American Tank Development During the Cold War

Maintaining the Edge Or Just Getting By?

by Dr. Robert Cameron

The first in this series of three articles, published in the September-October 1997 issue of ARMOR, addressed American tank development during the World Wars. This article focuses upon the Cold War era prior to the development of the M1 Abrams, illustrating the influence of the Soviet military threat. The desire to field a technologically superior tank that would more than offset Soviet numerical superiority made this period one of significant pioneering efforts in American tank technology. Despite problems in fielding reliable and effective designs, the efforts to build an ideal tank made possible the later development of the successful Abrams tank.

"We know exactly what we want. We want a fast, highly mobile, fully armored, lightweight vehicle. It must be able to swim, cross any terrain, and climb 30 degree hills. It must be air-transportable. It must have a simple but powerful engine, requiring little or no maintenance. The operating range should be several hundred miles. We would also like it to be invisible."

- General Bruce C. Clarke[1]

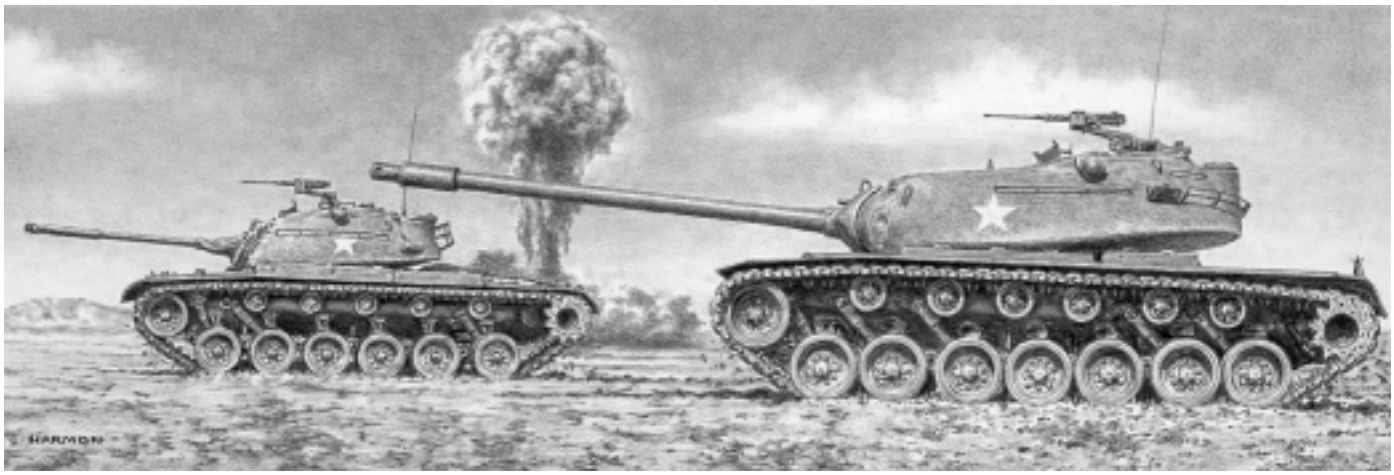
The close of World War II left the U.S. Army with three principal tanks in its inventory: the M24 light tank for cavalry missions, the M4 Sherman medium tank that constituted the bulk of the Army's tank strength and equipped the armored divisions, and the M26 heavy tank originally designed as a counter to the German Tiger and Panther tanks. None of these vehicles were considered ideal. The M24 proved popular and superior to the M5 light tank that it replaced, but it remained under-armed. Its low-velocity 75-mm gun, originally developed for aircraft use, possessed little antitank capability.[2] The various versions of the M4 medium tank proved mobile and reliable, but it lacked sufficient firepower and protection. The M26 heavy tank increased firepower and armor at the expense of mobility. It suffered from being under-powered. Its replacement, the M46, featured a new engine, cross-drive transmission, a bore evacuator, and fire control and suspension improvements, modifications that resulted in better overall performance, but it was still not an ideal heavy tank.[3]

In May 1946, the War Department Equipment Board completed its report on Army materiel needs. It acknowledged the need for a light, medium, and heavy tank, and recommended that a new tank be developed for each class.[4] Worsening relations with the Soviet Union encouraged implementation of the Board's proposals and development began upon the T37 light tank, the T42 medium tank, and the T43 heavy tank. In the immediate postwar years, however, this development occurred slowly amid Army demobilization and downsizing.

The Cold War's onset in the late 1940s triggered fears that the Soviet Union possessed far more tanks of superior quality.[5] The Army considered its own armored divisions as the principal defense against the Soviet military threat, but it did not believe it possessed enough tanks of the right type to sustain a ground conflict. Therefore the Army Field Forces Advisory Panel on Armor recommended accelerating development of new tank designs and focusing research and development efforts upon tank guns and ammunition.

