ammunition.^{136} The M60A3 carried sixty-three main gun rounds, nine hundred .50-caliber rounds, and six thousand 7.62-mm. light machine gun rounds. The new Patton had a crew of four and weighed fifty-eight tons with slightly increased armor protection. A twelve-cylinder diesel engine powered the tank providing it 750 hp and a top speed near thirty miles per hour. The eleven-foot tall behemoth had a three hundred mile road range before it needed to refuel. Benefits of new technology added state of the art night vision and a nuclear, biological, and chemical protective system.^{137} The M60A3 Patton tank, a direct descendant of the M26 Pershing, achieved a formidable combination of firepower, armor protection, and mobility. However, American tank evolution continued throughout the late 1970s and an entirely new tank arrived at the end of the decade.^{138}

The M1 Abrams

The XM1 tank rolled off the assembly line in 1979 and the vehicle was tested and approved for general production as the M1 Abrams in 1981.^{139} The Abrams was a new tank in that its chassis and turret was entirely different from the M60 series. The Abrams carried an improved 105-mm. main gun capable of firing super-high velocity, depleted uranium sabot rounds that produced increased armor penetration. An enhanced fire control system included a new ballistic computer to aid the gunner. The M1's secondary armament included a .50-caliber tank commander's weapon, a 7.62-mm. loader machine gun, and a coaxially mounted 7.62 mm. light machine gun. The M1 held fifty-five main gun rounds, one thousand .50-caliber rounds, and over ten thousand 7.62-mm. rounds. The Abrams weighed sixty tons and enhanced armor provided additional crew protection. An AGT-1500 turbine engine powered the tank allowing speeds above forty-five miles per hour.^{140} The Abrams tank achieved superior results in terms of firepower, armor protection, and mobility at the cost of high fuel consumption rates; the tank needed almost three hundred gallons of fuel thrice daily.^{141} Even though the evolution of the American main battle tank was a step closer to achieving designer's goals of maximizing the balance of firepower, armor protection, and mobility, and the M1 proved no exception.

Summary

Three factors played a significant role in the evolution of the U.S. main battle tank: a credible Soviet threat, industrial potential, and a changing combat environment. The Soviet Union spent most of the Cold War supplying its allies with training and equipment. Often times, the best way to collect information on Soviet weapon systems was through their observed employment in foreign armies on foreign battlefields. The Yom Kippur War provided such an opportunity and from it American analysts confirmed the new and more lethal capabilities of the Soviet armored forces. The early 1970s demonstrated a credible Soviet conventional threat to the United States.

An analysis of industry during this period revealed potential challenges like a weakening economy

coinciding with the waning war in Vietnam. The unpopularity of the Vietnam War impacted civilian manufacturers who preferred to distance themselves from military production towards the end of the conflict in favor of civilian customers who brought greater profits. No American president elevated the nation's industrial base to a level of emergency or crisis and as a result, the industrial complex continued to operate with profit as its main goal, not national security.^{142} However, the nation's military production was sufficient to sustain the Vietnam War, as well as to rebuild the Army afterwards and included evolutions of the tank in the 1970s.

The combat environment changed in concert with the changing Soviet threat. American analysts took advantage of the explicit knowledge gained from studying the results of the Yom Kippur War and extrapolated its potential to European battlefields. The result of the 1970s environment was another iteration of American tank development as the M60 tank series culminated in the M60A3. The M1 Abrams tank family arrived in the 1980s demonstrating improvements over the M60A3.^{143}

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