

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

**A Monograph
by
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Abstract

REASONS TO IMPROVE: THE EVOLUTION OF THE U.S. TANK FROM 1945-1991
by Major Anthony I. Bailey, U.S. Army, 52 pages.

The American primary tank in the Second World War was inferior to its German counterpart for all but the final months of the war. The U.S. tank evolved and demonstrated its superiority to the world in 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.

Table of Contents

| | |
|---------------------------------|----|
| INTRODUCTION..... | 1 |
| The Second World War..... | 7 |
| Adversary | 8 |
| Industry | 10 |
| Combat Environment..... | 13 |
| The M26 Pershing..... | 15 |
| Summary..... | 16 |
| The Korean War | 17 |
| Adversary..... | 18 |
| Industry | 20 |
| Combat Environment | 22 |
| The M48 Patton..... | 25 |
| The M60/A1/2 Patton..... | 25 |
| Summary..... | 26 |
| The 1973 Arab/Israeli War | 28 |
| Adversary | 28 |
| Industry | 31 |
| Combat Environment | 33 |
| The M60A3..... | 35 |
| The M1..... | 36 |
| Summary..... | 37 |
| Conclusion..... | 39 |
| BIBLIOGRAPHY..... | 42 |

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 M3 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

¹ Albert N. Garland and Howard McGaw Smyth, *U.S. Army in World War II: Mediterranean Theater of Operations, Sicily and the Surrender of Italy* (Washington D.C.: U.S. Government Printing Office, 1965), 3. Operation TORCH was the 1942 invasion of Northwest Africa designed to assist the Russians by pressuring the Axis forces from a different front. The operation also exposed U.S. forces to combat sooner than originally conceived.

² George F. Howe, *The Battle History of the 1st Armored Division – "Old Ironsides"* (Washington DC: Combat Forces Press, 1954), 56.

³ Center of Military History, *Kasserine Pass Battles* (Washington, D.C.: U.S. Army Center of Military History, 1992) and Paul M. Robinett, *Armor Command: The Personal Story of a Commander of the 13th Armored Regiment, of CCB, 1st Armored Division, and of the Armored School During World War II* (Washington D.C., 1958).

Regiment, as part of 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 a short-range

⁴ Tom Carhart, *Iron Soldiers* (New York: Pocket Books, 1994), 28.

⁵ *FM 3-20.15 Tank Platoon* (Washington DC: Headquarters United States Army, 2007), 6-13 and *FM 3-20.21 Heavy Brigade Combat Team Gunnery* (Washington DC: Headquarters U.S. Army, 2008), Ch 4-21. The order to "hold your fire" refers to the armor unit's most restrictive weapon control status prohibiting tank crews from shooting except in self-defense or until issued a formal order to fire. Sabot is a type of tank ammunition designed to penetrate enemy tank armor using kinetic energy resulting from force of velocity, rather than an explosive device. Kinetic energy equals mass multiplied by the squared velocity divided by two ($KE = \text{mass} \cdot \text{velocity}^2 / 2$).

⁶ *Ibid.*, 3-15. A line formation places armored vehicles abreast of each other in order to maximize firepower to the unit's front while sacrificing it to the flanks. Any line formation is difficult to maintain and the difficulty increases with the size of the organization. An attacking tank battalion in a line formation requires close management. Doing so at night is a more difficult task to achieve because vehicles falling too far behind the line might accidentally shoot friendly vehicles in front of them.

⁷ Stephen A. Bourque, "Correcting Myths About the Persian Gulf War: The Last Stand of the Tawakalna," *The Middle East Journal* 51, no. 4 (1997): 566-583.

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, proving the M1 Abrams and their crews excellent.¹⁰ 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

⁸ Army Times "*Desert Storm After-Action Review*" (Articles 1900s).

⁹ Stephen A. Bourque, *Jayhawk!: The VII Corps in the Persian Gulf War* (Washington, D.C.: Department of the Army, 2002), 342-343 and Carhart, *Iron Soldiers*, and Alastair Finlan, *The Gulf War 1991* (New York: Routledge, 2003).