It also requested immediate and sustained fiscal support of tank development and production to bridge the gap between American and Soviet tank numbers and capabilities.[6]

The outbreak of the Korean War in 1950 added urgency to the Advisory Panel's recommendations. Not only did the war catch the Army unprepared, the fear that it might become a global conflict highlighted the U.S. tank fleet's weaknesses, both in numbers and quality. The first tanks rushed to Korea came from infantry divisions stationed in Japan. On paper, each formation included one battalion of M4 medium tanks, but



in fact each division possessed only a company of M24 light tanks, which proved no match for the North Korean T34/85s. Not until the arrival of M4 and M26 tanks in August 1950 did American forces possess a comparable armor ability to the North Koreans.[7]

In the United States, tank development and production entered a period of frenzied activity similar to that experienced in 1940 and 1941. Testing and development cycles occurred simultaneously with production to ensure the speedy fielding of new tanks. Such rapid production guaranteed teething troubles, but the importance attached to rapidly equipping combat units with the new tanks precluded detailed testing and evaluation prior to quantity production.

Of the triad of new tanks under development, the T37 light tank reached completion first. Design work began in 1947 to build a vehicle to perform cavalry roles and support airborne operations. To overcome the M24's weakness in firepower, the T37 design featured a long-barreled 76-mm with a stereoscopic rangefinder. This device provided the gunner with a separate target image for each eye. Range determination occurred by alignment of the two images into one, but its accuracy depended upon focusing abilities that not all people possessed. Although this device enhanced target acquisition at long ranges, its complexity led to its removal from the design. Thus altered, the vehicle became the T41. The first production vehicle was built in 1951, and the series became standardized as the M41.[8]

No M41s saw combat in Korea, but the tank remained in service throughout the 1950s, and 5,500 were built. Principal modifications included a fuel-injected engine and a hydraulic turret traverse that provided exceptionally fast turret movement.[9] The M41 saw extensive service with other nations. In foreign hands, primary modifications included replacement of the gasoline engine with a diesel, an upgrade in armament to 105mm, and new ammunition.

Later retrofit packages focused upon improved fire control systems, provision of an NBC system, laser rangefinder, and thermal sights.[10] The M41 proved popular, and its 500-horsepower engine permitted rapid cross-country movement. However, at 25 tons, it was considered too heavy for efficient air transport to support airborne operations. As a recon vehicle, the M41 suffered from excessive noise and poor fuel efficiency, managing only 75 miles before refueling. It was seen as having minimal combat potential against the Soviet T54 or JSIII, and its survival even against the older T34/85 depended upon scoring a first-round hit.[11]

Progress in developing a new medium tank occurred slowly until the Korean War. The T42's turret design carried an improved 90mm gun and possessed better protection in comparison with the M46. It also featured a stereoscopic rangefinder. The main armament could be operated by either the tank commander or gunner. However, its engine remained unsatisfactory.

The M47 resulted from mounting the T42 turret on an M46 hull. After a short trial and test period, the tank entered quantity production in 1952, but a series of teething troubles prevented it from en-

tering active service until after the Korean War. The principal source of these problems lay with the rangefinder that proved unusually complex and fragile for operation on a battlefield environment. Its turret control system too often malfunctioned. Its air-cooled, gasoline engine and cross-drive transmission permitted a top speed of 37 miles per hour and good cross-country mobility, but it possessed a range of only 85 miles. Symbolic of its evolutionary background, the M47 retained the standard five-man crew and hull machine gun of the WWII generation of tanks. Production of the M47 reached 9,100 by November 1953 of which 8,500 were exported, many going to NATO countries.[12]

The Army intended the M47 only as a stopgap until a superior medium tank design could be developed. Work on this successor vehicle began in October 1950 before the first deliveries of the M47. The new tank that became the M48 underwent testing in 1952. It featured a one-piece cast turret in a dome shape that offered improved ballistic protection. Most contemporary turrets narrowed at their base, creating a shot trap between the lower turret and hull that increased vulnerability. The M48 design eliminated this weakness, since the turret base overhung the tracks. The turret's shape derived from the Soviet JSIII, considered the nemesis of American tanks in the late 1940s and early 1950s because of its superior armor, armament, and range. Other principal features of the M48 included wider tracks, a 90mm gun mounting that permitted 15-minute gun tube changes, and for the first time in an American medium tank, a four-man crew. The design incorporated a cross-drive transmission and the same 810 horsepower, 12-cylinder gasoline engine intended for the T43 heavy tank to ensure sufficient mobility.[13]

The Army's emphasis upon long range accuracy led to the incorporation of a fire control system in the M48. This system included a stereoscopic rangefinder, ballistic computer, ballistic drive, and gunner's periscope. Collectively, these mechanical devices resembled in miniature the fire control systems used by naval vessels. Only after WWII did such systems become small enough for use in combat vehicles. They permitted tanks to engage effectively at much longer ranges than in WWII — a critical consideration for an army expecting to enter the battlefield outnumbered. Instead of a gunner's sight slaved to the gun tube, the ballistic computer and drive computed the range and elevated the gun. The gunner's primary responsibility lay in keeping the sight on the target. The mechanical ballistic computer made a more accurate computation of range possible by mathematically accounting for such factors as vehicle cant and ammunition type.[14]

