ARTILLERY STRONG

Modernizing the Field Artillery for the 21st Century

Boyd L. Dastrup, Ph.D.

Combat Studies Institute Press
Fort Leavenworth, Kansas

Cover image: The US Army Field Artillery branch insignia features two crossed field guns.

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Preface

As the Soviet and Warsaw Pact threat declined late in the 1980s and as the risk of low-intensity regional crises was simultaneously increasing, the United States dispatched military forces into Southwest Asia. This effort as part of Operations Desert Shield and Desert Storm was in response to the Iraqi invasion of Kuwait in August 1990—to prevent further Iraqi aggression and protect American interests in the region. Operation Desert Storm validated the modernization of the Army's heavy forces during the preceding two decades and simultaneously confirmed known field artillery deficiencies that needed to be corrected through further modernization to meet future military threats.

The deficiencies highlighted by the Gulf War as well as the end of the Cold War and the escalating risk of regional crises generated interest in developing a strategically deployable and digitized Army able to fight across the spectrum of conflict anywhere in the world. Although the United States reduced both military spending and its military force and shifted funding from military to domestic programs following the demise of the Soviet threat in the 1990s, the Army and the Field Artillery still modernized their weapons and equipment.

As this modernization effort began producing substantive results, General Eric K. Shinseki, who became the Chief of Staff of the Army in June 1999, introduced his Transformation of the Army vision. Critical of the Army's existing force structure as revealed by the difficulty of the 1999 Task Force *Hawk* deployment to Kosovo, General Shinseki pushed to improve the Army's strategic mobility by equipping it with systems that possessed the robustness of Cold War heavy systems and the strategic deployability of light systems. Shinseki's Transformation of the Army represented an explicit break with the ongoing modernization endeavor and its stress on light and heavy forces. It moved modernization in an entirely new direction with an emphasis on creating medium forces with the strategic mobility of the light forces and the staying power of the heavy forces while acquiring appropriate weapons and equipment. This effort continued under Chief of Staff of the Army, General Peter J. Schoo-

maker, who adopted modularization, created brigade combat teams, and further developed new weapons and equipment.

General Schoomaker's modularization effort gave the Army the ability to deploy rapidly without creating temporary organizations and dramatically restructured the Army and the Field Artillery. However, the Global War on Terrorism during the first years of the 21st Century accelerated introduction of new field artillery systems and equipment; sped up the precision munition revolution; and transformed field artillery target acquisition, weapon platforms, support, and command and control. This study tells the story of the US Army's Field Artillery from the Gulf War of 1991 through the first two decades of the 21st Century.

This study originated as the US Army Field Artillery School published *Operation Desert Storm and Beyond: Modernizing the Field Artillery* in 2005. The 2005 edition covered field artillery developments during the 1990s. Major General (Retired) Fred F. Marty and Lieutenant General (Retired) David P. Valcourt, former US Army Field Artillery School Commandants, read the 2005 edition draft manuscript and made insightful comments. John Yager, who was on the ground floor for many of the combat developments as part of the Directorate of Combat Developments at Fort Sill, also provided solid comments regarding the 2005 draft manuscript.

With the passage of time, I decided to expand *Operation Desert Storm and Beyond: Modernizing the Field Artillery* by adding new material and retitling it as *Artillery Strong: Modernizing the Field Artillery for the 21st Century.* I revised chapters one and two from the original edition and wrote three additional chapters that examine developments since 1999 as well as an epilogue. Major General (Retired) David C. Ralston, former Assistant Commandant and Commandant of the US Army Field Artillery School, and Colonel (Retired) Frank J. Siltman, former Director of the Directorate of Training and Doctrine in the US Army Field Artillery School and current Director of Fort Sill's Museum Directorate, read all five chapters of the *Artillery Strong* draft manuscript and made invaluable suggestions to improve the narrative. Both had firsthand experience with the dynamic changes in the Field Artillery during the latter 1990s as well as the

first years of the 21st Century. I also acknowledge Ken Gott's staff on the Research and Books Team at the Combat Studies Institute for their perceptive comments and recommendations for changes. Dr. Don Wright and Diane Walker did excellent work with editing the narrative. Any errors in fact are mine.

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Chapter 1

The Collision of Armed Forces

In the 1970s, the US Army began an extensive modernization endeavor focused on preparing it for combat against the numerically superior and well-equipped Soviet-led Warsaw Pact threat. Just as that effort reached fruition, Iraqi military forces invaded Kuwait in 1990. The unanticipated invasion led to Operation Desert Shield of 1990 and Operation Desert Storm of 1991. For the Field Artillery, Operation Desert Storm tested the effectiveness of the modernization effort that was underway.

The Short War

Following the Iraqi invasion, the United States and United Nations initiated Operation Desert Shield in August 1990 to defend Saudi Arabia from a potential Iraqi attack. Over a period of seven months, the Army deployed more than 500,000 active and reserve component Soldiers with their equipment and weapons to Southwest Asia as part of a massive Coalition military buildup. When Saddam Hussein failed to withdraw his forces from Kuwait by the 15 January 1991 deadline established by President George H. Bush and supported by Congress and the United Nations, US-led Coalition forces from 36 nations launched Operation Desert Storm on 17 January 1991 to drive Iraqi military forces out of Kuwait. That day, eight AH-64 Apache attack helicopters of the 101st Airborne Division (Air Assault) destroyed two Iraqi radar facilities with Hellfire laser-guided missiles to permit allied bombers to penetrate Iraqi air space more easily. The attack was the first in an impressive air campaign that lasted through 23 February 1991 and systematically crippled Iraqi war-making capabilities by demolishing critical targets and neutralizing Republican Guard units and other ground units.[1]

While the January and February 1991 air campaign was shaping the battlefield for the ground war to follow, Coalition ground forces prepared for combat. Over a period of three weeks beginning on 17 January 1991, the Army shifted two corps and approximately

65,000 armored and support vehicles from defensive positions in eastern Saudi Arabia to a forward assembly area west of Hafar al Batin. This massive buildup effectively positioned the Army for an aggressive offensive against Iraqi military forces that were arrayed on the battlefield in three distinct echelons along the Soviet model. The first echelon consisted of 15 poorly trained, ill-disciplined, ineptly led, and eclectically equipped infantry divisions that stretched from the Persian Gulf Coast about 200 miles inland. Behind these infantry divisions stood the second echelon of six regular armored divisions equipped with second-line Soviet armament and Third World systems. Their mission was to conduct division-level counterattacks against any allied penetration. Forming the greatest threat, Republican Guard units composed the third echelon. Originally an elite palace guard of two brigades, the Republican Guards had grown to 28 combat brigades by 1990 and possessed the most modern equipment of the Iraqi ground forces. Deployed well to the north, the Guard units were situated to serve as a strategic counterattack force and could be quickly withdrawn to Iraq if necessary to prevent their destruction.[2]

Throughout the air campaign and the shifting of forces, the Field Artillery played a key role in protecting friendly aircraft from hostile air missile defense sites. Two days after the air war began on 15 January 1991, A Battery, 6th Battalion, 27th Field Artillery Regiment commanded by Lieutenant Colonel Michael D. Maples was moving westward along a busy two-lane Tapline Road—not anticipating any combat action on its way to its tactical assembly area as part of the US VII Corps movement. Around 1620 hours that day, the battery received a fire mission to destroy a surface-to-air missile site in Kuwait in support of B-52 bombing raids. First the Soldiers completed essential coordination with the Army and Air Force to ensure no friendly aircraft would be in the flight path of an Army Tactical Missile System, a long-range field artillery missile. Then at 0042 hours on 18 January 1991, the battery launched two missiles that destroyed the surface-to-air missile site. Later that day, the same battery fired six more missiles to neutralize other surface-to-air missile sites. Besides supporting B-52 raids, these missions made A Battery, 6th Battalion, 27th Field Artillery Regiment the first US VII Corps unit to fire in anger since World War II.[3]

Over the next month, Army field artillery participated in other combat actions to pave the way for the ground war. Field artillery units conducted numerous "shoot and scoot" raids to neutralize or destroy surface-to-surface or surface-to-air missile sites and reduce the risk to friendly forces. The US VII Corps and US XVIII Airborne Corps frequently moved field artillery units into hostile territory where they could easily range high-payoff targets. Upon reaching hostile territory, the designated firing batteries would unleash a few salvos and then immediately change positions to avoid enemy field artillery fire. Meanwhile, a "silent battery" would remain ready to deliver fires on any enemy field artillery that dared to engage the raiding force. If such fire was not required, the "silent battery" would fire at the high-payoff target and depart quickly. When it became evident that Iraqi field artillery could not find them, the raiding batteries stayed in position and even closed their range to deliver killing fires on enemy forward positions, field artillery emplacements, command posts, air defense facilities, and supply depots.[4]

On 13 February 1991, B and C Batteries, 1st Battalion, 27th Field Artillery Regiment—a Multiple Launch Rocket System unit assigned to the 42d Field Artillery Brigade that supported the 1st Cavalry, 1st Infantry (Mechanized), and 3d Armored Divisions during Operation Desert Storm—and A Battery, 21st Field Artillery Regiment (Multiple Launch Rocket System), 1st Cavalry Division participated in a field artillery raid under the control of the 1st Cavalry Division Artillery. The three Multiple Launch Rocket System batteries lit up the night sky when they fired rockets on targets that had been generated from US VII Corps and 1st Cavalry Division intelligence and targeting assets. At ranges of 21 to 30 kilometers, they engaged 24 targets with almost 300 rockets in less than five minutes.[5] This action, in the words of one US VII Corps commander, gave the batteries "valuable experience firing under combat conditions" and prepared them for ground combat action to follow.[6]

After completing preparations that included field artillery raids and cross-border patrols into no-man's land, the ground war opened on 24 February 1991. That day, American and Allied ground forces attacked along a line that stretched from the Persian Gulf westward about 300 miles into the desert with the major thrusts coming on the

flanks and a feint in the center. On the extreme left flank of the line, the US XVIII Airborne Corps—composed of the 6th French Light Division, 82d Airborne Division, 101st Airborne Division (Air Assault), 3d Armored Cavalry Regiment, and 24th Infantry Division (Mechanized) and commanded by Lieutenant General Gary E. Luck—invaded deep into Iraq to isolate the enemy and prevent reinforcements. They reached the Euphrates River Valley within days after the offensive started. Deployed on the right of the US XVIII Airborne Corps, the US VII Corps—consisting of the 1st Armored Division, 2d Armored Cavalry Regiment, 3d Armored Division, 1st Infantry Division (Mechanized), and the 1st British Armoured Division and led by Lieutenant General Frederick M. Franks Jr.—executed a massive wheeling maneuver north and east to encircle Iraqi forces and moved into a blocking position on 27 February 1991 along the highway connecting Al Basrah and Kuwait City. In the meantime, the Joint Forces Command North composed of Egyptian, Syrian, and Saudi Arabian military forces on the right of US VII Corps and in the center of the Allied line pushed beyond the Kuwaiti-Saudi border barriers toward Wadi al Batin to deceive the enemy into believing that a frontal assault was underway and then turned eastward. To the right of the Joint Forces Command North on the extreme Allied right flank stood the US Marines Central Command and the Joint Forces Command East respectively. As the Allies threatened amphibious landings along the coast, the 1st Brigade (Tiger) from the Army's 2d Armored Division, the 1st and 2d Marine Divisions of the US Marines Central Command, and Saudi forces from the Joint Forces Command East crossed the eastern part of Kuwait's southern border and drove toward Kuwait City. Within 100 hours of the initial 24 February 1991 attacks, Allied ground forces employed aggressive combined arms operations; they routed Iraqi military forces and liberated Kuwait, causing the Coalition to halt all offensive operations on 28 February 1991 and end the war.[7]

Although it was a short war, Operation Desert Storm tested the Army's modernization effort. The Persian Gulf War revealed that doctrine, organization, training, leadership, and materiel designed during the 1970s and 1980s for combat against Soviet and Warsaw Pact military forces produced a competent and well-equipped army.[8]

In July 1991 just a few months after the Gulf War ended, the Field Artillery School at Fort Sill, Oklahoma, addressed Field Artillery modernization. In a report to the Director of the Center of Army Lessons Learned, Fort Leavenworth, Kansas, school officials recounted the effectiveness of field artillery doctrine, organization, training, leadership, and materiel during combat operations.[9] Despite significantly higher numbers of Iraqi field artillery pieces, many of which had superior ranges to American field artillery, the Army's field artillery system of systems (target acquisition; command, control, communications, and computers; support and sustainment; and weapons and munitions) furnished overpowering fire superiority with massed fires (converging fires from many field artillery pieces, generally one or more battalions of 24 field pieces each, on a single target to inflict as much damage as possible). Such fires destroyed the enemy's target acquisition capabilities, silenced enemy indirect fire systems (field artillery and mortars) through counterfire (field artillery fires delivered to suppress enemy field artillery or mortars to prevent them from interfering with the movement of friendly forces), and provided timely close support (field artillery fires designed to engage enemy forces, generally infantry or armor, blocking the advance of friendly forces) to maneuver commanders to allow them to move their forces with minimum disruption from enemy direct fires. Massed fires also cleared routes for friendly aircraft by engaging known and suspected air defense artillery sites.[10]

According to the Field Artillery School, Operation Desert Storm clearly underscored the value of the massed fires doctrine. In an April 1991 *Field Artillery* article, Colonel David A. Rolston, who commanded the 24th Infantry Division (Mechanized) artillery for two years, evaluated the impact of massed fires on enemy troops and equipment. Rolston, who gave up command of the artillery unit in December 1990 to become Field Artillery School Deputy Assistant Commandant, wrote, "Training prior to the deployment and the operation itself reinforced that the Army should not dilute fire support by 'nickel and diming' the effort with fires on small and relatively insignificant targets. Hit the high-payoff targets with massed fires."[11]

Brigadier General (Retired) Paul F. Pearson, who served in various key positions in the Field Artillery School in the 1970s, and

General (Retired) Glenn K. Otis, the former Commanding General of the US Army Training and Doctrine Command, concurred with Colonel Rolston's incisive assessment. General Pearson and General Otis wrote that the massive use of field artillery fires paved the way for the rapid victory.[12] They noted that the Americans and Allies employed field artillery fire support "in Desert Storm to the maximum in order to minimize the number of effective enemy units that our Soldiers in tanks and infantry fighting vehicles had to take on at close range."[13]

In after action reports, maneuver commanders expressed similar thoughts about massed fires. In a 15 May 1991 letter to the Commandant of the Field Artillery School, Major General Raphael J. Hallada (1987–1991), about the US VII Corps' 24 February 1991 breaching operation, the Commanding General of the 1st Infantry Division, Major General Thomas G. Rhame, related:

> The performance of the Field Artillery in combat has caused all of us to remember what we had perhaps forgotten, namely its incredible destructive power and shock effect. The preparation fires I witnessed prior to our assault on the breachline were the most incredible sight I have seen in 27 years of service. The firepower generated by my DIVARTY [division artillery], the 42d, 75th and 142d FA [Field Artillery] Bdes [brigades] and the artillery of the 1st British Armoured Division was truly awesome.[14]

General Rhame's comments about the impact of massed fires were understandable. Notwithstanding the 1983 Urgent Fury against the insurgents in Grenada and 1989 Just Cause in Panama against Manuel Noriega and his followers, the Army's last extensive fighting experience came in Vietnam in the 1960s and early 1970s. During that effort, fire support was generally decentralized at the battery level. To furnish fires for a particular maneuver unit's area of operations and provide the maximum area coverage, the Army often located a battery with its supported infantry battalion on a fire base within range of another fire base for mutual fire support. With few exceptions, this dispersed battlefield organization precluded massing fire on a target from a battalion of three batteries let alone division artillery. Given this combat experience and the inability to

replicate massed fires in peacetime training exercises at the Combat Training Centers, General Rhame and few Army officers witnessed or really understood the influence of massed fires until Operation Desert Storm.[15]

Perhaps, the strongest endorsement about this impressive display of massed fires came from the Commander of the US VII Corps

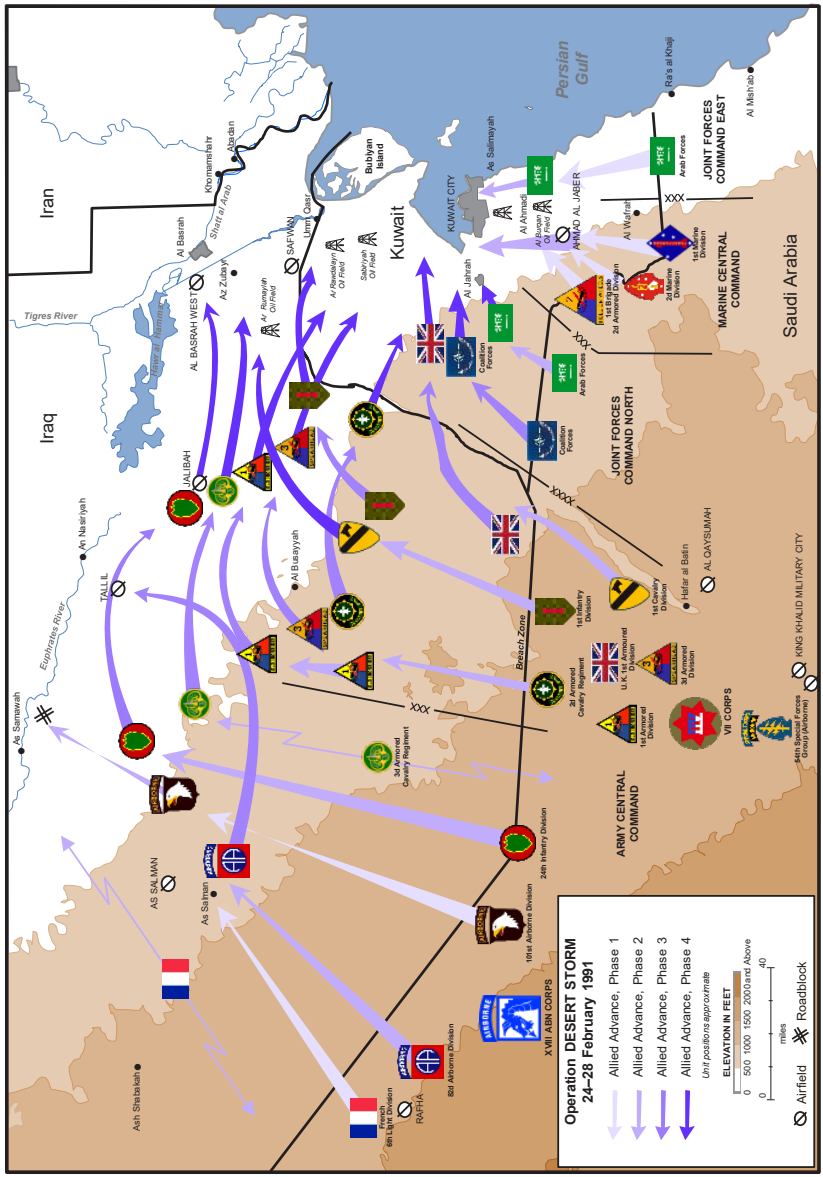

Figure 1: Operation Desert Storm map. *Source:* US Army Center of Military History.