¹⁰ John S. Brown, *The Maturation of Operational Art: Operations DESERT SHIELD and DESERT STORM* (Washington D.C.: Center of Military History, 2007), 452. Operation DESERT STORM was the air and ground preparation against Iraqi forces that followed by an enveloping ground attack designed to oust Saddam Hussein from Kuwait in 1991.

¹¹ John Ellis, "*Brute Force: Allied Strategy and Tactics in the Second World War*" (New York: Viking, 1990), 296. A note describes American armor using tactics similar to the British in the first few encounters against the Germans. The problem was that those tactics allowed unsupported tank charges that placed Allied armor in the open, becoming excellent targets for enemy tank and anti-tank fire. The American shortcomings include technical disadvantages in being comparatively under gunned and under armored, as well as the tactical shortcomings previously described.

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 heavier 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.

¹² Michael Knights, *Cradle of Conflict*, (Annapolis: Naval Institute Press, 2005), 103. The first class training of tank crews allowed them to engage and destroy enemy vehicles in conditions that prevented range confirmation by the laser range finder. Those conditions included sandstorms and billowing smoke as well as shots made from long distances (exceeding three thousand meters).

¹³ Robert Endicott Osgood, *Limited War; The Challenge to American Strategy* (Chicago: University of Chicago Press, 1957), 174-175. MacArthur desired action that he considered in keeping with Truman's idea of limiting the war. MacArthur wanted permission to bomb Manchurian airfields, blockade the coast of China, and to enlist the aid of Chinese Nationalist soldiers for combat in South Korea. President Truman and his administration felt that these actions, however limited, would provoke China into a total war with assistance from the Soviet Union.

¹⁴ Philip J. Philbin, "The Tank Program: A Statement Prepared for ARMOR by the Subcommittee on Tanks, House Armed Services Committee," *ARMOR Magazine* (September–October 1950): 21 and George F. Hofman and Donn A. Starry, *Camp Colt to Desert Storm: The History of U.S. Armored Forces* (Lexington: The University Press, 1999), 217-222. Philip Philbin begins his statement discussing the insufficient emphasis on tanks in modern warfare that resulted in a lagging tank building and development program. Hofman and Starry describe the readiness of the U.S. Army, including the armored force, after the Second World War until 1950. The five page discussion centers on the undermanned and underequipped conventional military that, in the late 1940s and early 1950, the United States began to improve.

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 any 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

¹⁵ Hofman and Starry, *Camp Colt to Desert Storm: The History of U.S. Armored Forces*, 219.

¹⁶ The author establishes and describes the term "combat environment," to emphasize the idea that the adversary is a combination of not only the enemy force, but also the results of interaction within the environment.

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 to 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.

¹⁷ *Report of Army Field Forces Advisory Panel on Armor to Chief of Staff, U.S. Army* (Fort Monroe: U.S. Army, 1949), Section 2-2.

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 into 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.

¹⁸ B.T. White, *German Tanks and Armored Vehicles: 1914-1945* (New York: Arco Publishing Company, 1968), 25.

¹⁹ Hardy L. Merritt and Luther F. Carter, *Mobilization and the National Defense* (Washington D.C.: National Defense University Press, 1985), 32. Industrial capacity, throughout this monograph, refers to the American industrial program required to meet the national military objectives including material, labor, capital, production facilities, and any such services essential to industry.

²⁰ Timothy D. Gil, *Industrial Preparedness* (Washington D.C.: 1984), 4.

Adversary

German armored firepower during the Second World War was superior to the United States in a 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

²¹ H. L. Hillyard, *Characteristics for Tank Guns* (Fort Leavenworth: Command and General Staff School, 1948), 8.

²² *Ibid.*, 8.

²³ *Ibid.*, 8.

²⁴ U.S. Infantry School, *The Operations of the Third Platoon, Company "D," 13th Armored Regiment (1st Armored Division) in the Vicinity of Mateur, Tunisia 1 May to 9 May 1943 (Tunisian Campaign)*, The Advanced Infantry Officer's Course (Fort Benning, 1948), 12-16.