The Army planned to produce over 9,000 M48s within three years of development. Such rapid, mass production would redress the imbalance between Soviet and American tank forces. Meeting this goal, however, required production simultaneous with operational testing and development. Chrysler Corporation became the principal producer of the tank. In a manner reminiscent of the M3 medium tank in WWII, Chrysler began building a new plant in Newark, New Jersey, to build the M48 while it continued to evolve the design. Expected production and teething troubles led to the creation of integrating committees to coordinate tank and component development. These committees included military and industrial representatives who provided early warning of defects and recommended remedies.[15]

Between April 1952 and December 1954, nearly 7,000 M48s were produced, with an additional 2,500 to be built through 1956. Combat units immediately received 2,120, but correction of defects discovered after production delayed the fielding of the remaining tanks. The first production vehicles suffered from excessive oil consumption and engine failures after only 1,000 miles. The gasoline engine managed only .33 miles per gallon, limiting range to 75 miles. The M48's width proved too wide for many European tunnels, complicating rail transport.[16] Operational readiness rates of M48-equipped units tended to be low. The tanks suffered from engine, transmission, track, and suspension problems, and the fire control system's complexity made it difficult to operate.[17] However, the M48 was considered an even match for its Soviet counterpart, the T54. The Army expected difficulties in engagements with the JSIII, since the M48's 90mm gun could not consistently penetrate the JSIII's frontal armor, even with special armor-piercing or HEAT ammunition.[18]

Correction of mechanical deficiencies resulted in a series of product improvements throughout the 1950s. The suspension, engine, and transmission underwent modifications that resulted in the M48A2. External fuel tanks boosted the tank's range but increased vulnerability, making them unpopular. Poor range remained a problem until the Army lifted its prohibition on the use of diesel fuel by large combat vehicles in 1955. Shortly thereafter the M48A3 emerged with a more fuel-efficient diesel engine that doubled the effective operating range.[19] Not until the emergence of the M48A5 in 1975, however, did the vehicle receive an 105mm gun to keep it competitive with more modern designs. The large turret and unusually large gun mounting of the orginal M48 design made it possible to increase the main armament with minimal modifications. Combat experience in Vietnam also generated several field modifications intended to provide better protection against shaped charge weapons, including covering the turret with sandbags and carrying chain-link fencing. When the tank moved into a position, the fencing was set up in front of the vehicle to detonate projectiles before they hit the tank. The cramped interior of the commander's cupola also led to the .50 caliber machine gun being remounted on a pedestal mount above the cupola for easier operation. The Israelis received the M48 in the mid-1960s. They immediately upgraded the tank with a diesel engine, 105mm gun, and lower silhouette cupola. In American service, these changes were not implemented until the M48A5.[20]

The various models of the M48 represented technologically advanced weapon systems. They fulfilled their intended role by providing the Army with a tank able to hold its own against all but the heaviest of contemporary Soviet tanks. It emerged during the crisis atmosphere of the Korean War, when America seemed to lag behind the Soviet Union in terms of tank quality and quantity. In 1960, the Controller General reported to Congress the findings of a General Accounting Office study of the M48 program. The report criticized the Army for placing a vehicle with known defects into mass production before correction, resulting in costly modifications only partially effective. It further accused the Army of issuing a defective tank to combat units. This report ignored the impact of the Korean War upon its development and the general satisfaction of crews issued the tank. It did, however, undermine Congressional faith in the Army's tank program.[21]

The last of the new triad of tank designs established after WWII was the

T43 heavy tank. Wartime experiences with German Tiger tanks and the postwar threat posed by the JSIII inspired this design. The T43 would support medium tanks, providing the necessary firepower to destroy heavier Soviet tanks like the JSIII and its successor, the T10. Design work began in 1948, but the outbreak of the Korean War resulted in a crash development program. The Army feared that an expansion of that conflict might result in American tanks entering combat against more heavily armed and armored Soviet models that they could not defeat. The Army authorized production of the T43 in 1950, despite the incomplete state of the design. Chrysler Corporation received an initial contract to build 80 tanks, later boosted to 300. All were complete by the end of 1954.[22]

The T43 became standardized as the 120mm Gun Full-Tracked Combat Tank M103. Armament consisted of a 120mm gun capable of direct or indirect fire, a coaxial .30 caliber machine gun, and a .50 caliber on top of the turret. Its fire control system included a stereoscopic sight for the tank commander for long range accuracy. The Continental AV-1790 gasoline engine provided 810 horsepower. The tank's weight of 62.5 tons, however, limited its top speed to 21 miles per hour, and it possessed a range of only 80 miles.[23]