Artillery, Brigadier General Creighton Abrams Jr., and the Commander of the 1st Infantry Division (Mechanized) Artillery, Colonel Michael L. Dodson. On 24 February 1991 in support of the US VII Corps assault, General Abrams allocated the 42d, 75th, and 142d Field Artillery Brigades, two division artilleries, and 10 Multiple Launch Rocket System batteries to create a Soviet-style attack at the breach area. General Abrams positioned approximately 22 artillery pieces for each kilometer of the attack zone. Prior to the attack, more than 350 field artillery pieces fired 11,000 rounds and 414 Multiple Launch Rocket System rockets in a field artillery preparation that lasted 30 minutes. Besides crushing Iraqi morale, this massed fire destroyed 50 tanks, 139 armored personnel carriers, and 152 field artillery pieces.[16] Accurate and deadly massed field artillery fires crushed the enemy, destroyed its will to fight, and permitted the 1st Infantry Division (Mechanized) to roll virtually unopposed through the breach area.[17] As the assault force moved forward to conduct the breach, there was no break in field artillery fire between the preparation and the fires in support of the movement.[18]

Colonel Dodson added his thoughts on the shock of massed fires that day. He reflected in a 25 March 1991 memorandum to the Commanding General of the US VII Corps, General Frederick M. Franks Jr.: "This is likely the first time in military history that an artillery preparation for a deliberate breaching operation has been so comprehensive that not one Soldier lost his life during the operation."[19] After noting the mass and speed of his division's field artillery actions throughout the brief war and the breaching operation in particular, Colonel Dodson addressed the significance of fire support. He pointed out: "Following our artillery fires, not a single round of [enemy] artillery counterfire was received," an indication that friendly field artillery did not have to worry about counterfire because enemy field artillery had been neutralized.[20]

As 1st Armored Division Artillery representatives also observed after the war, massed fires against enemy indirect fire systems and close support of friendly maneuver forces reflected the US VII Corps commander's intent. In numerous warfighter seminars and training exercises conducted prior to the war, commanders emphasized firepower's key role in defeating the enemy. "Pound them

to jelly with fire support and then roll over them with maneuver" formed the core of their thinking.[21] Command post exercises drilled battering the objective with fire support from air interdiction, close air support, attack helicopters, and field artillery then following up with aggressive maneuver assaults.[22]

Headquarters, XVIII Airborne Corps artillery also provided a compelling example of massed fires. After relative inactivity overnight, the corps renewed its attack early in the morning of 25 February 1991. The 18th Field Artillery Brigade and the 6th Battalion, 27th Field Artillery Regiment fired 10 brigade volleys on a series of enemy targets, including field artillery. "The brilliant MLRS [Multiple Launch Rocket System] fires lit the sky and invigorated our Soldiers as much as it disheartened the enemy," reported Lieutenant Colonel Patrick C. Sweeney, the corps artillery operations officer.[23] This firing broke the spirit of the enemy resistance. When asked why they surrendered, interrogated Iraqi prisoners of war pled, "No more rockets."[24]

One captured enemy officer also related the effect of the day's massed fires. He stated that moments after his battery fired a mission, Dual-Purpose Improved Conventional Munitions rained down on his position, destroying most of his weapons and killing two thirds of his soldiers. He added that the remainder of his soldiers immediately deserted their guns.[25]

One day later on 26 February 1991, the 42d Field Artillery Brigade commanded by Colonel Morris J. Boyd delivered massing fires in the VII Corps sector. "The advance continued at a brisk pace through the day meeting with only scattered, generally uncoordinated resistance," Colonel Boyd and Captain Randy Mitchell, an assistant operations officer for the brigade, wrote.[26] At dusk the situation abruptly changed. The 3d Armored Division, the 2d Armored Cavalry Regiment, and the 1st Infantry Division (Mechanized) smashed headlong into elements of three Iraqi armored units. "In a furious night battle that followed, the Brigade found its assets heavily committed," Colonel Boyd and Captain Mitchell reported.[27] The brigade's 3rd Battalion, 20th Field Artillery Regiment and the 2nd Battalion, 29th Field Artillery Regiment massed fires from their M109A2A3 self-propelled 155-millimeter howitzers in support of the M109A2A3s of the 2d Battalion, 82d Field Artil-

lery Regiment, the 4th Battalion, 82d Field Artillery Regiment, and 2d Battalion, 3d Field Artillery Regiment of the 3d Armored Division. Meanwhile the brigade's 1st Battalion, 27th Field Artillery Regiment (Multiple Launch Rocket System) provided rocket fires in a general support role. By dawn of 27 February 1991, the triple punch of close air, accurate and timely massed field artillery fires, and aggressive maneuver had broken the back of the Iraqi forces in the US VII Corps sector.[28]

In an after action report of the 2d Battalion, 17th Field Artillery Regiment of the 212th Field Artillery Brigade commanded by Colonel Floyd T. Banks and attached to the US XVIII Airborne Corps, leaders expressed comparable thoughts about massed fire later that day. On the evening of 27 February 1991, the 2d Battalion, 18th Field Artillery Regiment; the 2d Battalion, 17th Field Artillery Regiment of the 212th Field Artillery Brigade; and the 3d Battalion, 27th Field Artillery Regiment of the 24th Infantry Division (Mechanized) artillery received an emergency fire mission from the division's lead brigade that was receiving incoming fire from the Hammurabi Republican Guard Force Command. The three field artillery battalions massed fires and crushed enemy resistance.[29]

The 2d Battalion, 18th Field Artillery Regiment operations officer, Captain Alfred K. Grey II, furnished an even more descriptive account of that particular fight. As his unit was moving north in support of the 24th Infantry Division (Mechanized), the division's lead elements began receiving incoming fire from the Hammurabi Republican Guards, forcing the division to respond. "We were the first unit in the 212th Brigade. . .to engage the target," Captain Grey recalled.[30] "Within 2 minutes and 10 seconds, we occupied hasty firing positions and fired our first volley. Our fires, massed with 2/17 FA [Field Artillery] and 3/27 FA [Field Artillery] on enemy armor and infantry positions caused mass casualties and a collapse of enemy resistance."[31] Multiple Launch Rocket System rockets, eight-inch howitzer rounds, and 155-millimeter howitzer rounds wiped out the enemy forces.[32]

Field Artillery articles written by other Operation Desert Storm participants reached the same conclusion about massed fires. Major Mark S. Jensen of the 1st Battalion, 27th Field Artillery Regiment of the 42d Field Artillery Brigade said that his battalion repeatedly massed Multiple Launch Rocket System rockets on enemy forma-

tions in support of the 1st Cavalry Division, the 1st Infantry Division (Mechanized), or the 3d Armored Division to defeat the enemy decisively during the course of the ground war.[33] Major Kenneth P. Graves of the US XVIII Airborne Corps Artillery described how the 1st Battalion, 201st Field Artillery Regiment of the West Virginia Army National Guard; the 1st Battalion, 181st Field Artillery Regiment of the Tennessee Army National Guard; and the 1st Battalion, 623d Field Artillery Regiment of the Kentucky Army National Guard also reaffirmed the value of massed fires.[34] In the October 1991 *Field Artillery*, Major Graves noted that the 18th and 212th Field Artillery Brigades and the 24th Infantry Division Artillery massed nine battalions in the early morning hours of the final day of the war in preparation to destroy the Hammurabi RGFC [Republic Guard Force Command] Armored Division.[35] In light of these critiques and others, the Field Artillery School confidently briefed senior field artillery officers at a training seminar after the war "that massed fires are devastating."[36]

As field artillery officers explained in after action reports, massed fires provided effective counterfire and close support in Operation Desert Storm in accordance with accepted doctrine. Fire support doctrine was developed by Major General David E. Ott while he was serving as the Commandant of the Field Artillery School from 1973 to 1976 and codified in Field Manual 6-20, *Fire Support in Combined Arms Operations* (1976), as a vital part of the modernization effort to make the Army more effective in a high-intensity war in Europe. The approach gave a single individual the authority to manage all field artillery fires in a corps. The force commander had the prerogative to employ corps and division artillery in the more important battle—counterfire or close support—depending upon the circumstances. The new fire support doctrine centralized command and control of field artillery fires more than previously, permitted field artillery resources to be directed more effectively against the gravest threat, and ended the confusing practice of dividing counterbattery work among the corps, the division, and even the direct support battalion. Equally as important, Field Manual 6-20 stressed the importance of massed fires to defeat the enemy.[37]

In the October 1991 *Field Artillery,* the Commandant of the Field Artillery School, Major General Fred F. Marty (1991–1993),

discussed his observations about the effectiveness of counterfire in the Gulf War. He noted that Firefinder radars developed in the 1970s and fielded in the 1980s rapidly identified enemy targets and sent the data digitally or verbally to the guns. Then units used cannon and Multiple Launch Rocket System assets to silence Iraqi artillery by delivering "convincing" fires.[38]

Others made similar assessments about counterfire. A 1st Armored Division Artillery field artillery officer related, "In particular, we relied on the MLRS [Multiple Launch Rocket System] as the primary counterfire weapon system and in this role we were able to effectively silence all enemy artillery that fired at us."[39] A 24th Infantry Division (Mechanized) field artillery officer likewise reported that artillery gunnery "synchronized [the] delivery of fires and effectively denied the enemy the freedom to maneuver while protecting the Victory Division's capability to do so [with counterfire]."[40] Colonel Boyd and Captain Mitchell of the 42d Field Artillery Brigade assigned to US XVIII Airborne Corps indicated Iraqis referred to the field artillery rocket barrages as "iron rain."[41]

The 42d Field Artillery Brigade intelligence officer also offered comments about the 26 February 1991 battle, during which the 3d Armored Division destroyed the Tawakalna Mech division and the 42d Field Artillery fired to suppress or destroy at least 60 tubes of enemy artillery.[42] He noted that the AH-64s received little response from Iraqi antiaircraft artillery or air defense artillery. The intelligence officer concluded, "The absence of enemy artillery. . .throughout the war indicates the effectiveness of US artillery. . . . Friendly direct fire units were never hampered by enemy artillery throughout the war."[43]

Similarly, Colonel Garrett D. Bourne, Commander of the 210th Field Artillery Brigade attached to US VII Corps, wrote that the Multiple Launch Rocket System "proved to be indispensable in engaging the enemy out to great distances, allowing the maneuver units to become decisively engaged."[44] Along the same lines, 1st Armored Division Artillery leaders commented that the Multiple Launch Rocket System "performed superlatively" in its first combat test and added that they used it "as the primary counterfire weapon system and in this role we were able to effectively silence all enemy artillery that fired against us."[45] Fighting as part of US VII Corps, the divi-

sion's field artillery fired a 15-minute preparation of 192 Multiple Launch Rocket System rockets and 720 155-millimeter rounds on 24 targets during the 26 February 1991 battle. When US VII Corps subsequently attacked, 1st Armored Division Artillery and other field artillery units repeatedly shifted fires to engage enemy field artillery to permit the maneuver forces to advance. During one two-hour counterfire engagement on the afternoon of 27 February 1991, the 1st Armored Division's field artillery fired 288 rockets and 480 eight-inch rounds at 21 enemy field artillery positions. On average, American counterfire engaged enemy field artillery of the Medinah Division of the Republican Guard Army within six minutes after the enemy guns were acquired by a Firefinder Q-36 or Q-37 radar that day. Battle damage assessment after the war credited field artillery units with destroying 70 enemy field artillery tubes or their crews during this particular counterfire fight.[46]

In the meantime, the 3d Armored Division's field artillery and reinforcing field artillery repeatedly provided counterfire on 26 February 1991. Supporting the 3d Armored Division's second brigade, the 4th Battalion, 82d Field Artillery Regiment and the 3d Battalion, 20th Field Artillery Regiment of the 42d Field Artillery Brigade engaged enemy bunker complexes early in the evening to permit the maneuver arms to continue their advance with minimal resistance. Later, a Q-36 radar acquired active enemy indirect fire systems that the division's field artillery subsequently destroyed by counterfire. Shortly after this action, a Q-36 radar located more enemy field artillery; then three 42d Field Artillery Brigade battalions—the 2d Battalion 3d Field Artillery, 2d Battalion, 29th Field Artillery, and 1st-27th Field Artillery, massed fires to silence the enemy artillery."[47]

Major General Barry R. McCaffrey, Commanding General of the 24th Infantry Division (Mechanized), referred to 212th Field Artillery Brigade efforts and the unit's after action report during a 31 March 1992 briefing to the Field Artillery Conference at the Field Artillery School. He underscored the overriding significance of counterfire on the ground war: "First priority of FA [field artillery] is to win the counterfire battle."[48]

After reviewing after action reports, the Field Artillery School concurred with Major General McCaffrey and the 212th Field Artillery Brigade's conclusions about the efficacy of counterfire. In

a supportive appraisal of counterfire doctrine, the school noted, "The most important lesson here is that an aggressive proactive CB [counterbattery] policy pays tremendous dividends."[49] The school then noted, "The Firefinder family of radars was invaluable in detecting targets [indirect fire systems] and adjusting fire onto hostile positions [field artillery]."[50]

While counterfire was decisive, efforts to shift massed fires around the battlefield also played a pivotal role in furnishing close support to the maneuver arms and reinforcing the fire support team's importance for coordinating close air support, naval gunfire, mortars, and field artillery for the maneuver commander. If it functioned as intended, the fire support team—a concept developed in the 1970s—would provide the maneuver commander with close fire support when and where he needed it. Along with counterfire, proactive and responsive close support would permit friendly maneuver forces to make contact with less effective enemy forces.[51]

Many field artillery officers observed firsthand the effect of close support. In a draft article on the 2d Armored Cavalry Regiment's operations during the war, Major John Klemencic and Captain John Thomson discussed their unit's fire support as part of the US VII Corps' offensive. From 24 to 26 February 1991, the regiment's field artillery repeatedly shifted massed fires to strike dismounted Iraqi infantry and field artillery that had been acquired by Q-37 radars. During the Battle of 73 Easting on 26 February 1991, for example, the 6th Battalion, 41st Field Artillery Regiment of the 210th Field Artillery Brigade shot more than 700 rounds at enemy targets in a direct support role to the 2d Squadron, 2d Armored Cavalry Regiment. Reflecting on its overall combat action in the Gulf, the 2d Armored Cavalry Regiment's unit history applauded friendly field artillery for furnishing responsive and effective close support.[52]

On the morning of 26 February 1991, the 1st Armored Division under US VII Corps experienced the same kind of close fire support. The division approached Al Busayyah and then turned toward the Medinah Division of the Republican Guards situated about 100 kilometers to the east. As the division closed within 50 kilometers of the Medinah's main position, the division's intelligence (G-2) officer identified an enemy blocking position and sent the information

to the division's field artillery, which struck it with Multiple Launch Rocket System rockets. The same intelligence officer later picked up a second blocking position approximately 15 kilometers beyond the first. Again, the division's field artillery bombarded the enemy with rockets. Specifically, the 4th Battalion, 27th Field Artillery Regiment in support of the 1st Armored Division recorded in an after action report about numerous massing fires on 26 and 27 February 1991 to support the maneuver forces. With support from 8-inch and 155-millimeter self-propelled howitzers and massed rocket fires—called "Firestrike" by the battalion—the division attacked 65 armored vehicles on 27 February 1991; they neutralized about 50 percent of them according to Apache helicopters that assaulted the vehicles afterward and saw 25 to 30 burning.[53]

The 3d Battalion, 20th Field Artillery Regiment of the 42d Field Artillery Brigade described comparable action on 26 February 1991. After linking up with the 3d Armored Division and receiving a reinforcing mission to support the division's 4th Battalion, 82d Field Artillery Regiment, the 3d Battalion moved east toward Iraqi positions. After making contact with the enemy, the division stopped and called for field artillery fires. In support of the division's field artillery, the 3d Battalion opened up fire from its self-propelled 155-millimeter howitzers. Following this attack of more than 1,000 rounds, close air support from A-10s and attack helicopters hit the enemy.[54]

As might be expected, other field artillery officers furnished similar appraisals about the effectiveness of close support. The 2d Battalion, 29th Field Artillery Regiment of the 42d Field Artillery Brigade recounted providing many battalion massed fires on the evening of 26 February 1991 in support of the 3d Armored Division in the US VII Corps sector. Following the war, the 2d Battalion recorded:

> The battle raged throughout the evening and night with direct fire engagements, attack helicopters, CAS [close air support] and artillery raining steel on the Tawakalna. HE [high explosive shell] and white phosphorous proved particularly effective in the neutralization and destruction of the bunker complexes and associated ammunition caches as attested by the spectacular secondary explosions.[55]

In a report to the division G-3 (operations), the Commander of the 24th Infantry Division (Mechanized) Artillery, Colonel Ronald E. Townsend, wrote about his experience with close support. He noted:

> Throughout the entire operation, artillery fire was timely, accurate, and lethal. . . . This is a tribute to the Soldiers on the gun line, forward observers, and fire direction centers. The artillery gunnery chain synchronized delivery of fires and effectively denied the enemy freedom to maneuver while protecting the Victory Division's [24th Infantry Division (Mechanized)] capability to. . .[maneuver].[56]

On 17 June 1991, the 210th Field Artillery Brigade dispatched a memorandum to General Hallada about the unit's combat actions. "Never before was this [the effectiveness of close support] more evident than in Iraq and Kuwait as the brigade provided accurate and timely fires to the maneuver forces," the brigade reported.[57] Along the same lines the 6th Battalion, 27th Field Artillery Regiment (Multiple Launch Rocket System) in the 75th Field Artillery Brigade attached to the US VII Corps wrote:

> The dawn of this day [28 February 1991] saw our. . .brigade unleash it's (sic) full combat power in a final prep to destroy remaining Iraqi units. . . . We had in effect set up a firing assembly line. SPLLs [Multiple Launch Rocket System Self-Propelled Loader/Launchers] would fire, drive up to new rocket pods, reload, and go right back out to fire again. This ritual was performed over and over.[58]

From the unit's perspective, rocket and cannon fires furnished effective close support and helped destroy the Iraqi army.[59]

Upon succeeding Major General Hallada as the Commandant of the Field Artillery School in July 1991, Major General Marty described the contribution of close support in an October 1991 *Field Artillery* article:

> Massed artillery fires provided the maneuver commander combat power at the time and place he needed it. This gave him overwhelming fire superiority and allowed him to maneuver to exploit the effects of fire.[60]

As indicated by combat action during Operation Desert Storm, convincing massed fires in the form of counterfire and close support silenced Iraqi artillery, helped to destroy the enemy's will to fight, allowed the friendly maneuver forces to maintain the rapid pace of their attack, and saved friendly lives.[61] To accomplish this, active Army, Army reserve component, and Marine field artillery units fired more than 57,000 rounds. Of these they shot almost 6,000 rockets and 32 Army Tactical Missile System missiles; the rest were 105-millimeter, 155-millimeter, and eight-inch rounds.[62] Reflecting upon this contribution from a maneuver commander's perspective, Major General McCaffrey wrote, "All of us appreciate the tremendous contribution of the artillery. Our enormous success was due, in large part to the artillery. The success of your counterfire limited our casualties."[63] On another occasion on 31 March 1992, McCaffrey said, "Field Artillery is the dominant combat force on the battlefield. Commanders must understand how to plan, synchronize, and deliver its firepower."[64]

Although General McCaffrey and other Army officers praised the field artillery for its impressive performance in Desert Storm, the 210th Field Artillery Brigade wisely cautioned against unabashed exuberance. In a 17 June 1991 memorandum to Major General Hallada, the unit recorded:

> The success of the 210th FA [Field Artillery] BDE [brigade] in this war was phenomenal. The Soldiers were justifiably proud of their accomplishments. But let's not forget that combined arms tactics and doctrine really won the war. . . . Outstanding fire support execution was the culmination of strenuous training with the maneuver unit.[65]

As counterfire and close support with massed fires suggested during Operation Desert Storm, the Army's field artillery had fundamentally sound doctrine and performed well. By integrating target acquisition systems; command, control, communications, and computer systems; support and sustainment systems; and munitions and weapon systems, the units silenced enemy indirect fire systems and permitted the maneuver arms to advance relatively unscathed by enemy indirect and direct fires. Such performance in Operation

Desert Storm validated fire support doctrine in Field Manual 6-20, *Fire Support for Combined Arms Operations* (1983), which was the field artillery's capstone "how-to-fight" manual and the basic reference for fire support planning and coordination.