²⁵ White, *German Tanks and Armored Vehicles 1914-1945*, 68-70.

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

²⁶ David Doyle, *Standard Catalog of German Military Vehicles* (Iola: Krause Publications, 2005), 14.

²⁷ *Basic Field Manual, Military Intelligence Identification of Foreign Armored Vehicles, German, Japanese, Russian, and Italian* (Washington D.C.: Government Printing Office, 1942), 24.

²⁸ *Ibid.*, 48-51.

²⁹ Doyle, *Standard Catalog of German Military Vehicles*, 97.

³⁰ R. P. Hunnicutt, *Sherman: A History of the American Medium Tank* (Novato: Presidio Press, 1978), 176.

³¹ R. P. Hunnicutt, *Pershing: A History of the Medium Tank T20 Series* (Berkeley: Feist Publications, 1971), 200.

before the Shermans 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 prewar 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

³² Christopher F. Foss, *Jane's Armour and Artillery 1979-80* (London: Jane's Publishing Company, 1979), 90. Sherman tanks equipped with 75-mm. guns could penetrate almost three inches of armor at approximately nine hundred meters. The Panther had three inches of sloped frontal armor and the Tiger tanks four inches of frontal armor, and one and a half inches and three inches, respectively, of armor on the sides. They had less armor on the rear. The combination of armor distribution on a tank and the limited penetration value of the Sherman's main gun meant the Shermans had to maneuver dangerously close to the German tanks in order to make a side or rear shot to destroy that vehicle.

³³ Gill, *Industrial Preparedness* and Roderick L. Vawter, *Industrial Mobilization: The Relevant History* (Washington D.C.: National Defense University Press, 1983). There is little debate that the United States enjoyed a significant advantage over the Axis forces through the strength of American industry. There is academic discourse regarding the amount of coordination, planning, and luck behind American industrial growth, but that issue is not germane to this monograph. What remains significant is the fact that the United States could process the industrial demands made upon her to continually build, arm, equip, reinforce, as well as to evolve the military.

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 in 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 it 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

³⁴ *How Shall Lend-Lease Accounts be Settled?* (Washington D.C.: Government Printing Office, 1945), 1.

³⁵ Hofman and Starry, *Camp Colt to Desert Storm: The History of U.S. Armored Forces*, 41. During the late 1920s the Experimental Mechanized Force demonstrated the need to improve mechanized attributes in the form of tank shock effect and mobility. The War Department, accepting the Experimental Mechanized Force recommendations, planned for long-range mechanization that required a capable industrial base.

³⁶ *How Shall Lend Lease Accounts be Settled?*, 8.

³⁷ *Ibid.*, 2. The Lend Lease program was the legal methodology enacted in order to allow the transference of military aid, arms, and equipment to foreign countries without America necessarily receiving cash payment.

³⁸ *Ibid.*, 2.

³⁹ Vawter, *Industrial Mobilization: The Relevant History*, 7.

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 nation victory, but it certainly helps. Expanded industrial capacity

⁴⁰ U.S. War Production Board, *Minutes of the War Production Board* (Washington D.C.: U.S. Government Printing Office, 1946), 189.

⁴¹ *Ibid.*, 21.

⁴² *Ibid.*, 21.

⁴³ U.S. Office of Defense Mobilization, *Meeting Defense Demands, 2d Quarterly Report to the President* (Washington D.C.: U.S. Government Printing Office, 1951).

⁴⁴ R. Elberton Smith, *United States Army in World War II: The War Department, The Army and Economic Mobilization* (Washington D.C.: Military History Department, 1959), 9 and Ellis, *Brute Force: Allied Strategy and Tactics in the Second World War*, 556. The Sherman tank production figure, reported by the Ordnance Department: Procurement Deliveries of Selected Major Items, 1 July 1940-31 December 1945, is 57,027. The Germans produced a total of 46,857 tanks and self-propelled guns in the Second World War resulting in the Allied production advantage at 5:1 ratio.