The M103 suffered a number of shortcomings. Tests conducted at Fort Knox in October 1954 indicated substandard turret and main gun controls. The main gun ammunition required two loaders, and it proved erratic in flight.[24] Repeated firings of armor-piercing ammunition damaged the gun tube. Worse, the M103 initially proved underpowered for European terrain. Its engine and transmission required replacement after only 500 miles, and it threw its tracks easily. Early problems with the tank were considered correctable, but the Army suffered Congressional criticism in 1957 for fielding a defective tank. The Seventh Army, stationed in Europe, refused to accept the M103 until it demonstrated its ability to provide overwatch for the M48 and conduct mobile defensive operations. Corrective modifications permitted the tank to satisfy these requirements. In 1958, the M103 equipped the heavy tank battalions of the 1st and 2d Armored Divisions.[25]

The same year the Army abandoned the heavy battalions from its organization. Inspection of Soviet tank models captured by the Israelis during the 1956 Arab-Israeli War found the capabilities of the Soviet heavy tanks overrated. No need existed for American heavy tank units.[26] The Army also preferred to merge the capabilities of the heavy and medium tank into a single vehicle. The Marine Corps thus became the beneficiaries of the M103, continuing to employ and modernize it through the 1960s. Principal changes included improvements to the fire control system, turret, and the installation of a diesel engine. Although the tank never entered combat, tank crews assigned to the M103 liked it and appreciated its firepower.[27]

The M41, M48, and M103 symbolized the Army's initial postwar reaction to the threat posed by massed Soviet armor. All three vehicles experimented with advanced rangefinders and/or fire control systems intended to improve long range accuracy and the probability of a first-round kill. All suffered extensive teething troubles because of rushed production. None were considered ideal for their class, resulting in a reevaluation of the direction tank development would follow in the 1960s. In 1957, Army Chief of Staff General D. Maxwell Taylor directed that new design efforts focus upon two vehicles: a universal tank that merged the roles of the heavy and medium tanks, and a light tank to perform both cavalry and airborne support operations.[28]

The new policy bore the influence of the Ad Hoc Group on Armament for Future Tanks or Similar Combat Vehicles (ARCOVE), a study group under the Assistant Secretary of Defense for Research and Engineering. ARCOVE believed the state of fire control system technology inadequate to improving long range accuracy for kinetic energy weapons. It therefore embraced missile technology as a more promising alternative. ARCOVE recommended that:

"Maximum effort should be made to equip tanks, by 1965, with small guided-missile weapons with line-of-sight command guidance. To achieve this step within the framework of budgets, it is recommended that conventional-weapons programs, including hypervelocity fin-stabilized penetrators and guns, be sharply curtailed."[29]

A gasoline engine limited the range of the M47, above. Most were exported. Instead, the U.S. adopted the diesel-powered M48, below.

Pending development of new tanks carrying missile weapons, the Army opted to maintain production of the M48 through FY 1961, while completing development of a replacement vehicle designated T95. This new tank would fulfill the heavy and medium tank roles. Design had begun in 1954 and focused upon creating a lighter tank with a diesel engine and an armament capable of penetrating the current and anticipated armor of Soviet tanks. The first prototypes became available for test purposes in 1958. The T95's range of 150 miles doubled that of the M48. The design also offered better protection and incorporated a hydropneumatic suspension that enabled the vehicle to raise, lower, or tilt itself.[30] Several different turrets were built to experiment with different weapons, including large caliber smoothbore guns and hypervelocity ammunition.[31] A new rangefinder known as the Optical Tracking, Acquisition and Ranging (OPTAR) system measured the time taken for a pulse of light to travel to and from the target to provide an accurate range. OPTAR was the precursor to the laser rangefinder and more accurate than optical ranging systems. However, OPTAR

often generated multiple returns, requiring the gunner to use a visual estimate to determine the correct range reading. It was also considered too vulnerable, since it required a large external mounting on the side of the turret.[32]

The T95 served an important role as a test bed for new tank technologies. Its associated cost and its experimental status, however, led the Army to abandon it as the M48's replacement. Instead, the Army opted to build a new tank based upon proven concepts and components from the M48. This new design would serve as an interim vehicle pending development of a more sophisticated vehicle that would possess protection against nuclear, biological, and chemical (NBC) weapons and a missile armament. This "interim" design was standardized in March 1959 as the 105mm Gun Full-Tracked Combat Tank M60. In various configurations it would constitute the backbone of the American tank fleet until the 1980s.[33]

Typical of its evolutionary nature, the original M60 resulted from mating a 105mm gun and an AVDS-2 diesel engine with an M48. Combat units in Europe first received the M60 in December 1960, and a total of 2,205 M60s were built. Subsequent modifications made the M60-series more distinctive. These changes included a longer turret more suited to the 105mm gun, better suspension, a redesigned commander's cupola, a T-bar instead of a steering wheel, better armor protection, an electrical computer, and a coincidence rangefinder. The last device proved much simpler to operate than the stereoscopic rangefinder. The viewer observed the target as a split image. Aligning the image determined the range. These modifications resulted in the M60A1 that replaced the M60 on the production line, starting in October 1962. The production run stopped in 1980 after 7,948 M60A1s had been built.[34]