Confronting the Deficiencies

Although it highlighted existing strengths with fire support doctrine, Operation Desert Storm concurrently reinforced pre-war concerns held by many field artillery officers regarding equipment and weapon deficiencies that had not been eliminated through modernization. Many field artillery systems lacked the speed, mobility, and ranges required for the modern battlefield.

Of the major field artillery systems, the M981 Fire Support Team Vehicle adopted in the 1970s received the most scathing criticism from field artillery officers and Soldiers. During the Gulf War, the M981 validated pre-war apprehension because it was not sufficiently mobile to stay abreast of the faster M1 Abrams tank and M2 Bradley fighting vehicle. In their draft article about fire support during Operation Desert Storm, Major Klemencic and Captain Thomson described the M981 as "slow and unreliable."[66] They noted that the [2d Armored Cavalry] Regimental Commander and the Squadron Commander were cognizant of this problem and stressed not leaving the field artillery officers and Soldiers who rode in the slower vehicles; they were the eyes of the field artillery battalions with their ability to locate targets. In view of this, commanders had to consider the vehicle's limitations as they planned operations or potentially do without effective and responsive fire support.

The 1st Armored Division Artillery addressed the same issue and reached the same conclusion on 2 July 1991. It commented that the vehicle "is based on the old M113 family of vehicles and is not suitable for keeping up with the current M1 Abrams and M2/3 Bradley fleet of maneuver vehicles. . . . In the future, we need a fire support vehicle that can move as fast as the maneuver units it supports."[67]

Along the same line, the 1st Cavalry Division Artillery wrote about its experience with the vehicle during the war. It explained, "During Desert Shield training and actual combat operations, the FISTV could not physically keep up with the sleeker M1 and M2

even when they slowed down their pace significantly."[68] The offensive orientation of Operation Desert Storm built around AirLand Battle's doctrine of speed and maneuver clearly reinforced the obsolescence of the vehicle and the need for a Bradley-based fire support team vehicle advocated as early as 1976–77 by the former Commandant of the Field Artillery School, Major General Donald R. Keith (1976–77).[69]

Likewise, the war demonstrated the limited mobility of the AN/TPQ-36 and AN/TPQ-37 radars, often called Firefinder radars and introduced in the 1970s; the Tactical Fire Direction System adopted in the 1970s; the M198 towed 155-millimeter howitzer fielded in the late 1970s and early 1980s and used by the Army and the Marine Corps; and the M109A2/A3 155-millimeter self-propelled howitzer introduced in the 1970s. Mounted on old five-ton trucks, Firefinder radars that had been designed to locate Soviet and Warsaw Pact indirect fires systems and the Tactical Fire Direction System that had been developed to compute gunnery solutions were not constructed for rapid movement and had difficulties keeping up with the maneuver arms. To overcome this critical limitation, some field artillery units loaded their Tactical Fire Direction System shelters, Firefinder radar shelters, and generators on Heavy Expanded Mobility Tactical Trucks to give them better cross country mobility and more speed. Also, in some instances, M109A2/A3 units could not support task forces because they could not stay abreast of the faster maneuver forces, while the M198 was slow to displace.[70]

The range inferiority of the Army's field artillery in relation to Iraqi field artillery also alarmed many field artillery officers and Soldiers. Although the Multiple Launch Rocket System performed well in its first combat test and was accurate and lethal, the system lacked sufficient range.[71] In fact, Colonel Vollney B. Corn Jr., who commanded the 1st Armored Division Artillery during Operation Desert Storm, and Captain Richard A. Lacquemont, who was the assistant operations officer for the 1st Armored Division during Operation Desert Storm, outlined the consequences of the system's 30-kilometer range. Four Iraqi cannon systems and two multiple rocket launcher systems had longer ranges than the Multiple Launch Rocket System. "In the hands of a better trained and more intelligent

foe, these [Iraqi] systems could have made it extremely difficult for us in the counterartillery battle," they related in an October 1991 *Field Artillery* article.[72]

In June 1991, the 210th Field Artillery Brigade made a similar observation about the Multiple Launch Rocket System. It reported, "During the VII (US) Corps' offensive covering force operations, 2 ACR [Armored Cavalry Regiment] air scouts often identified high payoff targets at ranges beyond the current MLRS [Multiple Launch Rocket System] range. These targets were often engaged by CAS/AI [close air support/air interdiction] or helicopters when sorties were available and weather permitted."[73] In view of this example and their experiences with the Multiple Launch Rocket System, commanders from the 1st Cavalry Division Artillery, the 1st Armored Division Artillery, the 210th Field Artillery Brigade, and Multiple Launch Rocket System units recommended extending the system's range from 30 kilometers to 50 kilometers to provide critical standoff capabilities and stay abreast of likely improvements in international field artillery rocket systems. With a range of 23 kilometers, the M109A2/A3 155-millimeter self-propelled howitzer was also outranged by conventional and extended-range munitions fired by Iraqi cannon artillery. To eliminate this stark imbalance, future cannons required ranges of 40 kilometers with conventional munitions and 50 kilometers with extended-range munitions. Without rocket and cannon field artillery systems with longer ranges than the enemy's indirect fire systems, standoff capabilities would be sacrificed and counterfire would be seriously compromised.[74]

Besides recognizing the requirement for longer ranges, another significant Operation Desert Storm lesson focused on the need for more field artillery in the division and corps. Given the importance of the Multiple Launch Rocket System, a battery of nine Multiple Launch Rocket System M270 launchers in the division could be overworked if not simply overwhelmed by the demands of supporting the entire division and could not depend upon having the corps artillery's Multiple Launch Rocket System battalion available when it was needed. To eliminate this problem, some field artillery officers with Gulf War combat experience favored equipping division artillery with a battalion of 27 M270 launchers to replace the battery of

nine launchers. This would increase firepower, permit rotating fire missions among a greater number of launchers, and allow conducting maintenance and resting the crew.[75]

In addition to increasing the number of M270 launchers in the division, some field artillery commanders wanted more cannon artillery in the division. The commander of the 1st Infantry Division Artillery, Colonel Dodson, advocated making two additional cannon battalions organic to the division. This would give the division commander five cannon battalions (120 cannons) and sufficient fire support to conduct "most operations without further augmentation."[76]

Field artillery officers with experience at the corps also espoused more cannon artillery as the commander of the 42d Field Artillery Brigade, Colonel Boyd, urged. In an insightful memorandum he wrote, "We can make up for a shortage of artillery by focusing what you do have at the right place and right time, but it isn't easy."[77] More field artillery would make providing fire support easier.[78]

Although the Dual-Purpose Improved Conventional Munition was the overwhelming munition of choice for commanders and was devastatingly effective, its dud rate raised serious concerns.[79] During the war, unexploded Dual-Purpose Improved Conventional Munition bomblets from cannon and rocket systems formed hazardous minefields. Especially in soft sand, they created a significant battlefield hazard for friendly maneuver forces to negotiate. For example, a Multiple Launch Rocket System fire mission of 12 rockets, each containing 644 bomblets with an allowable dud rate of 2.5 percent, would produce a minefield of about 200 armed and deadly destructive munitions. Dual-Purpose Improved Conventional Munition dud minefields hindered movement, compelled maneuver forces to alter their routes, and led to some injuries and deaths to friendly forces.[80] In an after action report, Colonel Boyd and Captain Mitchell explained the conundrum. "DPICM [Dual-Purpose Improved Conventional Munition] showed itself to be a 'two-edge sword.' While this munition was very effective against enemy targets, there were at times large numbers of unexploded 'bomblets' left littering the area that maneuver (and subsequently support units) had to cross," they noted.[81]

Operation Desert Storm revealed another significant field artillery deficiency. Wire communications tied existing field artillery

systems together to limit their freedom of movement. Based upon the growing significance of smart, precision, and wide-area munitions that would increase the vulnerability of all combat systems throughout the battlefield, future field artillery systems required the ability to operate autonomously and move freely without being tethered to wire communications. Shoot and scoot capabilities, emerging with Multiple Launch Rocket System M270 launcher, were required for all field artillery weapons systems.[82]

Another technological problem also shed light on a limitation of the Total Army concept and its implementation. Prior to the war, Army National Guard field artillery units lacked the Tactical Fire Direction System for computing technical and tactical gunnery problems and had to rely on manual methods that were slow and subject to human error. Captain Richard A. Needham and Major Russell Graves of the 142d Field Artillery Brigade of the Arkansas Army National Guard explained after the war:

> Until mobilization, the brigade had strictly manual TOCs [tactical operational centers]. Rotation to the National Training Center (NTC) at Fort Irwin, California, with the 1st Infantry Division (Mechanized) and the 3d Armored Cavalry Regiment (ACR) had uncovered a serious flaw in the Army's Total Force concept. Manual TOCs don't have a place in the digital realm. Heavy TACFIRE [Tactical Fire Direction System]-equipped units don't have the time or assets to interface with manual TOCs.[83]

To be sure, Captain Needham and Major Graves touched on an important issue. Some of the modernization of the 1970s and 1980s had not yet reached the reserve components as part of the Total Army concept. In this particular instance, Army National Guard field artillery units still employed manual technical and tactical fire direction methods on the eve of Operation Desert Storm and searched frantically for Light Tactical Fire Direction Systems before deploying to the Gulf to give them automated fire direction capabilities and the ability to function as a team with active component field artillery units equipped with the Tactical Fire Direction System. Even though the contractor found sufficient numbers of the Light Tactical Fire

Direction System to equip Army National Guard field artillery units, the rushed fielding schedules hindered proper training.[84]

Despite this critical deficiency, Operation Desert Storm substantiated 1970s and 1980s modernization efforts that were designed to counter the Soviet-Warsaw Pact threat. Combat operations validated AirLand Battle fire support doctrine outlined in Field Manual 6-20. During the short war, field artillery units repeatedly provided effective and responsive massed fires to neutralize enemy indirect fire systems and facilitate the maneuver arms' attack, while the Multiple Launch Rocket System and the Army Tactical Missile System unequivocally demonstrated their ability to provide effective fire support.

Combat operations also underscored critical deficiencies. The Firefinder radars, the M981 Fire Support Team Vehicle for the fire support observer team, the Tactical Fire Direction System for computing gunnery problems, the M198 howitzer, and the M109A2/A3 howitzer lacked the speed to stay abreast of maneuver arm vehicles, while many Iraqi cannon and rocket systems outranged their American counterparts; and the Dual-Purpose Improved Conventional Munition's dud rate left impassable mine fields. Although these shortcomings did not detract from the Field Artillery's overall solid performance against the Iraqi military forces, the branch had to replace these obsolete systems with modern ones to ensure effective counterfire and close support to stay abreast of the capabilities of foreign field artillery systems. Failure to modernize would compromise providing effective fire support on the future battlefield.

NOTES

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Chapter 2

A New but Still Dangerous World

The collapse of the Warsaw Pact, the reunification of Germany, and the 1989–1991 disintegration of the Soviet Union demolished the cornerstone of American foreign policy of deterring Soviet and Warsaw Pact military aggression in Europe, negated the need for stationing a large military force in Europe, and undermined the rationale for maintaining a large military establishment to provide for US national security. This abrupt conclusion of the Cold War prompted Congress to reduce the US military's size and budget and prodded the US military to develop a new strategy during the 1990s to reflect the emerging international political environment. For the Army and the Field Artillery, power projection meant rewriting doctrine and introducing deployable weapon systems and equipment to complement those with less strategic mobility. Meanwhile the emerging budget reality required restructuring to accommodate shrinking end strength and funding. Simultaneously, the Army faced the imperative to implement lessons from Operations Desert Shield and Desert Storm. Working together, the end of the Cold War, Operation Desert Shield, and Operation Desert Storm caused the Army and the Field Artillery to restructure their forces and embark on a vast program to modernize their light and heavy forces.

A New World, Budget Reductions, and Restructuring

The post-Cold War world of the 1990s posed a dilemma for the Army. For the first time in five decades, the United States lacked a viable threat, meaning the Soviet Union and Warsaw Pact, to stimulate defense spending. Such circumstances motivated Congress to renew its determination to shrink the size of the military that Operation Desert Shield and Operation Desert Storm of 1990–1991 had temporarily derailed. After the Gulf War and the end of the Cold War, Congress picked up where it left off in 1990. Legislators started aggressively reducing the military's budget again and began shifting money from military to domestic programs to achieve a peace

dividend. This led to a massive reduction to the Army's budget and mammoth force structure and personnel cuts. From five corps, 18 active component divisions, and 10 reserve component (Army National Guard and Army Reserve) divisions in 1989, the Army's force structure shrunk over a period of eight years to four corps, 10 active divisions, and eight Army National Guard divisions. Simultaneously, the Army trimmed its personnel strength in Europe from 215,000 to 65,000 Soldiers and closed more than 700 installations in the continental United States and overseas. Voluntary early transition, voluntary separation incentives, special separation benefits, reduction-in-force actions, selective early retirement, and other programs meanwhile dropped the active Army's personnel strength from 770,000 to 480,000 and its reserve component personnel strength from 770,000 to 560,000 by 1999. The effort also included drastically decreasing the Army's civilian workforce from 403,000 in 1989 to 225,000 in 1999 through reduction-in-force actions and voluntary early retirement authority. At the completion of the downsizing, the active Army and its reserve components were the smallest that they had been since 1941 on the eve of World War II.[1]

For the Field Artillery, the downsizing also had a striking impact. In 1989, the Regular Army and its reserve components had a total of 218 field artillery battalions and 38 batteries, including batteries in armored cavalry regiments. While the Regular Army had 96 battalions, the Guard had 105 and the Army Reserve had 17. By the end of the 1990s, 141 field artillery battalions and 22 batteries remained—12 in the active component and 10 in the Guard. The active Army had 50 battalions, and the Guard had 91 battalions. The restructuring left the Army Reserve without any field artillery by 1996 and decreased the field artillery in the active component by 42 percent and in the reserve component by 36 percent.[2]

To adjust to the enormous reductions, the Army reallocated its combat, combat support, and combat service support units among its active and reserve components to achieve better balance and retain its fighting capabilities during the 1990s and into the near future. In 1990, the Army National Guard provided 44 percent of the combat forces, 31 percent of the combat support, and 25 percent of the combat service support; the Army Reserve had 53 percent of the

combat support and combat service support as well as a small portion of combat forces; and the active Army made up the rest.[3]

Based on 1993 recommendations from a comprehensive "bottom-up review," Secretary of Defense Les Aspin subsequently initiated far-reaching reforms that restructured the Army. Over a period of years, the reforms realigned the preponderance of the Army's reserve component combat capabilities in the Army National Guard and moved the bulk of the combat support and combat service support to the Army Reserve. Beginning in 1994 and continuing into 1997, approximately 50 combat units moved from the Army Reserve to the Army National Guard, while more than 100 reserve component combat support and combat service support units shifted from the Army National Guard to the Army Reserve. By the time the revamping was completed in 1997, the Army National Guard provided 55 percent of the combat units, 46 percent of the combat support, and 25 percent of the combat service support while maintaining its state and civil missions. The Army Reserve shifted to primarily a support force with 20 percent of the combat support, 47 percent of the combat service support, and one percent of the combat units. The active component filled in remaining combat, combat support, and combat service support. With the restructuring, the Army's reserve components took on a more prominent role in national defense. Because of its severely decreased size, the active Army was more dependent—lacking the capability to sustain the demand for peacekeeping missions and routine deployments without being augmented.[4]

As might be expected, the Field Artillery felt the impact of this sweeping restructuring and downsizing. Moving to ensure responsive and effective fire support, the Army Science Board of November 1995 examined the Army National Guard's general support and direct support field artillery missions to determine if they should be modified. During Operation Desert Storm, the 142d Field Artillery Brigade of the Arkansas Army National Guard, the 196th Field Artillery Brigade of the Tennessee Army National Guard, and other Army National Guard field artillery units furnished effective general support after a short pre-deployment training period and could maintain their proficiency with this mission during their 39 days of annual training.