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 area 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 their 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

⁴⁵ Howe, *The Battle History of the 1st Armored Division "Old Ironsides,"* Martin Blumenson, *The Patton Papers 1940-1945* (Boston: Houghton Mifflin Company, 1974).

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

⁴⁶ *Technical Manual Medium Tank M4A3* (Washington D.C.: U.S. Government Printing Office, 1942), 28-33.

⁴⁷ Gregory Allen Harding, *Third Infantry Division at the Battle of Anzio-Nettuno* (Fort Leavenworth: Command and General Staff College, 1995), 15.

⁴⁸ Stuart G. Fries, "The Tank as a Fighting Vehicle," *ARMOR Magazine* (Fort Knox: 1950), 37-38.

⁴⁹ Headquarters Western Defense Command & 4th Army, *Information Bulletin No 38: Tactical and Technical trends of the Axis Forces* (Presidio: 1943) 1-18. This information bulletin describes mostly German ground forces in the form of antitank, engineer, armored force, and artillery. It does not include any mention of air support and the artillery is very limited.

tanks during in 1944 and 1945 because Allied air coverage disrupted what was left of those formations.⁵⁰ Massed 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 fires 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

⁵⁰ Blumenson, *The Patton Papers 1940-1945*, 501. General Patton observed in his war diary that the Luftwaffe was forced to fly at night because they could not beat Allied air coverage during the day. Air forces in the Second World War were notoriously ineffective at night bombing.

⁵¹ Foss, 90.

⁵² Army and Navy Journal, "New Army Tank" *Army and Navy Journal* (Washington D.C.: Army and Navy Journal, Inc, 1945), 32. The journal article dated March 10, 1945 describes the Pershing tank's battlefield arrival quoting Under Secretary of War Patterson's radio statement, "That tank is America's answer to the German Tiger." The article notes that the Pershing is the most powerful (combat deployed) tank that the United States built to date.

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 Armor 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

⁵³ Hunnicutt, *Pershing*, 217.

⁵⁴ Foss, *Jane's Armour and Artillery 1979-80*, 88.

⁵⁵ *Ibid.*, 32.

⁵⁶ Joseph Williams, "Tank Analysis," *ARMOR Magazine* (1974) 10.

⁵⁷ Hunnicutt, *Pershing*, 13-40. The U.S. Army may not have paid particular attention to the Pershing's mechanical issues because it deployed into the European theater only a few months before Germany surrendered. Additionally the Pershing tanks benefitted from a travelling ordnance team designated to capture field and combat

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 its 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 forces 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

observations. Another benefit of the ordnance team included immediate mechanical support from the front line of combat reaching back to Aberdeen, Maryland.

⁵⁸ James F. Schnabel, *U.S. Army in the Korean War, Policy and Direction: The First Year* (Washington D.C.: U.S. Government Printing Office, 1972), 45.

⁵⁹ Hofman and Starry, *Camp Colt to Desert Storm: The History of U.S. Armored Forces*, 223. In order to maintain ten combat divisions, the U.S. Army reduced the number of battalions per regiment from three to two. That was also the case in the 8th Army in 1950. At best, units could muster sixty-six percent combat power in accordance with the reduction in force. American units suffered additional reductions in combat capability due to shortfalls in maintenance, training, and equipment.

⁶⁰ T.R. Fehrenbach, *This Kind of War: A Study in Unpreparedness* (New York: Macmillan, 1963), 65-71. Task Force Smith was an American infantry battalion from Japan that was hastily inserted into Korea in July, 1950 to assist the South Korean Army's defense against the North Korean People's Army. Task Force Smith, an infantry battalion with limited artillery and no anti-tank capability, linked into the South Korean forces defending north of Osan. The task force was the first American Battalion to stand against the North Koreans. On 5 of July 1950, Task Force Smith slowed the North Korean advance almost eight hours before the Task Force, now combat ineffective, withdrew.

⁶¹ Philbin, "The Tank Program: A Statement Prepared for ARMOR by the Subcommittee on Tanks, House Armed Services Committee," 21. Philip Philbin begins his statement discussing the insufficient emphasis on tanks in modern warfare that resulted in a lagging tank building and development program. His statement is a reflection of the variety of people and organizations that realized a need to evolve and agreed on endorsing methods to evolve, such as a presidentially approved five hundred million dollar tank development program.