The M60-series proved popular and reliable, free from the major teething troubles encountered by its predecessors. It represented the final evolution of a series of tank designs begun with the M26. Moreover, it fulfilled the roles of the earlier medium and heavy tank classes. Although only the engineer and bridgelaying versions of the M60 saw service in Vietnam, the Israelis used them in the October War of 1973. This war provided American military analysts a treasure trove of data on armored warfare and weapon systems, including the M60-series tanks. They outperformed the new Soviet T62, but were not invincible. Many became victims of Egyptian Sagger missiles and rocket-propelled grenades. Two features in particular lowered the vehicle's survivability: a flammable hydraulic system that horribly burned crew members if ruptured, and the turret ammunition stowage. A high probability existed that this ammunition would explode if a round penetrated the turret armor. In response to these vulnerabilities, a fire resistant hydraulic fluid was introduced into the M48 and M60-series tanks. New stowage arrangements were also proposed to move ammunition below the turret ring, but these changes required considerable change to the design. [35]

The pragmatism represented by the M60-series, however, did not end efforts to field tanks carrying missile systems instead of guns. The ARCOVE report had considered such an armament vital to ensure American tanks possessed superior lethality over their Soviet counterparts. Such a system appeared to be within reach with the Shillelagh gun/missile system. This weapon merged a conventional gun with an antitank guided missile launcher. Tests suggested that the missile had an 80%+ probability of a first-round hit at 1,500 meters and could effectively engage targets out to 3,000 meters.[36] This promising weapon became the key to the next generation of tanks intended to replace the M60 and the M41.

General Taylor's 1957 guidance also encouraged development of a single vehicle capable of performing the roles of reconnaissance and support of airborne operations. The emergence of the Soviet PT76 amphibious tank underscored this need. The PT76 possessed an amphibious capability that enabled it to maintain uninterrupted movement on land and water. The M41 possessed only limited water-crossing ability. Its weight precluded its use in support of airborne assaults.

As a replacement, design work began on the Armored Reconnaissance/Airborne Assault Vehicle. This vehicle would weigh 10-tons; offer protection from artillery blasts, 12.7mm machine gun fire, and antipersonnel mines; and be able to destroy tanks at 2,000 meters. Development priority initially went to the vehicle's amphibious capability and firepower. The Shillelagh gun/missile system was considered the " only weapons system acceptable." This weapon consisted of a 152mm conventional gun also capable of firing antitank guided missiles. The Shillelagh system would provide the light tank with massive firepower without a large increase in weight.[37]

Design work upon the AR/AAV, later redesignated the M551, began in 1959, and in 1961 General Motors Corporation began developing a pilot model. By 1964, prototypes had satisfactorily passed their initial engineering tests. In 1966, training preparations started and discussion commenced regarding the early employment of the M551 to Vietnam. In the same year, production timelines and funding streams were established. Behind this rapid pace lay a desire to place a promising weapon quickly into the hands of combat troops, especially in Vietnam.[38] From this point, however, an endless series of controversies began to plague the vehicle.

Despite the use of an aluminum-based chassis to keep the vehicle light, its 18 tons exceeded the original AR/AAV limitation of 10 tons. Nor did the M551 ever achieve its desired amphibious capability. Although capable of a low velocity air drop, this procedure was never used in an operational environment.[39] The principal source of the M551's problems stemmed from its armament. The Shillelagh missile promised the ability to kill any known tank at long ranges. Once fired, the missile received course adjustments via infrared transmissions from the vehicle. The gunner had only to keep the sight on the target; the electronic fire control system provided the necessary guidance to the missile.[40] Not only the M551, but the next main battle tank design and a planned M60A1 upgrade would carry this system.

The 152mm gun, however, required the design of new caseless ammunition, including a canister round. Firing the gun propelled the round out of the gun tube and burned up the casing. In an environment contaminated by the effects of NBC weapons, the gun could be fired from a sealed fighting compartment without allowing external toxins to enter the vehicle. Unfortunately, the caseless ammunition tended to absorb moisture, reducing its combustibility. Upon firing, smoldering debris often remained in the gun tube, resulting in the premature detonation of subsequent rounds. This problem represented a major safety hazard that plagued the vehicle until an effective scavenger system could be developed. The scavenger system removed debris from the gun tube after each firing. Even without the danger of premature ammunition explosions, the recoil of the 152mm gun lifted the front two road wheels off the ground and knocked the vehicle backward several feet. Special instructions had to be issued before firing to prevent crew injuries. Worse, the recoil tended to damage the delicate

electronics and sights necessary for the missile's operation. The gun was too powerful for the vehicle's light aluminum chassis.[41]