Because direct support was more complicated, Soldiers would have difficulty achieving competence within the allotted annual training time. Such circumstances prompted the Army Science Board to propose abolishing the reserve component's direct support field artillery mission but retaining its general support field artillery mission.[5]

Recognizing the validity of the recommendation, the Army reordered its field artillery missions. By the end of the decade, the Army National Guard retained 63 percent of the Army's general support field artillery while the active component assumed the remaining general support as well as all direct support artillery responsibilities. Also, because much of the general support field artillery transferred to the Army National Guard, one of two field artillery brigades with a general support mission in the heavy forces was in the Guard in 2000. In the light forces, three cannon battalions and one Multiple Launch Rocket System battalion of the XVIII Airborne Corps provided general support field artillery for all four light divisions (the 10th Mountain Division, the 25th Infantry Division, the 82d Airborne Division, and the 101st Airborne Division), two light separate brigades, and the 3d Armored Cavalry Regiment.[6]

To carry out the reorganized missions, the Army needed to rearm the Guard's field artillery. Since the Soviet Union was no longer a credible nuclear-capable enemy and the Cold War had ended, the Army no longer required the M110 eight-inch self-propelled howitzer's conventional and nuclear warheads in the Army of Excellence's corps artillery. Additionally, the Gulf War demonstrated that the M110 lacked the speed to keep up with fast-moving Abrams tanks and Bradley infantry fighting vehicles, was manpower intensive, and had low survivability. With these reasons in mind, the Army decided in 1992 to replace it with the Multiple Launch Rocket System M270 launcher by converting active component and Guard M110 units into Multiple Launch Rocket System units. Major General Fred F. Marty, Commandant of the Field Artillery School from 1991 to 1993, explained the change in a 1992 *Field Artillery* article on the state of the branch. He noted that a Multiple Launch Rocket System battalion provided up to 40 percent more firepower than an eight-inch howitzer battalion and required significantly fewer personnel. In an era of decreasing personnel, a weapon system with a

smaller crew was crucial. Equally important, the Multiple Launch Rocket System M270 launcher was fast enough to stay abreast of the Abrams tank and Bradley fighting vehicle in combat.[7]

Twelve years later in 2004, the Army changed the last Guard unit from the M110 to the Multiple Launch Rocket System M270 launcher when the Field Artillery School finished training the Colorado Army National Guard on the rocket system. Following this conversion, the Field Artillery had no nuclear capabilities for the first time since 1953 when it fired Atomic Annie at Frenchman's Flats, Nevada, and then fielded the more modern field artillery system to the active component and Guard operational units.[8]

To satisfy Army National Guard requirements, the Army reduced the number of M109A6 (Paladin) 155-millimeter self-propelled howitzers in the Army of Excellence heavy division that it formed during the 1980s to counter the Soviet and Warsaw Pact threat. The Army of Excellence heavy division had three battalions of M109A6s (72) for direct support and nine Multiple Launch Rocket System M270 launchers for general support. Because of plans to introduce the futuristic Crusader self-propelled 155-millimeter howitzer, the precision Sense-and-Destroy Armor Munition, the M270A1 launcher, and the Multiple Launch Rocket System Smart Tactical Rocket with its unprecedented lethality, the Army trimmed the number of Paladins in the heavy division to 54. By decreasing the number of howitzers, the Army abandoned the Army of Excellence cannon battalion of three eight-howitzer batteries (3x8 force structure) based on 1978 Legal Mix V Study recommendations for a cannon battalion of three six-howitzer batteries (3x6 force structure). This freed up Paladins for the Guard and personnel to form more Multiple Launch Rocket System batteries for general support in the heavy division. In 2003 following seven years of work, the Army completed transferring the extra Paladins gained by converting to the 3x6 force structure in the active force to the Army National Guard. Paladins replaced obsolete M109A2/A3 self-propelled 155-millimeter howitzers and some M109A5 self-propelled 155-millimeter howitzers to give the Guard a modern fleet of self-propelled howitzers to complement its Multiple Launch Rocket System M270 launchers.[9]

To compensate for the loss of 155-millimeter self-propelled howitzers in the active and reserve components, the Army increased the number of M270 launchers in the Army of Excellence active heavy division. Recognizing the need for more field artillery firepower based on lessons learned from the Gulf War, the Field Artillery School submitted a plan to the Chief of Staff of the Army, General Gordon R. Sullivan, in the summer of 1992 to double the number of M270 launchers in the heavy division to 18 by creating a battalion of two batteries of nine launchers each (2x9 force structure). General Sullivan approved the concept, but funding and manpower constraints prevented implementation.[10]

Prompted by the 1993 Legal Mix VII Study and the November 1995 Army Science Board Study that reinforced the requirement for more firepower and the availability of funding, the Army announced a major Multiple Launch Rocket System force structure initiative in June 1996. Beginning in 2000, the Army planned to add a second rocket battery in the heavy division to increase the number of launchers from nine to 18 and form a two-battery Multiple Launch Rocket System battalion.[11]

Even before the new organization could be implemented, the Army revamped the heavy division's rocket resources again, creating a battalion of three batteries of six launchers each (3x6 force structure). This action made rocket batteries leaner while reducing the size of the battery's battlefield footprint and logistical requirements, but retained the same number of launchers in the battalion to preserve firepower. Downsizing decreased the number of field artillery cannons in the heavy division, but new systems such as the M270A1 launcher and Paladin offset the reduction and greatly enhanced lethality to ensure responsive and effective fire support in the heavy division.[12]

Similarly, the Army overhauled its aging M198 towed 155-millimeter howitzer units in the active and reserve component light divisions. It reduced the number of M198s in the battalion from 24 to 18 by converting from the 3x8 force structure to the 3x6 force structure. This freed up M198s to replace the worst M198 guns and permitted the Army to send those cannons to the depots.[13]

Unquestionably, the end of the Cold War and Operation Desert Storm caused serious personnel reductions and drove significant force structure changes in the Field Artillery. Through force restructuring, the Army shifted the Guard's direct support mission to the active component while giving the Guard a portion of the general support mission—a role that Guard units had performed ably during the war in contrast to inadequate direct support mission performance. Additionally, the Army eliminated field artillery in the Army Reserve. This reorganization tied the active component and Army National Guard field artillery units more tightly together than they had ever been. Without the two Guard field artillery brigades that provided general support for each active component field artillery brigade, the active component's field artillery would have difficulties providing fire support when it went to war. As part of transferring more responsibility to the Guard, the active component reduced the number of Paladins in the heavy division and modernized the reserve component—equipping it with excess Paladins created by the downsizing and replacing the aging, slow, nuclear-capable M110 with Multiple Launch Rocket System M270 launchers. Restructuring effectively terminated Field Artillery nuclear capabilities in place since 1953 in favor of conventional firepower and simultaneously created a symbiotic relationship between the active component and the Guard.

Modernizing Field Artillery Systems

The Army's ability to dominate the future battlefield with a deployable force rested on equipping personnel with appropriate weapons and equipment, applying fire support lessons learned from Operation Desert Shield and Operation Desert Storm, and implementing serious modernization. Existing fire support system of systems—target acquisition; weapons and munitions; command, control, and communications; and support—had been designed for fighting in Europe against the Soviet Union and the Warsaw Pact. They also supported the heavy forces with some recognition of the light forces' requirements. To be a key player in power projection and complement new field artillery systems for the heavy forces,

the Field Artillery School faced the imperative to introduce new or modernized systems with strategic deployability.

In 1993, the school fully acknowledged the dilemma posed by current fire support systems. In a January 1993 report, the Army and the Field Artillery School concluded:

> While today's fire support systems are impressive, the requirement to keep pace in a changing world requires that we modernize continually. It is a given that the future field artillery force will be smaller. For it to remain effective, it must be more lethal with better systems and munitions, more survivable, and more deployable [than Cold War era systems].[14]

To accomplish this, the Field Artillery had to eliminate deficiencies identified during Operation Desert Shield and Operation Desert Storm while leveraging information technologies. Confronted by constrained budgets and an uncertain threat, the Field Artillery School announced a two-pronged approach in January 1993. It planned to improve existing serviceable platforms and systems by applying information-age technologies and develop totally new systems if existing systems could not be upgraded sufficiently to meet future needs. If modernization were done competently, it would create a power-projection force capable of winning an information-age war, conducting precision fires, and dominating the maneuver battle.[15] The school judiciously explained in 1993, "The future battlefield will place new demands on the fire support system. The requirement to achieve land force dominance with minimum losses places increasing emphasis on the use of fires to defeat the enemy."[16]

From the Field Artillery's perspective, the requirement to conduct precision fires placed a conspicuous onus on target acquisition systems. They needed to locate targets with greater accuracy at greater ranges than ever before. Introduced in the late 1970s and early 1980s, the AN/TPQ-37 mortar locating radar and the AN/TPQ-36 artillery locating radar were too large and heavy and used 1970s technology. Future target acquisition systems would require increased strategic mobility and ranges, among other critical capabilities, to stay abreast of the changing battlefield.[17]

Anticipating the increased emphasis on strategic deployability, Major General Raphael J. Hallada, Commandant of the Field Artillery School from 1987 to 1991, pushed to place the Q-36 radar on a trailer to improve strategic mobility for the heavy and light forces. Adopting General Hallada's recommendation, the Army fielded the Q-36 Version Seven in 1994 then subsequently enhanced the system with electronic upgrades. In 1999, the Army started fielding the new Q-36 Version Eight suitable for the digitized battlefield required by the Force XXI campaign plan.[18]

Then as an interim solution until an enhanced AN/TPQ-47 could be fielded, the Army initiated action in 1990 to improve the Q-37 to locate rockets and field artillery at longer ranges. The Army's intention was to field the Q-47 early in the first decade of the 21st Century that would provide better tactical and strategic mobility, improve accuracy, double the detection range to 60 kilometers with cannon artillery, furnish targeting capabilities of 100 kilometers for rocket artillery and 300 kilometers for missile artillery, satisfy the requirements for the digitized battlefield and AirLand Operations, and replace all Q-37s. However, technological and software problems with the Q-47 radar forced the Army to stop developmental work in 2004 and continue using an enhanced Q-37.[19]

As the Army and Field Artillery worked to modernize the Q-36 and Q-37 and develop an ill-fated Q-47 for detecting threat indirect fire systems and long-range precision strike capabilities, they also confronted the requirement to improve target acquisition for close support (field artillery fires designed to engage enemy infantry or armor that blocked advancing friendly forces) to the maneuver arms. After funding became available and the Cavalry and Infantry received their Bradley fighting vehicles, the Field Artillery replaced the aging and slow M981 with the Bradley A2 vehicle that maneuver arms had used in Operation Desert Storm. To make the Operation Desert Storm Bradley A2 suitable for fire support missions, the Army added a fire support mission package and started fielding the new version in the 1990s as the M7 Bradley Fire Support Team Vehicle.[20]

Because digitization or the employment of digital computers for command and control were inherent in Force XXI, the Army modernized the M7 Bradley Fire Support Team vehicle even more.

In 1995, the Army upgraded it to the M7A1 to furnish information superiority and defeat the projected threat in the 21st Century. As part of continuing modernization efforts, the Army added a digitized fire support mission package and changed the name to the A3 Bradley Fire Support Team Vehicle in 1999.[21]

In the meantime, the Army worked to improve the lasing capabilities of the combat observation lasing team in the heavy and light forces by taking steps to replace its M981 vehicle. Designed for heavy and mechanized forces, the M981 presented a unique signature in the light forces and stood out because they used High Mobility Multipurpose Wheeled Vehicles as their scout vehicles. To eliminate this striking discrepancy, the Army adopted the M707 High Mobility Multipurpose Wheeled Vehicle with a fire support mission package for the light forces. Initially known as the Striker, it became the Knight after 2002 to avoid confusion with the Stryker Brigade Combat Teams being formed at the time. This system provided precision targeting capabilities for the heavy and light forces and had unprecedented mobility, flexibility, and stealth. In 2001, the 3d Armored Cavalry Regiment received the first Knight vehicles for its combat observation lasing team. By the beginning of the 21st Century, the Field Artillery's target acquisition systems fielded or being developed were capable of fighting on the digitized battlefield and more strategically deployable for a force projection army than their predecessors.[22]

To add precision capabilities to the Knight and the A3 Bradley Fire Support Team vehicle, field artillery officers and Soldiers—often called fire supporters—initially employed the Ground/Vehicular Laser Locator Designator to lase targets. However, the 107-pound system used early in the 1990s reduced the mobility of light fire support teams, did not meet their needs, and was not man-portable. In 1993 to 1994, the Field Artillery School responded to the need for a man-portable system to designate targets for the light forces by developing the requirement for the Lightweight Laser Designator Rangefinder to replace the Ground/Vehicular Laser Locator Designator. Combining technological advances in position/navigation, thermal sights, and laser development, the lightweight system was a compact, man-portable system designed for dismounted light forces

or mounted operations on a Bradley fire support vehicle. Fielding began in 2004.[23]

Modernizing the Army's cannon artillery moved forward at the same time as the Field Artillery adopted the Lightweight Laser Designator Rangefinder.[24] After seven years of development and testing, the Army started fielding the M109A6 self-propelled 155-millimeter howitzer, commonly called the Paladin, in mid-1993. With its advanced technology, the Paladin possessed the capability to operate autonomously in dispersed operations, receive a fire mission, compute firing data, select and take up its firing position, automatically unlock and point its cannon, and fire and move out without any external technical assistance. Such characteristics permitted firing the first round from the move in less than 60 seconds and gave the system a "shoot-and-scoot" capability to protect the crew from hostile counterbattery fire. The Paladin was more responsive than the M109A2/A3, which took up to 11 minutes to respond to call to fire while on the move. The Paladin also had a maximum speed of 35 miles-per-hour to give it the ability to keep up with the Abrams tank and Bradley infantry fighting vehicle and had secure digital and voice communications. Such revolutionary advances made it superior to older M109s.[25]

The Vice Chief of Staff of the Army, General Maxwell R. Thurman, a field artillery officer with close ties to the Field Artillery School, realized that while the Paladin was effective, it represented an interim solution. In November 1984, he directed the Army to begin work on the next-generation Advanced Field Artillery System self-propelled 155-millimeter howitzer that would take advantage of quantum technological advances to improve availability, range, rate of fire, ammunition lethality, and battlefield mobility. However, a few years passed before serious developmental work started on the new system, which was designated as the Crusader in 1994.[26]

The Crusader would be a world-class cannon system capable of fighting on a digitized battlefield, would close the range gap between American and foreign systems, and would provide the mobility and survivability needed to keep pace with fast-moving maneuver operations, among other capabilities. Despite the anticipated gains, it faced critical challenges from detractors as it was being

developed. Beginning early in 1995 and continuing over the next several years, opponents questioned the rationale for the howitzer. They urged adopting the German PzH2000 155-millimeter self-propelled howitzer already in production both because it was a viable alternative and would be a cost-saving measure in an era of declining Army budgets. Although the PzH2000 was a sound system, the Undersecretary of Defense Dr. Paul G. Kaminiski repeatedly highlighted throughout 1996 that the German howitzer failed to satisfy the required criteria; he resisted adopting it and found support from an unexpected source.[27] In 1996–1997, the Government Accountability Office (GAO) reviewed the Crusader program to determine its status and the availability of viable alternatives. The GAO concluded in a 6 June 1997 report: "No existing artillery system met all of the Crusader requirements."[28]

Armed with this solid endorsement, the Army continued work on Crusader and its resupply vehicle.[29] Besides being suited to the digitized battlefield of the 21st Century, the 55-ton Crusader would operate completely autonomously, fire up to 10 rounds a minute at ranges in excess of 40 kilometers, and travel at speeds of more than 48 kilometers per hour cross country and 67 kilometers per hour on a hard surface road. The Crusader would be accompanied by a 45-ton resupply vehicle to keep the howitzer supplied with ammunition, fuel, and other supplies in forward positions so that it would not have to be pulled out of combat to rearm, refuel, and resupply. When it was fielded early in the 21st Century, the Crusader would dwarf the Paladin's rate of fire of four rounds a minute and cross country speed of 35 kilometers per hour and speed of 56 kilometers per hour on hard surface roads. Moreover, a single Crusader would cover the same area as four Paladins, while two Crusaders would engage targets at the same rate as a six-howitzer Paladin battery.[30]

As discussed earlier, the United States shifted its national defense priorities from forward-deployed forces in Europe to force projection from the continental United States at the end of the Cold War early in the 1990s. In keeping with this priority shift, the Army recognized the need to modernize its towed field artillery to complement the Crusader that was designed for a European-style, force-on-force battlefield. Through most of the 1980s, the M198 towed 155-millimeter howitzer satisfied the Army. The howitzer had a

range of 30 kilometers and weighed 15,000 pounds, making it the lightest towed 155-millimeter howitzer in the world. By the eve of Operation Desert Storm, the Army required a lighter, more mobile 155-millimeter towed howitzer. In response, the Army completed a plan in January 1991 for a lightweight towed 155-millimeter howitzer, called the Advanced Towed Cannon System, to replace the aging and heavy M198.[31]

A couple years later in May 1993, the Marine Corps approved developing a lightweight 155-millimeter towed howitzer to provide close and long-range fire support. At the time the Marine Corps employed the obsolete M101 towed 105-millimeter howitzer as a contingency weapon because the M198 was too heavy.[32]

Recognizing the Army's requirement for a new lightweight towed 155-millimeter howitzer and the growing focus on power projection from the continental United States, the Army and the Marine Corps signed a memorandum of agreement in October 1993 to develop the XM777, with a maximum weight of 9,000 pounds and capable of firing rocket-assisted projectiles to a range of 30 kilometers. A joint Army-Marine Corps program managed by the Joint Program Management Office at Picatinny Arsenal, New Jersey, existed in 1995 to manage developing the XM777. However, there was one basic difference between the two services' howitzers. Because the Marine Corps had an immediate requirement for a towed 155-millimeter howitzer to replace the M198 and the M101 105-millimeter towed howitzer, it opted to field a howitzer without digital capabilities and to add them later. In comparison, the Army planned to develop a fully digitized lightweight 155-millimeter towed howitzer; and this meant that the Marine Corps' howitzer would be fielded first.[33]

More than anything else, the Towed Artillery Digitization package that was scheduled to be added to the Army's XM777 distinguished it from the M198. As the Army explained, the digitization package would give the howitzer onboard advanced fire control capabilities like those associated with self-propelled howitzers such as the Paladin M109A6 155-millimeter self-propelled howitzer and the futuristic Crusader 155-millimeter self-propelled howitzer under development. It also would eliminate the need for external survey, aiming circles, aiming posts, and collimators. Capabilities, such as self-locating and orienting, onboard firing data computation, easy-

to-read electronic sights, digital communications, and improved direct fire sight, would also make the Army version of the XM777 superior to the M198. Additionally, the Towed Artillery Digitization package that was an automated fire direction system would be compatible with the Advanced Field Artillery Tactical System that the Field Artillery employed as its command and control system.[34]