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 unite 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's secondary armament included two 7.62-mm. machine guns, one in the hull and the other coaxially 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

⁶² Hofman and Starry, *Camp Colt to Desert Storm: The History of U.S. Armored Forces*, 224. The North Korean People's Army attacked with an estimated 225 T-34s, 140 of them in the 105th Armored Brigade that spearheaded the invasion.

⁶³ Martin J. Miller "Russian Combat Vehicles," *ORDNANCE Magazine* (July-August 1966): 51.

⁶⁴ John W. Prow, "What of Soviet Armor?," *ORDNANCE Magazine* (March-April 1967): 487.

⁶⁵ *Ibid.*, 487.

⁶⁶ *Ibid.*, 487.

countering the United State 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 These 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.

⁶⁷ Robert S. Cameron, *Mobility, Shock and Firepower*, (Washington D.C.: Center of Military History, 2008), 464-465. The M24 tank categorized as a light tank meant that its role was primarily for infantry support and reconnaissance. The M24 had a 75-mm. main gun but was not effective against medium tanks such as the T34/85.

⁶⁸ Williams, "Tank Analysis," 10.

⁶⁹ Foss, *Jane's Armour and Artillery 1979-80*, 88.

⁷⁰ Hunnicutt, *Pershing*, 154.

⁷¹ *Ibid.*, 35.

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 this 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 budgets 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.

⁷² A.H. Raskin, “U.S. Defense Hinges on Machine Tools,” *New York Times*, August 8, 1951.

⁷³ *Ibid.*, 18.

⁷⁴ James S. Lay, *A Report to the National Security Council on U.S. Objectives and Programs for National Security*, National Security Council 68, 1950.

⁷⁵ Lay, 9.

⁷⁶ Gill, 85.

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 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 to 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

⁷⁷ U.S. Congressional Service, *Defense Production Act of 1950* (St Paul: West Publishing Co, 1951), 859.

⁷⁸ Gill, 86.

⁷⁹ The Center for Grassroots Oversight, “Context of June 12, 1953: Office of Defense Mobilization(ODM) Replaces National Security Resources Board (NSRB),” *History Commons*, <http://www.historycommons.org/context.jsp?item=reorganizedm&scale=1> (accessed April 25, 2010).

⁸⁰ *Ibid.*, 1.

⁸¹ *Ibid.*, 1.

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

⁸² Center for Defense Information, “*U.S. Military Spending, 1945-1996*,” Center for Defense Information, <http://www.cdi.org/issues/milspend.html> (accessed May 9, 2010). The Center for Defense Information report on U.S. Military Spending shows the increased budget in terms of billions of dollars. The value of the military budget increased almost one hundred billion dollars between 1950 and 1951. Then in 1952, it increased another 182.8 billion dollars. The money for research and development, which was scarce in 1948, became abundant as a result of the Korean War effort.

⁸³ Lay, 1-27.

⁸⁴ *Ibid.*, 17-18.

⁸⁵ Lay, 16.

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 to defeat Britain through air attacks, and finally to attack the United States through a choice of atomic or 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 threat 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,

⁸⁶ Ibid., 4.

⁸⁷ Ibid., 17-18.

⁸⁸ Central Intelligence Agency, *Soviet Capabilities for Attack on the U.S. Through Mid-1955*, SE 36 (Washington D.C., 1953), 4-6.

⁸⁹ *FM 1-02 Operational Terms and Graphics*, (Washington DC: Headquarters U.S. Army, 2004), 25. This field manual defines combat effectiveness as the ability of a unit to perform its mission. Factors such as ammunition, personnel, status of fuel, and weapon systems are assessed and rated. There is no definitive qualification of seventy percent being the threshold for combat effectiveness, but some tank platoon and battalion standard operating procedures cite that percentage for planning purposes.

⁹⁰ Ibid., 3.

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 enhance 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.