Operational tests done at the Panama Tropic Test Center in 1967 revealed most of these problems. They also indicated that moist tropical climates adversely effected the tank's electronics, especially the missile system. The engines tended to overheat and proved exceptionally noisy. The vehicle also did poorly in Arctic tests conducted in Alaska. Despite these flaws, the vehicle entered full rate production and deployed to Vietnam in early 1969. A belief existed that these flaws could be corrected and that use in combat would demonstrate the M551's potential effectiveness. Supporters of the vehicle also feared that delays in fielding would result in the withdrawal of Congressional funding, effectively killing the program.[42]

The M551: Its problems were never solved.

In Vietnam, the canister round proved devastating against personnel. However, the light chassis was easily torn and damaged beyond repair. Mine explosions that only immobilized the M48 resulted in catastrophic destruction of the M551. Fear of mines led some crews to ride outside the vehicle and rig the gun for remote firing. Several modifications were introduced based upon the recommendations of M551 tank crews in Vietnam. The most important of these changes included the provision of a belly armor kit to reduce the danger posed by mines and a gunshield kit for the tank commander's machine gun. The latter created an armored "crow's nest" that reduced the commander's exposure to sniper and small arms fire when operating the weapon. Other changes based upon combat experience included a winch kit for self-recovery, an increased capacity bustle rack, and efforts to improve the fire protection system following complaints from the field. In Europe, field units requested the vehicle be equipped with a laser rangefinder before accepting delivery. This request was met, and thus equipped, the tank received the designation M551A1.[43]

However, even when deployed to the more moderate European climate the M551 suffered an excessive part failure rate that sharply reduced its operational readiness rate. The vehicle's armament and turret proved exceptionally difficult to maintain, even with the availability of mechanics familiar with the tank's unique components. The complexity of the vehicle resulted in a four-volume operator's manual constantly undergoing change, ensuring that few soldiers understood how the M551 operated. An endless stream of product improvements failed to eliminate these problems, but sharply increased the expense of the M551 program.[44] In 1978, the Army withdrew the M551 from all active units except the 3-73 Armor Battalion of the 82d Airborne Division. It also continued to equip the OPFOR at the National Training Center.[45] In 1996, however, the Army inactivated the 3-73 Armor. The tank's NTC role will also end soon as funding for the M551 stops.[46]

The failure of the M551's innovative armament destroyed plans to upgrade the entire M60 fleet by equipping it with the Shillelagh gun/missile launcher. Although the M60A2 did enter service with this armament, it did not meet expectations. It, too, suffered development problems never entirely solved. It proved difficult to maintain in the field and earned the nickname "Starship" for its complexity. Although development began in the 1960s, the M60A2 did not reach combat units until 1974. Only 540 of these tanks were produced, equipping six armor battalions. By 1982, the M60A2 had been phased out of active service. Most of these tanks were sent to Anniston Army Depot for conversion to other M60 configurations.[47]

The priority given to the Shillelagh's development also slowed work on conventional gun designs. When the gun/missile system failed, the Army found itself without an effective conventional substitute other than the M68 105mm gun originally designed by the British. Congress viewed the M551's unhappy service life as a complete debacle, blaming the Army for again rushing a flawed design into production and making false promises of performance. Moreover, Congress became disillusioned with the Army's tank program and viewed subsequent tank designs with an unprecedented degree of skepticism and cynicism.

Nor did the development of a successor to the M60 series improve this negative perception. In August 1963, the United States and West Germany agreed to develop jointly a main battle tank design known as the MBT70. The design team identified weaknesses in the M60 and M60A1 and then planned a tank that would eliminate them. The MBT70 was specifically intended to operate in the high intensity combat environment of central Europe. Armament included the Shillelagh gun/missile system with an autoloader, a 7.62mm coaxial machine gun, and a 20mm cannon for the commander. A special air-conditioned fighting compartment in the turret housed the three-man crew. While this arrangement allowed the tank's height to be reduced and simplified protection against NBC weapons, it became an engineering challenge to permit the driver to continue to see forward while the turret rotated. Other features that would become common on tanks of the 1980s and 1990s included a digital computer, laser rangefinder, and a sophisticated gun stabilization system for firing while moving. The complexity of the tank and specific problems related to the Shillelagh gun/missile system slowed development and resulted in massive cost increases. The West Germans abandoned the program in 1969 in favor of a newer Leopard design. American efforts to continue the project as the XM803 finally ended in 1971, when Congress stopped funding the program.[48]

The growing problems and costs of the MBT70 coincided with the controversy surrounding the M551 development and fielding. The program further alienated support for the Army's tank program, and it ensured that any future tank design would receive critical scrutiny from a skeptical public. However, many of the MBT70's components would be developed and incorporated into the M1-series tanks. While the MBT70 overstretched the technological capabilities of the 1960s, it symbolized the pioneering efforts of the 1950s-1970s. In this period, American tank designs too often suffered from rushed production and a desire to compensate for numerical inferiority on the battlefield with technological gadgetry. Yet the continued interest in sophisticated components made possible the very real advances achieved in the de-

sign and operation of every major tank part. The M60A1 represented the culmination of lessons learned from the WWII generation of tanks. The failures of the M551, M60A2, and the MBT70 demonstrated the danger of over-reliance on unproven technology. Consequently, the Army adopted a back-to-basics design philosophy that merged the practical lessons learned since WWII with advanced technology in the final stages of development. One of the most effective American tanks resulted: the M1 Abrams.