To distinguish the Army howitzer from the Marine Corps howitzer, the Joint Management Program Office designated the Army version as the XM777E1. With the emergence of the XM777E1, two XM777 programs coexisted—the XM777 type classified in 2003 as the M777 with onboard conventional optical fire control capabilities for the Marine Corps and the Army howitzer with onboard automated fire control capabilities type classified as the M777E1 in 2003.[35]

In the meantime, the Army continued making improvements to other weapons. Largely through the efforts of personnel at Fort Bragg, North Carolina, the 82d Airborne Division obtained funding in 1998 for the Light Artillery System Improvement Program to provide needed changes to the M119 towed 105-millimeter howitzer to make it more maintainable and more operationally suitable. The original M119A1, which was towed by a High Mobility Multipurpose Wheeled Vehicle, was type classified in 1985. In 1998, the Army made Block I improvements and then additional Block II upgrades in 2002. Because of the aggregate differences, the Army designated the modified howitzer as the M119A2 on 15 February 2005.[36]

Power projection and Operation Desert Storm also highlighted the need to introduce the High Mobility Artillery Rocket System and modernize the Multiple Launch Rocket System rocket and Army Tactical Missile System, a long-range field artillery missile. During the early 1980s, the 9th Infantry Division documented the requirement for a light multiple rocket launcher for the light forces, but the Army and the Field Artillery School instead continued focusing on the heavy forces. As the Cold War began waning at the end of the 1980s, interest grew in projecting contingency forces to respond to worldwide crises. Similarly, Army and the Field Artillery School attitudes about a light deployable multiple rocket launcher to support the light forces moved from indifference to enthusiasm.[37]

Understanding the inherent limitations of tactical air support, naval gunfire, attack helicopters, and corps artillery as well as the need for mobile counterfire (field artillery fires delivered to suppress enemy field artillery or mortars to prevent them from interfering with the movement of friendly forces) for light forces, the Field Artillery School finally acknowledged the need for the High Mobility Artillery Rocket System; the Multiple Launch Rocket System M270 launcher's weight restricted its strategic mobility.[38] In a 10 April 1990 letter to General John W. Foss, Commanding General of the US Army Training and Doctrine Command, General Hallada wrote, "I intend to develop a requirement by this July [1990] for a light weight MLRS [Multiple Launch Rocket System], wheeled or tracked, that is deployable on a C130, but. . .retains the munitions flexibility of the current system [M270 launcher]."[39]

Events in Southwest Asia reinforced General Hallada's vision for a lighter multiple rocket launcher and pressured the Army to fund the High Mobility Artillery Rocket System. In Operation Desert Shield of 1990, the Army flew M270 launchers from Fort Sill, Oklahoma, and Fort Bragg, North Carolina, to provide long-range

Figure 2: M142 High Mobility Artillery Rocket System.
Source: US Army photo by Sergeant Brian Glass.

fires for the initial units in theater. This was costly in terms of the number of aircraft required. Equally important, the launchers did not arrive with the initial forces, leaving them with 105-millimeter towed artillery for fire support. "Had fighting begun immediately, the corps would have had no long range rocket artillery fires," the XVIII Airborne Corps observed in a September 1991 message to Forces Command after Operation Desert Storm concluded.[40] Given the strategic mobility limitations of the M270, long-range fire support would be tenuous in future anticipated power projection missions without the High Mobility Artillery Rocket System. Operation Desert Shield and Operation Desert Storm seemed to presage the future where armed forces would be deployed to distant hotspots, especially with the end of the Cold War, and the need for deployable field artillery.[41]

Although budget cuts made it challenging to find funds through most of the 1990s, the Army and the Field Artillery School pushed acquisition forward. After the successful mid-1998 Rapid Force Projection Initiative Advanced Concepts Technology Demonstration with four High Mobility Artillery Rocket System prototypes at Fort Bragg, Lieutenant Colonel Donald E. Gentry and Major Cullen G. Barabato of the 3d Battalion, 27th Field Artillery Regiment of the XVIII Airborne Corps wrote, "HIMARS [High Mobility Artillery Rocket System] is a significant leap forward in fire support for early entry and light forces. Light force commanders who must deploy to undeveloped areas soon will have the firepower normally associated with heavier forces with the fielding of HIMARS early in the twenty-first century."[42] The commanding general of the XVIII Airborne Corps, Lieutenant General William F. Kernan, expressed similar thoughts in an interview: "HIMARS is paramount to our success and survivability."[43]

The need to deploy for worldwide contingency operations grew more significant as the 20th Century drew to a close and the requirement for lightweight, mobile firepower grew exponentially. Enhanced firepower for light forces would improve survivability. The High Mobility Artillery Rocket System M142 launcher with its digital capabilities would furnish the requisite firepower and would shoot six rockets. In view of this, the Army approved an accelerated develop-

mental program with the goal of equipping the first unit with the High Mobility Artillery Rocket System M142 launcher by 2005.[44]

Meanwhile, two critical factors encouraged modernizing the M270 launcher. Early in 1990, the Army realized that the M270 was growing obsolete; its electronic parts were becoming more expensive and difficult to obtain by the 21st Century. To combat the growing obsolescence, the Army initiated the improved fire control systems program in 1992 to replace existing electronic systems and provide the growth potential for future munitions. Operation Desert Storm also demonstrated the need for a more responsive and survivable M270 to engage highly mobile targets, such as mobile rocket launchers. This led to the improved launcher mechanical system program in 1995 to decrease the launcher's aiming and loading time.[45]

For a couple of years, the modifications existed as two separate programs. As a result of its integrated test program initiative, the Army combined the two programs in 1997 to produce the M270A1 launcher for the digitized battlefield then fielded it early in the 21st Century. The M270A1 would shoot the entire family of Multiple Launch Rocket System munitions, including the Extended-Range Multiple Launch Rocket System rocket, the Guided Multiple Launch Rocket System rocket, and the Unitary Multiple Launch Rocket System rocket with its three different fuse capabilities. The proximity fuse capability would permit a large air burst over the target, while the point-detonating fuse capability would reduce the size of the burst to minimize collateral damage, a serious concern during the Gulf War. The time-delay fuse capability would allow the rocket to penetrate certain types of structures or targets and then detonate.[46]

As the Army worked to modernize the M270 launcher, it took action to improve its Army Tactical Missile System missile, eventually known as Army Tactical Missile System I. Based on their 1991 experience in Operation Desert Storm, commanders, their staffs, and users visualized the need for a longer-range Army Tactical Missile System missile. Some insisted that the current range was inadequate and restricted the number of targets that could be engaged. With engineering changes, the system could achieve at least twice the range of the current, battle-tested Army Tactical Missile System I and give commanders more flexibility to attack deep targets; compensate for

availability shortfalls with tactical air caused by other priorities, weather, and darkness; and attack targets more quickly than tactical air.[47] In 1994, the Army designated the improved system as Army Tactical Missile System IA. It would have a range of 70 to 300 kilometers plus a Global Positioning System navigational system to give the Field Artillery a long-range precision missile. The Army Tactical Missile System I and IA both saw extensive action during Operation Iraqi Freedom in 2003.[48]

Meanwhile, the Army launched work on the Army Tactical Missile System II and IIA that would have longer ranges than the Army Tactical Missile Systems I and IA and soon coupled the Army Tactical Missile System IIA with the Brilliant Anti-armor submunition, a precision munition intended to engage and destroy armored forces. When budget reductions ended development of the Tri-Service Standoff Missile in 1993, the Army decided to use the Army Tactical Missile System IIA to carry the submunition.[49] Although the original justification for the submunition disappeared with the end of the Cold War, the Army explained in 1994:

> The greatest potential threat to US Forces is that posed by armored and motorized forces. These highly mobile armored maneuver forces, supported by armed helicopters, are expected to pursue battlefield objectives using numerical force superiority, speed, and penetration.[50]

The Army also noted its inability to attack armored vehicles and surface-to-surface missile launchers beyond the range of close combat weapons and the urgent need for an autonomous, terminal homing submunition to defeat moving and stationary targets in the second echelon of the threat array. Upon fielding in the 21st Century, Block IIA with the Brilliant Anti-armor submunition would address those needs.[51]

To tie field artillery weapons, munitions, and sensors together, the Field Artillery meanwhile replaced the 1970s Tactical Fire Direction System with the Advanced Field Artillery Tactical Data System. The Advanced Field Artillery Tactical Data System was a network of computer stations that processed and exchanged information from the forward observer to the fire support element (field artillery cannons, rockets, and missiles; mortars; close air support;

naval gunfire; and attack helicopters). It automatically processed fire requests, generated multiple tactical fire solutions, monitored mission execution, and supported the creation and distribution of fire support plans. The Field Artillery introduced the system's software in incremental versions. Each was built on the previous to get it to the field sooner rather than waiting for the objective software to be completed. Fielded between 1996 and 2002, the Advanced Field Artillery Tactical Data System and its software offered unparalleled automated capabilities to process information rapidly and accurately and was a critical element of the Army Battlefield Command System—a digital command, control, communication, computers, and intelligence system of computers. To transmit and receive fire support messages, forward observers and fire support teams used the Pocket-Size Forward Entry Device with a laser range finder to locate a target accurately. The Lightweight Tactical Data System, known as the Centaur, served as a lightweight backup for the Advanced Field Artillery Tactical System and computed technical fire direction data for cannon units.[52]

As indicated by field artillery systems during the last decade of the 20th Century and the first years of the 21st Century, the Field Artillery took a balanced approach to modernization. With power projection in mind, the Field Artillery started developing the M777 and the High Mobility Artillery Rockets Systems. These light and strategically mobile systems were suitable for power projection. At the same time, the Field Artillery did not neglect its heavy forces—adopting the Paladin and the Bradley Fire Support Team Vehicle and initiating development on the Crusader.

Although weapons, munitions, and equipment efforts were important, digitization formed the heart of modernization efforts. The Advanced Field Artillery Tactical System not only promised to enhance responsiveness by reducing the amount of time to process information from the forward observer to the firing unit but also signaled a move into the digital age.

New Doctrine for a New Age

The same European political events that drove concurrent downsizing and restructuring and simultaneous modernization of

field artillery systems persuaded the Army to rewrite its fighting doctrine. Based on Mutual and Balanced Force Reduction talks during the early 1980s and the growing political fragmentation in Eastern Europe, AirLand Battle-Future studies from 1987 to 1990 outlined an umbrella concept for fighting throughout the world. They included a heavy concept for fighting in Europe, with an emphasis on deep, destructive fires and a linear front. Subsequent political events soon rendered the AirLand Battle-Future studies obsolete. The November 1990 Conventional Forces Reduction Treaty spelled an end to the applicability of the studies and to large military forces in Europe by bringing a termination to the Warsaw Pact and North Atlantic Treaty Organization military buildup. As a result of the treaty, smaller military forces would defend the same amount of territory that larger armies had guarded in the past. This abolished the North Atlantic Treaty Organization's continuous strategic front against the Soviet and Warsaw Pact threat and created gaps between its units. The subsequent end of the Cold War in 1991 set in motion even more reductions in troop numbers in Europe and the imperative to reexamine Army doctrine.[53]

Understanding the necessity of adapting to changing political conditions and the emerging battlefield, General Foss and the Chief of Staff of the Army, General Carl E. Vuono, concurred about the urgent need to revise Army doctrine to reflect future international conditions. They simultaneously pushed to abandon AirLand Battle doctrine designed for fighting an echeloned threat on a linear front and the deep battle to attrit the enemy's follow-on forces for a new warfighting doctrine. In February 1991, General Foss explained in his warfighting concept that long-range intelligence systems would detect enemy forces and that long-range precision fires from fire support systems would cover the gaps created by the smaller forces, destroy the enemy force on the non-linear battlefield, and set the conditions for decisive operations.[54]

Subsequently in March 1991, General Vuono endorsed General Foss's basic concept and directed the US Army Training and Doctrine Command to formulate new doctrine for the post-Cold War world. General Vuono also reaffirmed the necessity to incorporate lessons learned from the recent Gulf War. Additionally, he empha-

sized force projection to regional hotspots as a vital aspect of the new doctrine with the end of the Cold War and its attending massive forward-deployment of troops in Europe. This led to extensive and heated discussions throughout the Army, conferences, and the August 1991 publication of US Army Training and Doctrine Command Pamphlet 525-5, *AirLand Operations: A Concept for the Evolution of AirLand Battle for the Strategic Army of the 1990s and Beyond*.[55]

US Army Training and Doctrine Command Pamphlet 525-5, *AirLand Operations*, co-signed by the US Air Force Tactical Air Command Commanding General, expounded an overarching idea of future Army operations and provided a basis for the development of joint operations and doctrine. Although *AirLand Operations* signaled a continuation of AirLand Battle doctrine, the pamphlet also suggested a significant new orientation. Reflecting lessons from the recent Gulf War, it emphasized depth and simultaneous attack throughout the depth of the battlespace that permitted no sanctuary for the enemy to hide; non-linear maneuver warfare; decisive army operations as part of a joint, combined, and interagency team; and power projection on short notice.[56] As envisioned by General Foss and other high-ranking Army officers, long-range operational fires from the country's different military branches would destroy the enemy and minimize friendly casualties. Following this, tactical fires from air-, land-, or sea-based delivery systems would support maneuver forces attacks on enemy flanks and rear to avoid frontal assaults with their attending battle of attrition.[57]

Following the publication of 525-5, the US Army Training and Doctrine Command shifted its attention to rewriting Field Manual 100-5, *Operations*, with the intention of incorporating AirLand Operations into it. This would make AirLand Operations doctrine and not just a concept for fighting. When he became the US Army Training and Doctrine Command Commanding General on 23 August 1991, General Frederick M. Franks Jr. temporarily suspended work on the field manual to focus on doctrinal problems that had emerged during Operation Desert Storm. Based on his experience in the Gulf, he identified five battlefield dynamics of early entry and lethality, depth and simultaneous attack, battlespace, command and control (subsequently renamed battle command), and combat service sup-

port that required attention and incorporation into doctrine. For the Field Artillery School, depth and simultaneous attack loomed especially critical because the Field Artillery would be the major contributor. As the school and the US Army Training and Doctrine Command defined in August 1991, depth and simultaneous attack meant the simultaneous application of combat power throughout the depth of the battlefield. To execute depth and simultaneous attack, the school envisioned employing joint precision strikes at the enemy's centers of gravity and critical functions.[58]

Using his battlefield dynamics as a foundation for revising Army doctrine, General Franks restarted work on Field Manual 100-5, *Operations*, later in 1991 with the goal of internalizing the lessons of the Gulf War throughout the Army. He tasked the School of Advanced Military Studies at the US Army Command and General Staff College, Fort Leavenworth, Kansas, to assume the lead with the US Army Training and Doctrine Command's service schools providing input as required. The School of Advanced Military Studies produced a draft Field Manual 100-5*, Operations*, by mid-1992 and distributed it to the service schools for comments. Major General Fred F. Marty, who was Field Artillery School Commandant from 1991 to 1993, criticized the draft in July 1992 as being too timid. He said that the manual required "hard-hitting language" to attract people's attention and sell the Army's position on joint precision strike and joint precision interdiction.[59] Subsequently in the fall of 1992, the Field Artillery School explained in terse wording that the examination of depth and simultaneous attack was incomplete. The Army had to explain why the deep battle was critical and how to fight the deep battle. Also, the manual had to point out the Army's ability to conduct precision interdiction as well as depth and simultaneous attack.[60]

Based on this critique, a team of writers in the school rewrote much of Field Manual 100-5 on its own initiative and submitted it with General Marty's support to the School of Advanced Military Studies for review. Among other things, the school stressed the firepower and maneuver relationship, the lethality required for early deployers, and the importance of depth and simultaneous attack. In 1993, the Depth and Simultaneous Attack Battle Laboratory that was created in 1992 at Fort Sill as part of General Franks' battle

laboratory program broadened the initial definition of depth and simultaneous attack. It clarified that depth and simultaneous attack was the simultaneous application of combat power against an enemy throughout the depth of the battlefield. Depth and simultaneous attack would place all critical functions at risk and accelerate defeat by overwhelming the enemy with continuous, all-weather, simultaneous application of joint fires across the battlefield and by forcing the enemy commander to react to multiple threats rather than focusing on any single threat.[61]

Much to the Field Artillery School's delight, General Franks accepted this definition, concurred with the school's recommendations and revisions, and directed the School for Advanced Military Studies to rewrite the Field Manual 100-5 preliminary draft for staffing early in 1993. Although depth and simultaneous attack was the heart of the new battle dynamics, the draft manual still noted the potential of fighting outnumbered, which reflected previous 1970s and 1980s doctrine and demonstrated the difficulty of breaking with the past. Even so, General Franks believed that depth and simultaneous attack would prevent the enemy from finding a sanctuary or safety because combat power would be applied throughout the depth of the battlespace simultaneously and would stun and then rapidly defeat the enemy.[62]

On 14 June 1993, the Army's 218th birthday, the Army published Field Manual 100-5, *Operations* (1993), as the fourth edition of the field manual. Previous editions were published in 1976, 1982, and 1986. The new edition recognized worldwide changes since the end of the Cold War; the increased importance of peacekeeping, disaster assistance, and nation building; the imperative of joint US operations and combined operations with foreign allies; and the emerging information age. Additionally, the field manual defined the Army's doctrine for defending the nation, addressed multiple threats, emphasized depth and simultaneous attack, and discussed the Army's role as a power-projection force to reflect the necessity of deploying forces rapidly and effectively throughout the world as required. Just as important, the new field manual recast doctrine in the strategic and joint context by devoting chapters to joint operations and combined operations; it also introduced and described full-dimensional operations.[63]

From the Field Artillery School's perspective, Field Manual 100-5, *Operations* (1993), took advantage of American fire support superiority and equally as important modified the role of corps artillery. Employing AirLand Battle fire support doctrine that had been codified in Field Manual 100-5, *Operations* (1982 and 1986), the corps commander retained some of his field artillery assets and allocated the rest of his cannons and M270 launchers that could shoot the Army Tactical Missile System missile and the Multiple Launcher Rocket System rocket to support the division's 3 field artillery battalions of 72 cannons and 9 Multiple Launch Rocket System launchers. With the help of corps artillery, division artillery provided counterfire and close support to the maneuver arms.[64]

Field Manual 100-5, *Operations* (1993), changed the role of corps artillery. As part of a joint forces command, the corps commander would retain control of his Multiple Launch Rocket System and Army Tactical Missile System assets and assign them to attack specific targets with overwhelming firepower to hold all enemy functions at risk as part of the stress on depth and simultaneous attack. Conducted by the corps commander, long-range operational precision fires from rockets and missiles as well as indirect fire systems under development would be the major killers on the battlefield. They would disrupt, delay, degrade, or divert enemy capabilities and set the conditions for future battles. Once the long-range, operational, precision fires from rockets and missiles had sufficiently destroyed the enemy, the division's direct and general support artillery would support the maneuver forces as they attacked the flanks and rear and then deliver the final blows with assistance from corps artillery as needed.[65]

Unlike AirLand Battle with its Europe orientation, Field Manual 100-5, *Operations* (1993), manifested the end of the Cold War and the beginning of a new era. Rejecting the long-held emphasis on defending Europe from a Soviet-Warsaw Pact attack, AirLand Operations' force projection focus underscored the need for versatile, deployable, strategically mobile, and lethal active and reserve forces that could respond rapidly to a crisis anyplace in the world. By doing this, AirLand Operations reflected a critical lesson coming out of Operation Desert Shield and Operation Desert Storm. The Army had to be prepared to fight anywhere in the world at a moment's notice—placing paramount emphasis on deployability and readiness.