⁹¹ *Report of Army Field Forces Advisory Panel on Armor, 18 February 1949 to Chief of Staff, U.S. Army, 7.*

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 frontal 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

⁹² "New Striking Power for the Mobile Arm," *ARMOR Magazine* (July-August, 1952):15.

⁹³ *Ibid.*, 16.

⁹⁴ Foss, *Jane's Armour and Artillery 2007-2008*, 179.

⁹⁵ Army Tank Automotive Command, *Standard Military Vehicle Characteristic Data Sheets* (Center Line: Research and Engineering Directorate, 1963), 19.

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

⁹⁶ Williams, "Tank Analysis" *ARMOR Magazine*: 11 and Foss, *Jane's Armour and Artillery 2007-2008*, 237.

⁹⁷ Williams, "Tank Analysis" *ARMOR Magazine*: 11.

⁹⁸ *Technical Manual 43-0001-31: Equipment Data Sheets for TACOM Combat and Tactical Equipment*. Washington D.C.: U.S. Government Printing Office, 1985, 75.

⁹⁹ *Ibid.*, 75.

¹⁰⁰ Foss, *Jane's Armour and Artillery 2007-2008*, 237.

¹⁰¹ *Ibid.*, 237.

¹⁰² *Ibid.*, 237.

¹⁰³ Miller, "Russian Combat Vehicles," 49 and Army Training and Doctrine Command, *TRADOC Bulletin 2: Soviet ATGMs: Capabilities and Countermeasures* (Ft. Belvoir: Defense Technical Information Center, 1975).

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 postwar industry greatly reduced the ability of the United States to maintain and manufacture new tanks. The Communist invasion of South Korea highlighted that 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.

Miller's article goes on to describe the Soviet ground threat capabilities and the TRADOC bulletin highlights the Soviet capability to mount anti-tank guided missiles on helicopters indicating both a ground and air threat to tanks.

¹⁰⁴ Gil, 85.

The 1973 Arab/Israeli War

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 that 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-

¹⁰⁵ Comptroller General, *Critical Considerations in the Acquisition of a New Main Battle Tank* (Washington D.C.: Department of Defense, 1976), i.

¹⁰⁶ U.S. Army Training and Doctrine Command, *TRADOC, Bulletin 2: Soviet ATGMs: Capabilities and Countermeasures*, 3.

range lethality combined with its relative low cost and ease of use.¹⁰⁷ The Soviet Union provided modern T62 tanks to Arab forces; 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 deeper 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

¹⁰⁷ Ibid., 3. The TRADOC bulletin reports that Sagger operators used simulators to achieve a remarkable 2300 simulated firings before the start of the 1973 War and the Egyptian Army brought portable simulators into the fight and required Sagger gunners to for up to thirty simulations daily.

¹⁰⁸ Ibid., 3.

¹⁰⁹ Ibid., 5.

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 armored 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 new enemy.¹¹⁰

The T62, wielding the fastest main gun round in the world, was the mainstay of the Soviet armored 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 this bulletin was to familiarize every soldier with the Soviet

¹¹⁰ Paul E. Herbert, *Deciding What Has to Be Done: General William E. DePuy and the 1976 Edition of FM 100-5 Operations* (Fort Leavenworth: Combat Studies Institute, 1988). American adaptation to new Soviet weaponry was not limited to the production of new tanks. The Army took great lengths to update doctrine as well.

¹¹¹ Army Training and Doctrine Command, *TRADOC Bulletin 10: The Soviet Main Battle Tank: Capabilities and Limitations* (Ft. Belvoir: Defense Technical Information Center, 1979), 1 and Miller, —Russian Combat Vehicles,” *ORDNANCE Magazine* , 51. First appearing in 1949 and armed with a 100-mm. rifled main gun, the T54 replaced the T34 as the Soviet main battle tank. Continual improvements and modifications to the tank series include the addition of 7.62-mm. machine guns as well as upgraded internal components resulted in the T55. The T54/55 series tank has been produced in greater quantities than any other tank worldwide and remains in service around the globe today.

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 in 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

¹¹² Ibid., 1.