Notes

[1]General Bruce C. Clarke, "Future Tank Requirement," *ARMOR*, September-October 1960, p. 11.

[2]Steven J. Zaloga, *U.S. Light Tanks 1944-84: M24 Chaffee, M41 Walker Bulldog, and M551 Sheridan* (London: Osprey Publishing Limited, 1984), pp. 5-6.

[3]Ordnance Tank-Automotive Command, "A History of the Development and Production of the M48 90mm Gun Tank," report, January 3, 1955, pp. 1-2, Patton Musem of Cavalry and Armor (hereafter referred to as PTM) Library; Steven J. Zaloga and LTC James W. Loop, *Modern American Armor: Combat Vehicles of the United States Army Today* (Harrisburg, Pa.: Arms and Armour Press, 1982), p. 7.

[4]"War Department Equipment Board Report," May 29, 1946, pp. 32-36, PTM Archives, Mark Falkovich Papers, Box 5.

[5]Hanson W. Baldwin, "The Decline of American Armor," *ARMOR*, September-October 1949, pp. 2-6.

[6]Department of Army Office of the Chief of Staff, "Report of Army Field Forces Advisory Panel on Armor," February 25, 1949, pp. 1-11, U.S. Army Armor Center Historian's Office.

[7]Zaloga, *U.S. Light Tanks 1944-84*, pp. 6-7.

[8]Zaloga and Loop, *Modern American Armor*, p. 29.

[9]Zaloga, *U.S. Light Tanks 1944-84*, pp. 9-11; Richard M. Ogorkiewicz, *Technology of Tanks* (Coulsdon, Surrey, UK: Jane's Information Group Limited, 1991), Vol. I, pp. 45-46.

[10]Richard P. Hunnicutt, *Sheridan: A History of the American Light Tank*, (Novato, Calif.: Presidio Press, 1995), Vol. 2, pp. 246-248.

[11]"Final Report of United States Army Armor Policy Conference, 15-19 November 1954," Section V, p. 11, PTM, Falkovich Papers, Box 2.

[12]"Final Report of United States Army Armor Policy Conference, 15-19 November 1954," Section V, pp. 3-4; Ordnance Tank-Automotive Command, "A History of the Development and Production of the M48 90mm Gun Tank," pp. 16-17; Rolf Hilmes, *Main Battle Tanks: Developments in Design since 1945* (McLean, Va.: Pergamon-Brassey's International Defense Publishers, 1987), p. 11; Zaloga and Loop, *Modern American Armor*, p. 8.

[13]Ordnance Tank-Automotive Command, "A History of the Development and Production of the M48 90mm Gun Tank," pp. 17-21; Hilmes, *Main Battle Tanks*, p. 12.

[14]Ordnance Tank-Automotive Command, "A History of the Development and Production of the M48 90mm Gun Tank," pp. 70-72; T.W. Terry, S.R. Jackson, C.E.S. Ryley, B.E. Jones, P.J.H. Wormell, *Fighting Vehicles* (McLean, Va.: Brassey's (US) Inc., 1991), p. 91.

[15]Ordnance Tank-Automotive Command, "A History of the Development and Production of the M48 90mm Gun Tank," pp. 21-22, 27, 29, 57-59.

[16]Ibid., pp. 67-69, 76, 80.

[17]COL Robert J. Icks, (Ret.), "The M48-M60 Series of Main Battle Tanks," in *Modern Battle Tanks* (New York: Arco Publishing Company, 1978), pp. 22-23.

[18]"Final Report of United States Army Armor Policy Conference, 15-19 November 1954," Section V, p. 12.

[19]Office of the Assistant Secretary of Defense for Research and Engineering, "Armament for Future Tank or Similar Combat Vehicles," report, January 20, 1958, p. 32, PTM Archives, Mark Falkovich Papers, Box 1; Richard P. Hunnicutt, *Patton: A History of the American Main Battle Tank* (Novato, Calif.: Presidio Press, 1984), Vol. I, pp. 107-114.

[20]Hunnicutt, *Patton*, pp. 238, 381, 400.

[21]Icks, "The M48-M60 Series of Main Battle Tanks," pp. 22-23.