Louisiana Maneuvers, Battle Laboratories, & Force XXI

As it was writing Field Manual 100-5, *Operations* (1993), doctrine that was the first major 1990s reform effort and would be applicable to the present and foreseeable international environment, the Army initiated a second major effort to modernize its fighting forces. In 1992, it organized the Modern Louisiana Maneuvers Task Force to help guide the Army into the 21st Century. Subsequently, the US Army Training and Doctrine Command established its battle laboratory program to complement and support the Modern Louisiana Maneuvers and conduct experiments using computers and field exercises. Two years later in 1994, the Army launched the Force XXI campaign plan with three axes of effort (modernization of the institutional Army, modernization of the operational forces under the Joint Venture rubric, and digitization of the force by expanding dependence on computers). Working together, the Modern Louisiana Maneuvers, the battle laboratories, and the Force XXI campaign plan created an aggressive and ambitious endeavor to move the Army from an Industrial-Age force to a deployable, Information-Age force with the ability to dominate the 21st Century battlefield.

Chief of Staff of the Army, General Gordon R. Sullivan, recognized that the Army of Excellence of the 1980s was obsolete in the post-Cold War world as well as the need to go beyond rewriting doctrine. Thus he officially chartered and funded the Modern Louisiana Maneuvers Task Force on 22 May 1992 at the US Army Training and Doctrine Command. Inspired by the 1941 Louisiana Maneuvers that General George C. Marshall and Lieutenant General Lesley J. McNair developed to help prepare the Army for World War II, Sullivan wanted to organize and conduct the Modern Louisiana Maneuvers process to manage change, identify ideas for resolution, establish consensus among senior leaders, and serve as a headquarters for experimentation and change. Led by Brigadier General Tommy Franks, the task force was stood up and collocated with the US Army Training and Doctrine Command. By the end of 1992, the task force—essentially a think tank that brainstormed new ideas—identified more than 200 issues for further study and refinement and presented the top 20 to the four-star generals who comprised the Modern Louisiana Maneuvers Board of Directors. Among other recommendations, task force members strongly encouraged exploit-

ing digital information technologies to move the Army into the 21st Century and enhance situational awareness and lethality. Over the next four years the task force continued to explore various ideas to modernize the Army and employed the US Army Training and Doctrine Command's battle laboratory initiative as needed.[66] It ceased operations in 1996 after organizing the Force XXI effort in 1994.

Created in May 1992 by the commanding general of US Army Training and Doctrine Command, General Frederick M. Franks Jr., the battle laboratory program helped define capabilities, identify requirements, and determine priorities for a power projection army of the future. The program also supported the Modern Louisiana Maneuvers process of modernizing the Army for the 21st Century battlefield. The battle laboratory program consisted of six battle laboratories (Battle Command at Fort Leavenworth, Kansas; Depth and Simultaneous Attack at Fort Sill; Mounted Battle Space at Fort Knox, Kentucky; Dismounted Battle Space at Fort Benning, Georgia; Combat Service Support at Fort Lee, Virginia; and Early Entry Lethality and Survivability at Fort Monroe, Virginia). The battle laboratories took advantage of simulations and computers that replicated reality to conduct their experiments and investigations into new concepts, emerging technologies, and procedures to determine the priorities and requirements for a power projection army. Through advanced concept technology demonstrations that identified and exhibited the military utility of emerging concepts and technologies as well as advanced technology demonstrations that showed the maturity and potential of advanced technologies for military operations, the battle laboratories energetically pursued a far-reaching agenda to help modernize the Army. Together, the Modern Louisiana Maneuvers and the battle laboratories promoted extensive change to move the Army into the 21st Century in the face of declining budgets.[67]

As it addressed capabilities vital for the future and fostered sweeping change, the battle laboratory concept unquestionably represented a significant break with the Cold War era threat-driven decision-making and combat developments process. Acknowledging this, General Franks mentioned:

> Current methods of determining requirements and setting priorities cannot keep pace, will not allow us to meet the

> budget challenges, will not allow us to maintain the edge. . . . Battlelabs are an initiative analyzing capabilities and requirements rather than depending on concepts based on analysis and comparison against a firm threat, like we had in the Cold War. We can't depend on Cold War. . .processes to determine priorities.[68]

In seeking to increase battlefield effectiveness by optimizing technology, the battle laboratory program focused its energies on needed capabilities and not a specific threat as General Franks noted. Before any concept or equipment was tested in the field, the battle laboratories analyzed it. Outlining the process, Colonel William Hubbard, the Director of the Battle Lab Integration and Technology Directorate at the US Army Training and Doctrine Command, explained that the battle laboratories would send the concept or technology through simulation then bring it back again, tweak it, send it back through again to get a near optimum solution, and then test it in rigorous field exercises.[69] This methodology saved money without sacrificing quality.[70]

Fort Sill's Depth and Simultaneous Attack Battle Laboratory (renamed the Fires Battle Laboratory in 2006) focused on improving fire support.[71] The laboratory examined fire support concepts, analyzed new fire support technologies, conducted simulations that replicated reality, and participated in advanced concept technology and advanced technology demonstrations in support of the Field Artillery School, the battle laboratory endeavor, and the Modern Louisiana Maneuvers process.[72]

Two demonstrations were key to this effort. In October 1992 within a couple months of being stood up, the Depth and Simultaneous Attack Battle Laboratory participated in a precision strike demonstration at the White Sands Missile Range, New Mexico, where Apache helicopters conducted a deep attack against targets out to 150 kilometers. To support the attack, a live-fire mission with an Army Tactical Missile System suppressed enemy air defenses and validated the Automatic Target Handoff System. The system linked Air Force sensors with Army firing systems to reduce the time between locating the target and engaging it. Later in the year, the laboratory took part in Operation Desert Capture at the National Train-

ing Center, Fort Irwin, California, where the Joint Surveillance and Attack Radar System (an Air Force airborne command and control system) Ground Station Module was linked to the Tactical Fire Direction System at Fort Sill for improved command and control and field artillery deep attack capabilities; the demonstration reaffirmed the ability to join Air Force sensors and Army indirect fire systems.[73]

The growing emphasis on deep attack (precision strike) operations during these exercises revealed the need for a specialized planning, coordination, and execution cell at the corps level and led to the organization of the Deep Operations Coordination Cell. As an extension of the corps fire support element, the cell would be responsible to the corps fire support coordinator for conducting all deep attack operations. The existing fire support element would retain its current functions but would not have the burden of planning and conducting deep attack/precision strike missions.[74]

During this 1992 to 1994 period, the Modern Louisiana Maneuvers process and the Depth and Simultaneous Attack Battle Laboratory were examining ways to modernize the Army through computer simulations and field exercises as well as examining emerging technologies. Meanwhile, Secretary of Defense Les Aspin initiated a comprehensive review of national defense strategy, force structure modernization in March 1993 in response to the end of the Cold War and the emergence of a new world order. As Secretary Aspin called it, the Bottom-Up Review moved the military's attention away from the Soviet threat to regional threats; it viewed Iraq's 1990 invasion of Kuwait as an example of the new world order that would require American attention in the future. With this in mind, the Bottom-Up Review published in October 1993 defined the strategy of power projection, the forces, and the budget required to move into the 21st Century with its perceived regional threats.[75]

The Bottom-Up Review's focus on worldwide challenges prompted the Army to launch the Force XXI campaign plan developed by the Modern Louisiana Maneuvers task force. Building on the work of the battle laboratories, the campaign outlined making significant force structure changes, integrating advanced information technology (computers) more fully through its forces, and transforming operational units so that they could deploy more

rapidly, would be more combat capable, and could dominate future battlefields with real-time situational awareness.[76]

The Force XXI campaign plan outlined three axes of modernization. The Joint Venture axis would redesign the operational Army through battle laboratory conceptual testing by employing advanced concept technology demonstrations and advanced technology demonstrations, advanced warfighting experiments with an experimental force, and digitization of command and control systems. A second axis outlined revamping the institutional Army that generated and sustained the operational Army. Led by the Army Digitization Office that would integrate all digitization efforts, the third axis set out to acquire digital information technology for the operational and institutional Army.[77]

On 8 March 1994, Chief of Staff of the Army, General Gordon R. Sullivan, directed beginning the Force XXI campaign plan. Writing in the May 1994 *Army*, he explained:

> Today, we are at the threshold of a new era, and we must proceed into it decisively. The industrial age is being superseded by the information age—the third wave—hard on the heels of the agrarian and industrial eras [first and second waves]. Our present Army is well configured to fight and win in the. . .industrial age, and we can handle agrarian-age forces as well. We have begun to move into the third-wave warfare, to evolve a new force for a new century—Force XXI.[78]

General Sullivan noted that the Army needed to adapt to the Information Age without any hesitation. It had to take advantage of the computer so that its operational forces could function at even greater performance levels in speed, space, and time and also break free of old concepts. The Force XXI initiative proposed to design a force projection Army for the 21st Century through Joint Venture that would leverage the power of people, information, and technology to win the nation's wars and be a reality by 2010, although planned reforms would continue after that date.[79]

According to General Sullivan, doctrine served as the Force XXI's engine of change. Within a year after publishing Field Manu-

al 100-5, *Operations* (1993)—with its emphasis on providing operational, long-range fires, countering multiple threats, and projecting power from the continental United States—the US Army Training and Doctrine Command published a revised Pamphlet 525-5, *Force XXI Operations*, on 1 August 1994. The new pamphlet built on Field Manual 100-5 (1993), which provided a short lead on the future, and allowed the Army to move forward in its thinking. Pamphlet 525-5 (1994) represented a continuation of change, continuity with the past, and growth that would enable the Army to remain a relevant, strategic force capable of decisive victory in the 21st Century with a high degree of strategic mobility. Besides explaining the importance of modularity to the future Army, the pamphlet outlined a future vision, provided an intellectual foundation for Force XXI, and furnished a vision of future conflict for the US Army Training and Doctrine Command's Task Force XXI, its battle laboratories, doctrine writers, combat developers, and trainers.[80]

Using the August pamphlet as a foundation, the US Army Training and Doctrine Command rewrote doctrine as tasked by the Chief of Staff of the Army, General Dennis J. Reimer, who had served as Deputy Assistant Commandant of the Field Artillery School in the 1980s. On 25 October 1995, the Commanding General of the US Army Training and Doctrine Command, General William W. Hartzog, published a program directive that charged the School of Advanced Military Studies at the US Army Command and General Staff College, Fort Leavenworth, Kansas, to develop Force XXI doctrine. He explained that the new doctrine should build on the existing field manual and integrate peace operations, humanitarian assistance operations, power projection operations, and military operations short of general war into the body of operational doctrine. At the same time, General Hartzog emphasized the joint, interagency, and combined aspects of war as well as the incorporation of information technology at all levels of command more than his predecessors had done. In 1997, the school produced a final draft of the new field manual that reflected General Hartzog's desired orientation. However, debates throughout the Army over terms and content continued into 1999 and forced a major rewrite to be completed that year. The Army redesignated Field Manual 100-5

as Field Manual 3.0, *Operations*, in 2000 to keep it parallel with the joint force publications numbering system then approved it on 14 June 2001 as official doctrine.[81]

Force XXI doctrine meanwhile compelled the Field Artillery School to revise fire support doctrine to keep it current with Field Manual 3.0.[82] At the time, the Field Artillery was platform-based and possessed state-of-the-art howitzers and rocket launchers that shot "conventional, dumb, large amounts of ammunitions out onto the battlefield in support of maneuver forces."[83] Major General Leo J. Baxter, who was Commandant of the Field Artillery School from 1997 to 1999, explained late in 1998 that the Field Artillery was in the process of shifting from a platform-based force to a munitions-based force. This required the branch to move from managing weapon systems to directing fires effects by ensuring that they would be delivered at the right place and right time. Smart or brilliant munitions with increased ranges and lethality would give the Field Artillery precision and enhanced terminal effects on the target, making the location of the platform less important. Essentially, General Baxter envisioned "effects-based fires."[84] One field artillery officer commented as the school started writing fire support doctrine in March 1999: "Current digital operations are just the old way of executing fire support operations, but now we sometimes plan and execute with computers. . . . We have refined and digitized. . .[fire support]; but, at its base, it has changed little since the early 20th Century" because it is still platform-based.[85] Along with General Baxter, he called for completely revamping fire support doctrine to exploit the emerging information technology and precision munitions. Similar to General Baxter, he advocated effects-based operations with their emphasis on precision munitions as the preferred solution and urged abandoning platform-based operations.[86]

With this concept of munitions-based or effects-based operations that represented a radical departure from platform-based operations, the ground commander would no longer focus on the source of the supporting fires. Historically, the Field Artillery positioned firing platforms close to supported maneuver units and exercised centralized command and control through the fire direction center. Rather than concentrating on the source of fires as field artillery of-

ficers and Soldiers had done traditionally, the maneuver commander would focus on the effects required to accomplish the mission. The maneuver commander would describe the effects required and the effects coordination center would deliver them. The effects coordination cell concept was evolving in 1998 and 1999, with the Depth and Simultaneous Attack Battle Laboratory testing it as part of its Future Fires Command and Control Concept Evaluation Program in the fall of 1999. However, the Field Artillery School foresaw that it would most likely be at the brigade and above echelons to integrate effects delivery systems and organizations.[87]

Under Major General Toney Stricklin, who succeeded Major General Baxter in 1999 to 2001, effects-based fires and effects further evolved. Upon arriving at the school in August 1999, General Stricklin outlined his concept of the effects coordination cell. The cell needed to be applicable for today's Army to gain acceptance but lacked critical tools to function as envisioned. Implementing the full vision would require communications systems with greater bandwidth and more robust, firing platforms that had the ability to do more technical work than existing systems. In view of this, General Stricklin scaled back the Effects Coordination Cell's functions and renamed it the Fires Effects Coordination Cell. This signified an evolution from the fire support element, was designed to gain wider acceptance throughout the Army, and signaled the shift from platform-based fires to effects-based fires.[88]

Besides providing the same functions as the fire support element at brigade and above echelons, the cell incorporated new ones. Upon becoming operational early in the 21st Century, the cell furnished deep operations that were formerly provided by the Deep Operations Coordination Cell at the corps and provided close support by controlling cannon, rocket, attack aviation, and close air support lethal effects. Just as important, the cell managed nonlethal effects, such as electronic warfare, civil affairs, information operations, and psychological operations. These last functions previously were beyond the purview of the fire support element at the battalion and the brigade; this broadened the scope of fire support functions beyond the traditional focus on lethal fires to the consideration of nonlethal effects.[89]

In 2000, the Army formed its first Fires Effects Coordination Cell based on successful 1999 and 2000 testing in the Future Fires Command and Control Concept Evaluation Program and advanced warfare experiments. The first Initial Brigade Combat Team included a Fires Effects Coordination Cell that was more capable than the fire support element that it replaced by having the capability to provide lethal and nonlethal effects.[90] The team was organized at Fort Lewis, Washington, as part of the Transformation of the Army under Chief of Staff, General Eric Shinseki. As Colonel Jerry C. Hill and Major Carl R. Trout of Fort Sill explained late in 2000, "The addition of the nonlethal effects cell, with its diverse composition, is. . .significant. . . . It includes information operations, electronic attack, psychological operations (PSYOP), civil affairs, and legal assistance."[91] Continuing, they pointed out, "It also includes a tactical intelligence officer who is a key contributor to nonlethal targets. The FECC [Fires Effects Coordination Cell] has links to the common ground station (CGS) and all-source analysis system (ASAS). It is designed to exploit sensor technology and leverage organic, joint, and national assets."[92]

By creating the Fires Effects Coordination Cell with its effects-based orientation, the Field Artillery took a concrete step to move from platform-based fires and integrating nonlethal effects as a capability. As effects-based fires indicated, the Field Artillery entered a new age of fire support where effects were becoming more important than the firing platform and the ability to furnish nonlethal effects was growing more critical.