¹¹³ Ibid., 3.

¹¹⁴ Ibid., 10-12.

¹¹⁵ Leon N. Karadbil and Roderick L. Vawter, *The Defense Production Act, Crucial Component of Mobilization Preparedness* (Washington D.C.: National Defense University Press, 1985), 37.

¹¹⁶ Vawter, *Industrial Mobilization: The Relevant History*, 58.

important role in meeting industrial demands 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 as 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 in consistency stemmed from the difference of planning periods required by the

¹¹⁷ Frank Burnham, "The Pentagon and Industry: Antagonism Replacing Trust" *Armed Forces Management Journal* (Washington D.C. 1970), 33-37. This is an interesting era in which to study industry because the military production aspect of America's industrial base was by no means perfect as there were numerous differences between military and civilian agencies vied to influence industry. However, the industrial system remained capable of producing the military components, including tanks, throughout the referenced years.

¹¹⁸ Vawter, 58.

¹¹⁹ *Ibid.*, 59.

¹²⁰ Gill, 15.

¹²¹ *Ibid.*, 16.

¹²² Vawter, 61.

different armed force 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

¹²³ Ibid., 62.

¹²⁴ Ibid., 66.

¹²⁵ Weapons Systems Evaluation Group, *WSEG Report 237 Data from The October 1973 Middle East War, Volume VII: Combat Vehicle Assessment Report* (Arlington: WSEG, 1974), 1-5.

¹²⁶ Army Training and Doctrine Command, *TRADOC Bulletin 2*, 3.

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

¹²⁷ Weapons Systems Evaluation Group, *WSEG Report 237*, 1-5.

¹²⁸ *Ibid.*, 28.

¹²⁹ *Ibid.*, 28.

¹³⁰ Army Training and Doctrine Command, *TRADOC Bulletin 8: Modern Weapons on the Modern Battlefield* (Ft. Belvoir: Defense Technical Information Center, 1975), 1-36.

¹³¹ WSEG Report 237 notes that the Jordanians used British Centurion tanks against the Israelis. One can only imagine the potential confusion tankers of all nationalities had in differentiating friend from foe. Incidents of fratricide may have increased during these armored battles. This reminds those on the battlefield to know their armored forces vehicle identification to prevent fratricide.

¹³² Prow, "What of Soviet Armor?," 486-488 and U.S. Army Training and Doctrine Command, *TRADOC Bulletin 10*, 5.

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 where 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.¹³⁵ The Sagger anti-tank guided missile 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

¹³³ Army Training and Doctrine Command, *TRADOC Bulletin 10*, 1-45.

¹³⁴ Army Training and Doctrine Command, *TRADOC Bulletin 2*; 25.

¹³⁵ The author participated in battle drills, as the one described, as a tank platoon leader in 1995. The significance of which lends credence to the process of analyzing the combat environment with the goal of establishing tactics, techniques and procedures to increase survival. That battle drill trained in 1995 germinated in the 1973 Arab Israeli War.

¹³⁶ *Technical Manual 43-0001-31: Equipment Data Sheets for TACOM Combat and Tactical Equipment*, 77.

miles per hour. The eleven-foot tall behemoth had a three hundred mile road range before it needed to refuel. Benefits of 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's 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

¹³⁷ Ibid., 77.

¹³⁸ Williams, "Tank Analysis" *ARMOR Magazine*: 11-14. The M1 Abrams is the result of lessons learned from the failed attempt to co-produce a main battle tank with the Federal Republic of Germany. The genesis of that partnership came from the idea of the interoperability of parts and ammunition. The program failed because it was too expensive and too slow to progress. The M1 also incorporated corrections and improvements on the M60 family of tanks.

¹³⁹ *Technical Manual 43-0001-31: Equipment Data Sheets for TACOM Combat and Tactical Equipment*, 59.

¹⁴⁰ Ibid., 59.

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 Every 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 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.

¹⁴¹ Bourque, *Jayhawk!*, 352.

¹⁴² Gill, 16.

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

¹⁴³ Army Tank Automotive Command, *Standard Military Vehicle Characteristic Data Sheets*, 75.