[22]Richard P. Hunnicutt, *Firepower: A History of the American Heavy Tank* (Novato, Calif.: Presidio Press, 1988), pp. 113, 115; COL Robert J. Icks, (Ret.), "M103 Heavy Tank," in *American AFVs of World War II* (Garden City, NY: Doubleday and Company, Inc., 1972), p. 190.

[23]Icks, "M103 Heavy Tank," pp. 193, 197.

[24]Hunnicutt, *Firepower*, p. 122.

[25]"Final Report of United States Army Armor Policy Conference, 15-19 November 1954," Section V, pp. 5-6; Icks, "M103 Heavy Tank," pp. 190, 193; Zaloga and Loop, *Modern American Armor*, pp. 7-8.

[26]Zaloga and Loop, *Modern American Armor*, pp. 7-8.

[27]Hunnicutt, *Firepower*, pp. 134-137, 140-143.

[28]Office of the Assistant Secretary of Defense for Research and Engineering, "Armament for Future Tank or Similar Combat Vehicles," January 20, 1958, Appendix B, p. 19; Hunnicutt, *Patton*, p. 149.

[29]Office of the Assistant Secretary of Defense for Research and Engineering, "Armament for Future Tank or Similar Combat Vehicles," January 20, 1958, p. iv.

[30]Ibid., p. 32.

[31]Office of the Assistant Secretary of Defense for Research and Engineering, "Armament for Future Tank or Similar Combat Vehicles," January 20, 1958, p. 32; Zaloga and Loop, *Modern American Armor*, p. 12.

[32]Ogorkiewicz, *Technology of Tanks*, Vol. I, p. 174.

[33]Hunnicutt, *Patton*, pp. 152, 157.

[34]Hunnicutt, *Patton*, pp. 163-165, 168-174; Zaloga and Loop, *Modern American Armor*, p. 12.

[35]Hunnicutt, *Patton*, pp. 400-401.

[36]Zaloga and Loop, *Modern American Armor*, p. 20.

[37]Subcommittee on Artillery and Vehicle Systems, "Armored Reconnaissance/Airborne Assault Vehicle, Initiation of Development and Recording of Military Characteristics. (Department of the Army Project No. 545-02-003, Ordnance Project No. TW-429)," August 20, 1959, Appendix I, pp. 110-111; Appendix II, pp. 113-114, 117-120, PTM Archives, Mark Falkovich Papers, Box 10.

[38]"Summary Chronology of Major Decisions/Events, M551 Sheridan, 152mm Ammunition and XM35 Conduct of Fire Trainer," undated; PTM Archives, Mark Falkovich Papers, Box 10.

[39]CPT John Orifici, 1LT Rene Junco, and William J. Bielauskas, Report No. ARSEM 79-7, "A Comparative Evaluation of Lightweight Anti-Armor Systems," October 1979, pp. 39-41, PTM Archives, Mark Falkovich Papers, Box 8.

[40]U.S. Army Missile Command, "Information Booklet: Shillelagh Missile System," April 17, 1968, PTM Archives, Mark Falkovich Papers, Box 5; Zaloga and Loop, *Modern American Armor*, p. 32.

[41]Orifici et al, "A Comparative Evaluation of Lightweight Anti-Armor Systems," pp. 52-55, 116-117; Zaloga and Loop, *Modern American Armor*, p. 33.

[42]"M551 Sheridan Weapon System Chronology," undated, PTM Archives, Mark Falkovich Papers, Box 8; Zaloga, *U.S. Light Tanks 1944-84*, pp. 15-16.

[43]List and Description of Improvements Desired in M551, untitled, undated report, PTM Library, Vertical Files, Folder "M551 (Sheridan)"; Orifici et al, "A Comparative Evaluation of Lightweight Anti-Armor Systems," pp. 70, 72; Hunnicutt, *Sheridan*, pp. 255, 264, 267.

[44]Orifici et al, "A Comparative Evaluation of Lightweight Anti-Armor Systems," pp. 114-120; General Donn A. Starry, *Mounted Combat in Vietnam* (Washington, D.C.: Department of the Army, 1978), pp. 142-145.

[45]Orifici et al, "A Comparative Evaluation of Lightweight Anti-Armor Systems," p. 23.

[46]Sean D. Naylor, "Goodbye, Sheridan," *Army Times*, September 23, 1996, pp. 14-16.

[47]Orifici et al, "A Comparative Evaluation of Lightweight Anti-Armor Systems," p. 119; Zaloga and Loop, *Modern American Armor*, p. 20; *Jane's Armour and Artillery 1982-1983*, 3d edition (London, United Kingdom: Jane's Publishing Company, Ltd., 1982), p. 116.

[48]Zaloga and Loop, *Modern American Armor*, p. 19; Hilmes, *Main Battle Tanks*, p. 20; Mark S. Watson, "MBT-70 — The Tank in Your Future," *ARMOR*, January-February 1966, pp. 7-10.

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