The Digital Puzzle

Work continued to explore new technological and organizational solutions that would improve lethality and responsiveness and complement the writing of new doctrine as a Joint Venture priority, as well as developing the Fire Effects Coordination Cell. Continuing its simulation and virtual reality endeavor begun in 1992, the Depth and Simultaneous Attack Battle Laboratory took part in 1995 to 1998 Precision/Rapid Counter-Multiple Rocket Launcher Advanced Concept Technology Demonstrations that were conducted by the Joint Precision Strike Demonstration Project Office at Fort Belvoir, Virginia. The demonstrations were designed to furnish creative and

innovative solutions to operational problems in response to combatant commanders' and Office of Secretary of Defense requirements. At the time, about 70 percent of North Korea's armed forces along the demilitarized zone were forward deployed. Such deployment included long-range field artillery and 240-millimeter multiple rocket launchers that were located in hardened mountainside sites. These systems had rapid emplacement, firing, and displacement capabilities; posed a threat to US and South Korean military forces; provided little reaction time and few indicators of an impending strike; and would need to be eliminated in the event of war. To offset these strengths, the demonstrations focused on deep strike capabilities of the Army Tactical Missile System I (the original Army Tactical Missile System that became operational in 1991 as a replacement to the conventional Lance missile), the Army Tactical Missile System IA that had a Global Positioning System in its guidance system to increase accuracy at long ranges and became operational in 1998, and Army Tactical Missile II that was under development. Army Tactical Missile II would carry the Brilliant Antiarmor Munition, a precision munition that was also under development. Ultimately, the demonstrations validated the ability of current and emerging advanced technologies to defeat a North Korean multiple rocket launcher attack within hours after a conflict began.[93]

As this advanced concept technology demonstration was concluding, the Department of Defense approved the Theater Precision Strike Operations Advanced Concept Technology Demonstration on 21 November 1997. This new addition for Fiscal Year 1998 was in response to the Joint Forces Land Component Commander's requirement for an enhanced capability for theater precision engagements and fires. As part of the demonstration, the Depth and Simultaneous Attack Battle Laboratory supported Foal Eagle, Reception, Staging, Onward Movement and Integration, SummerEx, Ulchi Focus Lens, and other exercises between 1998 and 2001. The exercises exhibited new capabilities to enhance interoperability among Army, Navy, and Air Force automated systems; improve counterfire; upgrade automated methods for deconflicting airspace; update information on potential targets; and enhance predictive battle damage assessment.[94]

While the Depth and Simultaneous Attack Battle Laboratory and other TRADOC battle laboratories tested doctrine, organization, and emerging equipment employing advanced concept technology demonstrations and advanced technology demonstrations as a part of Joint Venture, advanced warfighting experiments capped Joint Venture. In April 1994, the Army conducted the Desert Hammer VI Advanced Warfighting Experiment at the National Training Center, California—the first of several advanced warfighting experiments that would be conducted through 1997. Using a brigade-level task force from the 24th Infantry Division (Mechanized), the demonstration tested digital command and control systems and corresponding tactics, techniques, and procedures in a field setting. Through two weeks of intense, almost non-stop, simulation-enhanced force-on-force battles, the experiment clearly verified digitization's capability to increase lethality and tempo.[95]

Addressing Desert Hammer VI of 1994, Major General John A. Dubia, Commandant of the Field Artillery School from 1993 to 1995, explained the Field Artillery's role in the experiment. Desert Hammer VI provided the Field Artillery with the opportunity to unveil its newest system, the M109A6 self-propelled 155-millimeter howitzer with digital and shoot-and-scoot capabilities that protected it from enemy counterfire. Called the Paladin, the howitzer far exceeded the performance of field artillery in previous National Training Center rotations. The howitzer also represented the greatest opportunity to rethink field artillery tactics since Gustavus Adolphus gave each regiment its own accompanying artillery piece in the 1630s, according to Lieutenant Colonel William M. Bransford, who commanded the 4th Battalion, 41st Field Artillery Regiment. During the exercise, Paladins from the 24th Infantry Division (Mechanized) easily outpaced and outperformed the predecessor M109A2/A3 self-propelled 155-millimeter howitzer, which depended on wire and analog communications. Major General Dubia also pointed out that the Bradley Fire Support Team Vehicle represented a quantum leap forward and would begin development in the fall of 1994 and be fielded in 1999. A mockup of the Advanced Field Artillery Tactical Data System and the Initial Fire Support

Automation System likewise showed their ability to take the Field Artillery into the 21st Century with dramatic improvements in digitized command and control.[96]

Over the next several years, the Army scheduled additional advanced warfighting experiments. Between February and September 1995, Task Force *2000*—organized in the Field Artillery School in August 1994 to oversee the school's participation in modernization activities—took part in the Focused Dispatch Advanced Warfighting Experiment for the heavy forces at Fort Knox, Kentucky. This follow-on to Desert Hammer VI consisted of a series of constructive and virtual simulations and a field training exercise with a portion of the forces live and a part portrayed in virtual and constructive simulations. The experiment centered on developing digitized doctrine and tactics, techniques, and procedures for armored and mechanized forces. It also illustrated the advantages and disadvantages of sensor-to-sensor links and the importance of careful fire support planning and proper clearance of fires when employing sensor-to-shooter links.[97]

Subsequently, Task Force *2000* played a part in the November 1995 Warrior Focus Advanced Warfare Experiment for light forces at the Joint Readiness Training Center, Fort Polk, Louisiana. Warrior Focus compared the performance of a conventional, non-digitized light task force to a fully digitized light task force and found the latter to be superior in performance. In particular, it revealed the Advanced Field Artillery Tactical Data System's ability to support fast tempos and the imperative to digitize the Advanced Towed Cannon Artillery System that was under development (later designated as the M777 towed 155-millimeter howitzer) as well as the requirement for the Lightweight Laser Designator Rangefinder to lase and designate targets for precision munitions that were being developed.[98]

Subsequently, the Army conducted the Prairie Warrior 96 Advanced Warfighting Experiment and followed it with the Prairie Warrior 97 Advanced Warfighting Experiment. Carried out at the US Army Command and General Staff College, Fort Leavenworth, Kansas, both highlighted fires as a potentially dominant force on the 21st Century battlefield. They also confirmed the necessity to preserve division artillery as the command and control headquar-

ters of the division's fire support assets as well as the requirement for two field artillery brigades to reinforce the fires of a committed division. Equally as important, the experiments allowed students at the college to employ the Field Artillery's most advanced future capabilities—the Crusader self-propelled 155-millimeter howitzer, the Sense-and-Destroy Armor Munition, and the High Mobility Artillery Rocket System, which were in varying stages of development. The experiments confirmed that these systems were essential for expanding and dominating battlespace, that division artillery could plan and execute attacks much like a maneuver brigade, that the division artillery structure was essential, and that information technologies enhanced division artillery and fire support capabilities.[99]

Building on the 1996 to 1997 advanced warfighting experiments, the Task Force *XXI* Advanced Warfighting Experiment tested a modernized brigade combat team of two heavy battalions, one light infantry battalion, and a brigade support slice to demonstrate the potential improvements created by digitization. The March 1997 experiment provided information for Force XXI on operational and organizational concepts as well as materiel acquisition opportunities and assessed the doctrinal, training, leadership, organization, materiel, and soldier impacts of information-age technologies.[100]

On a smaller scale, the Task Force *XXI* Advanced Warfighting Experiment offered a glimpse of the Field Artillery's future. After noting that the school was still sifting through the vast expanse of data, Major General Leo Baxter, Chief of Field Artillery from 1997 to 1999, noted late in 1997 that the fire support system was "capable of shaping battlespace and setting the conditions for decisive maneuver."[101] In fact, fires were critical for successful operations because they eliminated the enemy's capability to fight in a coherent manner.[102]

These advanced warfighting experiments carried out during the late 1990s confirmed the ability of digital information technology to increase the lethality, survivability, and operating tempo of ground forces, including fire support. As a result, the Army pushed to develop digital systems and conducted an advanced warfighting experiment to test the Division XXI that would exploit information and communications technology to provide situational awareness

and increased combat effectiveness as well as permit reducing the size of the division by 15 percent.[103]

On 15 March 1995, General Reimer designated the 2d Armored Division (reflagged in January 1996 as the 4th Mechanized Infantry Division), Fort Hood, Texas, as the Army's experimental force to conduct the Division XXI Advanced Warfighting Experiment and placed it under the operational control of the US Army Training and Doctrine Command.[104] Held at Fort Hood in November 1997, the Division XXI Advanced Warfighting Experiment capped the multiyear heavy forces experimentation effort and evaluated a conceptual digitized mechanized division, including emerging field artillery systems. Every divisional platform was equipped with a computer that was linked to the tactical Internet. The experiment clearly demonstrated that digitization permitted the commander to see where friendly and enemy units were on the battlefield for enhanced situational awareness; allowed the division to cover the battlespace of a current corps; and enabled reducing the number of tanks, infantry fighting vehicles, and personnel without sacrificing lethality and survivability to promote expeditionary capabilities that had been the province of the Army's light forces. The successful experiment led the Army to convert the 4th Infantry Division (Mechanized) into a digital division by 2000.[105]

For the Field Artillery, lessons emerged quickly from the Division XXI Advanced Warfighting Experiment. Fire support initiatives—the Brilliant Antitank and Sense-and-Destroy Armor munitions, the Crusader, the Firefinder AN/TPQ-37 Block II radar, and the M270A1 launcher—under development and the Advanced Field Artillery Tactical Data System being fielded provided seamless coverage of the division's battlespace. The advanced warfighting experiment demonstrated the ability of division artillery with its three howitzer battalions (54 howitzers) and one Multiple Launch Rocket System battalion (18 launchers) with assistance from two reinforcing field artillery brigades of two howitzer battalions (36 howitzers) and one Multiple Rocket Launcher System battalion (18 launchers) to pave the way for decisive maneuver by killing hostile armor.[106]

Acknowledging that the Division XXI Advanced Warfighting Experiment of 1997 focused on the heavy division, the Army con-

currently recognized the imperative to modernize its light forces for contingency operations and force projection. Prompted by this imperative, the Army decided in 1998 to digitize its light forces and organized the Rapid Force Project Initiative Advanced Concept Technology Demonstrations. Based on the success of these demonstrations, the 10th Mountain Division (Light Infantry) participated in the Joint Contingency Force Advanced Warfighting Experiment in September 2000. The effort was part of the Millennium Challenge conducted by the Joint Forces Command to test ways to improve contingency force capabilities and serve as the foundation for light force modernization.[107] Conclusions indicated that digitization improved situational awareness and enhanced lethality and versatility in light forces as they did with the heavy forces. As the US Army Training and Doctrine Command Deputy Chief of Staff for Combat Developments noted in October 2000, the digitized light force demonstrated the ability to collect and exploit digital information and achieved demonstrable improvements over the non-digital force.[108]

With the disappearance of the Soviet and Warsaw Pact threat in Europe, the Force XXI Campaign Plan played a critical role in adapting the Army and the Field Artillery to a new international environment. Using battle laboratory assets, Force XXI tests and experiments demonstrated the potential of a digitized, strategically mobile, force projection ground force with unprecedented situational awareness and the capability to dominate the battlefield of the 21st Century. For the Field Artillery, Force XXI reinforced the key role of field artillery fire support and the importance of systems being fielded and those in various stages of development.

The Army After Next

As the Army pushed forward with Force XXI, it initiated the third reform effort. Early in 1996, the Chief of Staff of the Army, General Dennis R. Reimer, and the US Army Training and Doctrine Command Commanding General, General William W. Hartzog, launched the Army After Next campaign plan to help Army leadership craft a vision of future Army requirements. Force XXI would field technologies for the near term and an Army that was smaller and more deployable than the Army of Excellence of the 1980s and 1990s and

was becoming a reality as the 1990s came to a close. The Army After Next, also known as Objective Force, would be its successor—envisioning technologies for 2025 and creating a rapidly deployable, digitized force with unprecedented offensive capabilities.[109]

A 1996–97 study by the Defense Advanced Research Projects Agency developed suggestions for the Army After Next that were briefed to the US Army Training and Doctrine Command in October 1997. Then in mid-1998, General Hartzog unveiled the Army After Next blueprint at a Pentagon presentation. The blueprint formulated a three-axis experimental plan to carry it beyond Force XXI—officially called Army XXI—to the Army After Next of 2025. The light axis centered on developing new equipment and force structure for the light contingency forces. The mechanized axis focused on fielding the 4th Infantry Division (Mechanized) as the Army's first digitized division and III Corps as the first mechanized corps during the first decade of the 21st Century to complete the Force XXI effort. The strike axis outlined creating a highly deployable brigade-size force to bridge the lethality and survivable gap between the early entry or light forces and campaign or mechanized forces.[110]

The incentive behind the strike axis stemmed from the Army's experience during Operations Desert Shield and Desert Storm, which highlighted the necessity to change the Army dramatically. Deploying a heavy brigade to the Persian Gulf took 18 days in 1990. In the future, US military forces would not have the luxury of taking so long shipping and organizing sufficient combat power into theater to prevent a major conflict. Potential enemies would not permit the Americans to build up their forces at their leisure and establish the terms of fighting. With this conclusion in the mind, the Army, the Defense Science Board, the Army Science Board, Army After Next studies, and other mid-1990s studies concluded that the American military would have to force its way into the theater of operations against armed opposition and would require a mobile, modular, deployable force in the future.[111]

As of 1998, neither the Army's light forces nor its mechanized forces had the ability to deter or defeat an aggressor in the manner envisioned. Force XXI's enhanced firepower, command and control, and survivability added early entry capabilities, and possessed stra-

tegic mobility. However, a Force XXI light force still lacked sufficient power to defeat a mechanized force. Force XXI also improved the mechanized forces' command and control, strategic mobility, survivability, and lethality. However, the heavy forces still required prepositioned equipment to enhance strategic mobility. Task Force *2000* action officers at the Field Artillery School and the US Army Training and Doctrine Command observed a critical deficiency. The Army lacked the capability to respond rapidly and effectively to regional hotspots with a medium force. During the previous two decades, the emphasis on the Soviet Union and Warsaw Pact caused the Army to organize heavy divisions for combat in Europe and light divisions for combat in other parts of the world.[112]

After two years of conceptual and developmental work, the US Army Training and Doctrine Command initiated strike force experimentation in 1998 to develop and field an adaptable, rapidly deployable force that would be decisive upon arrival and capitalize on the best of the light and mechanized forces. It would serve as a test bed for developing capabilities that would meet the Army's long-term transformation objectives. The force would have 3,000 to 5,000 Soldiers and be equipped and trained to deploy anywhere in the world in four to seven days by air or sea in response to a wide spectrum of threats and contingencies—from early entry to peacekeeping operations. Equally important, the force would be more survivable, lethal, and maneuverable than existing early entry forces and would present a smaller and more sustainable profile than current heavy force designs. Although the deployable time of four to seven days certainly did not meet the 18-hour goal established by General Reimer, it eclipsed the 18 days required for the Army to deploy a heavy force to the Persian Gulf in Operation Desert Shield in 1990.[113]

The Army examined four options to meet the requirement for a lethal strike force that minimized the weakness of the light and heavy forces while maximizing their strengths. First, the Army could modernize the 2d Armored Cavalry Regiment with near-term, off-the-shelf technology. Second, the Army could develop a prototype strike force by anticipating capabilities and technologies that land forces would require 25 to 30 years in the future. Third, the Army could upgrade the 2d Armored Cavalry Regiment with leap-

ahead technology. Fourth, the Army could design a force with force packaging and tactical tailoring that would be capable of intervening rapidly and decisively. As the US Army Training and Doctrine Command noted, options one through three centered on forming a standing organization and promoting unit cohesion as primary goals. In comparison, the fourth option focused on creating a highly deployable headquarters that could command and control a tailored force of Army of Excellence or Force XXI capabilities.[114] Commenting on the options, General John N. Abrams, the US Army Training and Doctrine Command Commanding General, observed in October 1998: "We're probably going to have a blend of these ideas."[115]

As General Reimer explained early in 1999, the Army planned to use the 2d Armored Cavalry Regiment to create a strike force that would provide an adaptive, near-term, early entry force capable of rapid strategic deployment. The regiment in effect would become a headquarters that was capable of being task-organized. Once fielded, the strike force would serve as a prototype for testing organizational structures, operational concepts, and critical Army After Next leader and Soldier skills.[116]

In early 1999, the final force structure design did not exist for a strike force that would be composed of modular units and employ advanced digital information technology to provide timely information. However, the Field Artillery School moved out to develop a strike force field artillery headquarters Effects Coordination Cell that would assemble real-time information, process that information, and apply the appropriate effects (lethal and nonlethal) to the required battlespace. Specifically, the Chief of the school's Task Force *2000*, Colonel Jerry C. Hill, remarked that the headquarters effects coordination node would have three major functional areas: an intelligence and targeting cell, a lethal effects cell, and a nonlethal effects cell. These cells would give the commander the desired effect, such as disrupting an enemy supply line or removing a communications center through air strikes, field artillery, or other methods.[117]

While designing its Effects Coordination Cell (later renamed the Fires Effects Coordination Cell), the school anticipated creating a composite field artillery battalion of the High Mobility Artillery Rocket System, the Advanced Technology Cannon Artillery System

(later renamed M777 towed 155-millimeter howitzer), a platoon of AN/TPQ-47 radars, a terminal effects coordination platoon, and an electronic attack platoon for the Strike Force. While the rocket system would provide long-range fires, the cannon system would furnish close support operations. Functioning as part of the command post, the effects coordination platoon would have state-of-the-art communications equipment and would plan, coordinate, and synchronize lethal and nonlethal effects from space, sea, air, or ground delivery systems throughout the battlespace.[118]

As the Army worked on designing the Strike Force and the school was planning which fire support systems would be part of the Strike Force, the Army fielded its first heavy digital division as part of the Joint Venture portion of the Force XXI and the Army After Next modernization effort. Based on the successful Division XXI Advanced Warfighting Experiment of 1997 and the tasking of the Chief of Staff of the Army, the 4th Infantry Division (Mechanized) finished converting to the digitized force structure in 2000. The following year, the digitized 4th Infantry Division (Mechanized) demonstrated its go-to-war capability under a realistic and demanding scenario in division capstone exercises in March and September 2001.[119] Commenting on the March 2001 exercise, the division's commanding general, Major General Benjamin S. Griffin, noted, "the DCX [Division Capstone Exercise] provided us with a continuous operation in a tactical environment to challenge our communication systems, our digital systems, and our warfighting systems, against a very, very competent OPFOR [opposing force]."[120]

The 4th Infantry Division (Mechanized) successfully performed in both 2001 exercises, which validated transforming the division into a digital combat force and its ability to contribute to the III Armored Corps' counteroffensive capability. The exercises highlighted the digitized division's improved situational awareness, battlespace dominance, and ability to defeat the enemy at a time and place of the division's choosing. The exercises also demonstrated the Field Artillery's key role in setting the conditions for maneuver success on the battlefield. Further, they underscored its ability to provide timely and accurate fires as well as mass fires at critical phases of the fight throughout the depth of the battlefield using the

Advanced Field Artillery Tactical Data System that processed information rapidly and accurately and that was at the forefront of digitization in the Army, according to General Griffin.[121]

As the 2001 4th Infantry Division (Mechanized) exercises indicated, the Field Artillery underwent significant changes during the 1990s. Although several years would pass before field artillery precision munitions, effects-based fires, and light, deployable systems and equipment for power projection from the United States to worldwide crises would become a reality, the Field Artillery aggressively started moving into the digital age that would improve fire support responsiveness and effectiveness by processing information more quickly than ever before and becoming more mobile without sacrificing lethality to support power projection.