Conclusion

Between 1945 and 1991, a persistent requirement for a modern army rested on armored formation's offensive capabilities that centered on the tank. Those capabilities in terms of firepower, armored protection and mobility, provide the cornerstone of conventional armies. The U.S. Army's purpose during the Cold War was deterrence first, then the ability to win on the battlefield. To achieve those purposes, it required sophisticated and capable equipment to keep pace with changing threats and technological advances.

The evolution of the Army's primary tank of the Second World War into the main battle tank of today resulted from assessments of a changing adversary, managed American industrial capacity, and an understanding of the combat environment. The German Panther and Tiger tanks in the Second World War provided the adversarial impetus to cause tank designers to evolve an insufficient tank, the M4 Sherman, into the much more capable M26 Pershing tank. The Pershing tank brought more firepower and armor protection to American tank crews at the end of the Second World War.

The T34, a Second World War vintage tank was the armored adversary in the Korean War. The T34 was formidable and outclassed lighter American tanks but could not withstand the offensive capability that the Pershing tank brought to the Korean battlefield. The true adversary for the Pershing tank was its own mechanical issues that combat in Korea highlighted. The war sped the evolution of American tank from the M26 to the M46 and finally into the M48 Patton tank, through increased capital and industrial output.

The Soviet Union was the primary adversary throughout the Cold War for U.S. tank designers. The lessons derived from the Arab Israeli Wars, particularly the 1973 Yom Kippur War, provided the genesis for the next round of American tank evolution. The M60 Patton

model surpassed the M48 tank and demanded improvement when compared to the T62 and lethal anti-tank guided missiles. The result was the evolution of the M60 through the M60A1 and A2 models ultimately leading to the M60A3 model. The 1970s also provided the foundation for the United States to replace the M60A3 with a new tank—the M1 Abrams tank. In the years between 1945 and 1991, there remained a clear and present danger to the American main battle tank that required its continual evolution. A strong industrial base remained an essential capability to support ongoing evolution throughout those years.

The Second World War saw the U.S. industrial base move to total war. The United States produced massive amounts of war material before her declared entry into the war, which made it easier to prepare a growing army for combat. After the Second World War, the United States drastically reduced the output of war material and returned to a peacetime footing with the assurance of national security through the possession of atomic weapons. The Korean War occurred just as strategists and politicians began to recognize the lack of sufficient industrial military output. Besides increasing military output for the war, legislation enabled a long-term provision for military production to keep the Army continuously armed with modern equipment. The policy that allowed for limited industrial mobilization served the United States well until challenges surfaced, challenges exacerbated by Vietnam War production. The Industrial Advisory Council captured and recommended corrections for many of these emerging issues, allowing for continued military production, specifically in terms of tank evolution.

Assessment of the combat environment incorporated the final urge for the evolution of the tank. The combat environment changed at least three times between 1945 and 1991 and each time it changed, tank designers compared the ability of the current tank to handle the new threat. If the tank could not meet the new threat, then some evolutionary process took place. However,

despite any alteration of the combat environment, designers consistently saw Europe as the most likely scene of the next major war. The focus on Europe was not out of neighborly compassion so much as it was deduced from Soviet aims and the conclusion that Europe would be the logical first step to best position Soviet forces for future attacks against the United States. Recognition of the changing environment encouraged the evolution that permitted the United States to remain competent on the battlefield. The ultimate result of this continuing evolution was the M1 Abrams series tank.

The tank will remain an integral part of any conventional armed force, as it has since its inception. The Abrams was a superior tank in 1991 during Operation DESERT STORM and remained exceptional in 2003 amid the Global War on Terror. Seven years later, in an era of persistent conflict, that same tank family continues to serve. Two things changed with combat operations between 1991 and 2010. First, the M1 Abrams family of tanks continues to operate in a dynamic combat environment, and second, the Abrams continues to age and is currently over thirty years old. This reality demands the Abrams tank be evaluated for evolution to endure in both the remainder of the Global War on Terrorism and, more importantly, for the next significant military crisis.

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