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Chapter 3

Transforming the Force

As the sweeping Force XXI and Army After Next efforts to implement the lessons of the Gulf War and carry the Army and the Field Artillery into the 21st Century began unfolding, the Army's modernization priorities suddenly shifted. Called Transformation of the Army, this new course proposed to create medium forces with the lethality of the heavy forces, the strategic mobility of the light forces, and the ability to exploit the Information Age battlefields of the 21st Century. The centerpiece of the modernization effort focused on developing the self-contained modular brigade combat team and introducing Future Combat Systems made up of lightweight, networked weapon platforms.

The Beginnings

During the latter years of the 1990s, a crisis erupted in Kosovo. To provide additional support to the North Atlantic Treaty Organization's Operation Allied Force actions against the former Yugoslavian government during the unrest in Kosovo, General Wesley Clark, the 1997–2000 Supreme Allied Commander Europe of the North Atlantic Treaty Organization, decided in March 1999 to deploy Task Force *Hawk* from Germany to Kosovo. Composed primarily of AH-64A Apache helicopters, the task force had the mission of augmenting the ongoing air campaign that was employing Air Force assets. The effort was not going well because poor weather hampered flying. On 4 April 1999, a Pentagon official announced the task force's deployment, indicating that it would be on the ground in Macedonia within eight days. Eighteen days and 475 C-17 aircraft sorties later, the task force had 51 Apache helicopters and Multiple Launch Rocket System M270 launchers in place in Macedonia and was mission-capable. Because the routes from Macedonia into Kosovo were restricted by mountainous terrain and because the Serbs had strengthened their air defenses there anticipating an attack, heavy field artillery suppressive fires would be required to get the aviators

through. While such fires would risk substantial politically unacceptable collateral damage, flying without them would entail risk and produce an intolerable number of friendly casualties. As the weather cleared, fixed-wing bombing efforts picked up. Meanwhile, cooperation with the Kosovo Liberation Army produced better target information. Target acquisition assets deployed with Task Force *Hawk* generated targets more quickly than the airmen could attack them. However, Serbian resistance was eroding, making ground combat unwarranted. As a result, Apache missions with their associated risks did not prove necessary.[1]

The failure to employ the Apaches and the length of time required to get the task force into theater prompted the Army's critics to speak out. They challenged the Army's relevance in light of the air campaign success and portrayed the Force XXI modernization effort as being too slow and deliberate. Meanwhile, the Quadrennial Defense Review characterized the modernization effort as being too limited in scope. Pre-positioning material configured unit sets and enhancements in sea and airlift boosted strategic mobility, but nothing had been done to alter the weight and size of the Army's equipment. The Army's near-term approach to strategic mobility had been to move the heavy forces more rapidly and make the light forces more lethal while the long-term goal envisioned making the heavy forces platforms lighter. Meanwhile, General Dennis J. Reimer, Chief of Staff of the Army, initiated a promising Strike Force experiment with the 2d Armored Cavalry Regiment to capitalize on advanced information technologies and integrating assets from the heavy, light, and sustainment forces. However, these efforts did not address the weight of the heavy forces, which relied on the 72-ton M-1 Abrams tank and the 55-ton Crusader 155-millimeter self-propelled howitzer that was under development.[2]

When he became the chief of staff of the Army in mid-1999, General Eric K. Shinseki espoused General Reimer's modernization vision that he had helped fashion as vice chief of staff of the Army. At the same time, he faced criticism about Task Force *Hawk*'s slow deployment and from the Quadrennial Defense Review, which advocated more comprehensive modernization than General Reimer had initiated. This forced General Shinseki to ad-

dress the deficiencies clearly manifested by the task force. In June 1999, he explained that the Army aspired to be the most respected and most feared ground force to those who threatened United States vital interests. This required the Army to improve its strategic responsiveness, develop a clear long-term strategy to improve operational jointness, implement Joint Vision 2010 goals (centered on achieving dominance across the spectrum of military operations and as the US Army's conceptual template for future joint warfighting), and produce leaders for joint warfighting. The Army also had to integrate the active and reserve components completely; staff its combat units; and provide for the well-being of its soldiers, civilians, and family members.[3]

Although he recognized the importance of each goal, General Shinseki faced the imperative of improving strategic responsiveness to mitigate the adverse fallout from Task Force *Hawk*. From the general's perspective, the world situation demanded a strategically responsive Army capable of operating throughout the range of conflict. Specifically, it required more versatile, lethal, and survivable forces than ever before. It had to have early entry forces capable of operating jointly without access to fixed forward bases and the power to slug it out and win campaigns decisively. Shinseki noted, "At this point in our march through history, our heavy forces are too heavy and our light forces lack staying power. Heavy forces must be more strategically deployable and more agile with a smaller logistical footprint, and light forces must be more lethal, survivable, and tactically mobile."[4]

Over the next several months, General Shinseki refined his vision—called the Transformation of the Army and sometimes referred to as the Army Transformation, the name of the effort initiated by General Reimer. In August 1999, General Shinseki's Transformation included developing lighter, more deployable forces and equipment as well as standing up two Initial Brigade Combat Teams at Fort Lewis, Washington, to serve as a test bed for new ideas, force structure, weapons, and equipment. A major element of the Initial Brigade Combat Team effort would be to test off-the-shelf tracked and wheeled vehicles that appeared to offer the desired characteristics; this would give the transformation a quick start.[5]

Along with the Secretary of the Army Louis Caldera, the general wanted to convert the Army into a more dominant and strategically responsive force and outlined his ideas to achieve this.[6] "To this end," he told the attendees of the 45th Annual Meeting of the Association of the United States Army on 12 October 1999, "we will begin immediately to turn the entire Army into a full spectrum force which is strategically responsive and dominant at every point on the spectrum of operations."[7] As the Director of the Transformation Axis at Headquarters, US Army Training and Doctrine Command, Fort Monroe, Virginia, Colonel Joseph Rodriguez, and the Director of the Battle Laboratory Integration, Technology, and Concepts at the US Army Training and Doctrine Command, Colonel Michael K. Mahaffey, noted in December 1999 that General Shinseki desired lighter heavy forces and heavier light forces and wanted to erase the distinction between them.[8] This involved building a totally new force structure around combat systems with the survivability of the Abrams tank and the Bradley fighting vehicle but the strategic mobility of light systems so that an independent combat brigade could deploy anywhere in the world within 96 hours, a division within 120 hours, and five divisions within 30 days.[9]

From Shinseki's perspective, the Army had a bifurcated force. It possessed equipment, such as the Abrams tank and Bradley fighting vehicle, and divisions that had been designed for the Cold War and European combat against the Soviet and Warsaw Pact threat but could not go everywhere and had light forces that lacked the lethality or survivability to be placed in the middle of a high-intensity conflict. In view of combat and contingency operations in the 1990s, the Army needed a totally new force structure to handle future wars with survivable but deployable combat systems.[10]

The Transformation of the Army represented an abrupt change in the trajectory that modernization had been travelling for 20 years; it abandoned the emphasis on heavy and light divisions with their respective equipment and weapon systems. By the fall of 1999, General Shinseki had devised a three-prong developmental program. The first Legacy Force consisted of digitizing existing systems, such as the Bradley fighting vehicle and Abrams tank, to enhance situational awareness and introducing the Crusader 155-millimeter self-

propelled howitzer and the Comanche helicopter. The Interim Force would provide crossover capabilities between the Legacy Force and the Objective Force, build and deploy brigade-sized units of intermediate weight-equipped weapons and equipment with the most advanced information technologies that were available, and revolve around the Stryker Brigade Combat Team composed of medium-weight vehicles. The Objective Force reflected a vision of future warfare that would center on technologies yet to be developed, be built around the Future Combat System, a vehicle platform with different variants, consist of readily deployable forces, and support the full spectrum of conflict. Of the three prongs, the Interim Force and the Objective Force received the most attention and occupied the focal point of modernization.[11]

General Shinseki launched Transformation with the Initial Force that would pave the way for the Interim Force. Fielded between 2000 and 2003, the Initial Force would be composed of two Initial Brigade Combat Teams at Fort Lewis that would be the prototypes for others to follow and would be equipped with off-the-shelf equipment and vehicles. Some equipment already in the Army's inventory would be adapted to meet existing requirements. The initial brigades also would be retrofitted with the Interim Armored Vehicle, a medium-weight armored vehicle, when it was fielded to become part of the Interim Force.[12] As US Army Training and Doctrine Command Deputy Chief of Staff for Combat Developments,

Figure 3: Crusader self-propelled 155-millimeter howitzer.
Source: US Army photo by Boyd L. Dastrup.

Major General Daniel R. Zanini explained in November 1999 that the Army planned to equip the Interim Force with Interim Armored Vehicles between 2003 and 2010. Next, the Army would introduce the Objective Force with breakthrough technologies beginning in 2008, with complete conversion around 2032.[13]

The Army pointed out that the three prongs would be parallel and complementary but distinct for about a decade.[14] At a November 2000 briefing, General Shinseki explained that the Army had started work on the Initial Force late in 1999. Concurrent with this, the Army set out to modernize and recapitalize select current capabilities in the Legacy Force that was composed of heavy and light forces and was organized and equipped during the Cold War. Modernizing centered on developing new systems with improved warfighting capabilities. Additionally, the intent was to recapitalize by restoring aging fielded systems to a like-new condition and simultaneously adding improvements, such as advanced information technology, to address capability shortcomings. As General Shinseki noted, modernizing and recapitalizing the Legacy Force would extend Army capabilities into the future and guarantee near-term fighting capabilities. From the general's perspective, the March 2001 Division Capstone Exercise Phase I at the National Training Center, Fort Irwin, California, validated the Legacy Force effort.[15]

Other Army officers shared the same conclusions about the exercise. Digitizing the Legacy Force permitted soldiers to move over battlespace that was larger than the Army of Excellence's battlespace of the 1990s and allowed officers to leverage information. In 21 April 2001 comments about digitization, the Commander of the 4th Infantry Division artillery, Colonel Ben Allen, noted that digital command and control systems provided situational awareness because the division always knew where it was in relation to the enemy and could exploit that information. Ultimately, the exercise illustrated the importance of information dominance furnished by command, control, communications, computers, intelligence, surveillance, and reconnaissance systems as well as their prominent role in the Transformation of the Army.[16]

For the Field Artillery School, the Division Capstone Exercise Phase I strengthened the Field Artillery's role in the Legacy Force.

In the November–December 2001 *Field Artillery*, Brigadier General William F. Engel, who was the school's Assistant Commandant from 1999 to 2001, noted the Legacy Force's dependence on fire support and the importance of fielding the next-generation Crusader self-propelled 155-millimeter howitzer under development and the Multiple Launch Rocket System M270A1 launcher under development to Legacy Force units to complement the M109A6 (Paladin) self-propelled 155-millimeter howitzer.[17]

As the Army worked to digitize the Legacy Force, the Interim Armored Vehicle fielding would initiate phase two (Interim Force) of transformation that would culminate when the last Interim Brigade Combat Team was fully manned, equipped, and trained. While Objective Force scientific and technological research and development would continue, the two Initial Brigade Combat Teams would be retrofitted with Interim Armored Vehicles to become Interim Brigade Combat Teams; they would join four Interim Brigade Combat Teams, including an Army National Guard brigade. The Interim Force would bridge the gap between the Legacy Force and the Objective Force. These six Interim Brigades would complement the Legacy Force and maximize lethality and survivability while increasing tactical, operational, and strategic maneuver; they also could be transported anywhere in the world within 96 hours and complement light or mechanized forces in a major regional contingency operation.[18]

For the Field Artillery, the Initial and Interim Brigade Combat Teams' organization revealed a shocking ambivalence about the future role of fire support. Although field artillery was not included in the working draft organization of the Initial Brigade Combat Team, designers conceded its requirement and projected the need to procure an Interim Armored Vehicle-based self-propelled 155-millimeter howitzer for the team sometime in the near future. During a December 1999 briefing at the Pentagon, US Army Training and Doctrine Command representatives pointed out that they did not know exactly what type of field artillery would be a part of the brigade in the future. For the present, the Initial Brigade Combat Team would not have any field artillery, because existing weapons systems were too heavy and lacked strategic deployability. Leaving field artillery

out introduced risk, because the brigade's organic mortars simply lacked the ability to handle indirect fire support requirements.[19]

Analysis by the Field Artillery School highlighted the Initial Brigade Combat Team's fire support deficiency and strengthened arguments for including fire support in the initial brigade. In December 1999, the school pointed out in stark terms that the brigade would be vulnerable to counterfire and unacceptable high casualties without organic fire support beyond mortars. Based on this scrutiny, the US Army Training and Doctrine Command revamped fire support in the Initial and Interim Brigade Combat Teams in January 2000. It made fire support teams and sections organic to the brigades, created a Fires and Effects Coordination Cell to coordinate fire support, and added target acquisition radars. For weapons, the command included six deployable High Mobility Artillery Rocket Systems M142 launchers, which were basically a small Multiple Launch Rocket System that shot six rockets rather than 12 in the Initial Brigade, as well as 18 Interim Armored Vehicle-based self-propelled 155-millimeter howitzers in the Interim Brigade. According to the school, the proposed fire support organization would increase the volume of fire, provide close support, furnish proactive and reactive counterfire, and deliver shoot-and-scoot capabilities without sacrificing strategic and operational mobility.[20]

Placing the High Mobility Artillery Rocket System in the Initial Brigade Combat Team, however, failed to diminish the risk. As of February 2000, the Army had only four High Mobility Artillery Rocket System prototypes—three at Fort Bragg, North Carolina, and one at a factory in Dallas—and did not anticipate receiving the first production systems until 2002 at the earliest. For the near term, the Initial Brigade Combat Team would not have any fire support. To address this unacceptable situation, the Field Artillery School proposed substituting the M198 towed 155-millimeter howitzer for the High Mobility Artillery Rocket System. General Shinseki concurred. On 3 March 2000, he resolved to use the M198 because of the decision to use off-the-shelf equipment if possible and because of the pressing requirement for organic fire support in the Initial Brigade. As outlined in April 2000, the M198 battalion in the Initial Brigade Combat Team would consist of three firing batteries of six howitzers

each for a total of 18 howitzers in the battalion, a headquarters and headquarters battery, a target acquisition platoon of Firefinder AN/TPQ-36 and AN/TPQ-37 radars, and a medical platoon.[21]

Eventually, the Army planned to replace the M198 with modern technology. Although the Army still maintained that an Interim Armored Vehicle-based self-propelled howitzer would be the ideal for the Interim Force, the Army opted to replace the M198 with the lightweight towed 155-millimeter howitzer (type classified as the M777), a joint developmental program with the US Marine Corps. The imperative to have fire support in the Interim Brigade compelled the Army to reverse its earlier rejection of the M777 because it lacked the agility of a self-propelled howitzer and was not designed to fit on a C-130 aircraft with its prime mover. Yet, employing the M777 would be consistent with the Army's desire to employ off-the-shelf or near-off-the-shelf equipment and would facilitate a transition to the Interim Armored Vehicle-based 155-millimeter self-propelled howitzer. When it was fielded, the Interim Armored Vehicle-based howitzer would replace the M777; the new weapon would possess the mobility and survivability equal to the maneuver force and would provide the lethality, precision engagement, and extended range to furnish responsive and accurate fires throughout the battlespace.[22]

While the Field Artillery School pushed the fire support imperative with the M198 and M777, the Army stood up its first Initial Brigade Combat Team. Starting in April 2001, the 3d Brigade, 2d Infantry Division converted to the Initial Brigade Combat Team design and achieved initial operational capability in December 2001. Although it had been constituted from a traditional light brigade, the 3d Brigade demonstrated warfighting competency, the ability to perform as a unit, and the basic soundness of the initial brigade concept during testing in September 2001.[23]

Subsequently, the 1st Brigade, 25th Infantry Division transformed to the Initial Brigade Combat Team design—with initial operational capability in December 2002. Both brigades trained using combat vehicles on loan from Canada and were scheduled to adopt Interim Armored Vehicles in the near future to make them Interim Brigade Combat Teams. Major General James M. Dubik, US Army

Training and Doctrine Command Deputy Commanding General for Transformation, explained that the Initial Brigade Combat Teams represented a short-term goal and the first step in transforming the Army to make it more deployable without losing survivability. The second step centered on forming Interim Brigade Combat Teams.[24]

As work on the Initial Brigade Combat Teams moved forward, the Interim Brigade Combat Team began taking shape in 2000. The brigade would need to participate in the full spectrum of conflict ranging from a major theater war to small scale contingency in an urban/close terrain setting and have core capabilities of high tactical mobility and robust dismounted assault. Given these requirements, the Army planned to organize it as a combined arms, self-contained, mounted infantry organization with the ability to reach throughout the battlespace as required. Major organic sub-elements would include three motorized, combined arms infantry battalions with organic mortar companies; a reconnaissance, surveillance, and target acquisition squadron; an anti-tank company; a field artillery battalion of three firing batteries, a target acquisition platoon, a headquarters and headquarters battery, and a meteorological section; a survey company; a signal company; and a brigade headquarters and headquarters company.[25]

This notional design would help ensure responsive and proactive lethal and nonlethal fires. To accomplish this, the Interim Brigade Combat Team's field artillery would be outfitted with the latest technology. Because the Interim Armored Vehicle-based self-propelled 155-millimeter howitzer would not be available, the field artillery battalion would have 12 M198s divided into three batteries of four howitzers each. Plans were to use the M777 to replace the M198 in 2005, organized into a battalion of three batteries of six cannons each for a total of 18 in the battalion, and would be replaced by the Interim Armored Vehicle-based howitzer in the near future. These weapon systems, especially the self-propelled howitzer, and other field artillery systems would possess mobility and survivability that would be equal to the maneuver force and furnish lethal, precision fires.[26]

To ensure effects coordination and precision fires for the Initial and Interim Brigade Combat Teams and the Interim Division under

development, the US Army Training and Doctrine Command made the Fires and Effects Coordination Cell central to the Field Artillery's fire support role. This represented a significant break from the existing fire support organization. At the brigade level, the cell would perform the traditional functions of the fire support element; obtain guidance from the commander about the desired effects; and then plan, prepare, and direct the execution of the desired effects utilizing organic and non-organic means. Unlike the existing fire support element, the Fires and Effects Coordination Cell would provide expanded access to joint assets; furnish an ability to plan, coordinate, and employ lethal and nonlethal effects; perform a counterfire function; and focus on effects-based fires.[27]

Work on the Interim Brigade produced results by 2002. After becoming the first Initial Brigade Combat Team in 2001, the 3d Brigade, 2d Infantry Division received its Stryker Interim Armored Vehicles in May 2002 to become a self-contained Interim Brigade Combat Team. The vehicles were named after Medal of Honor winners Private First Class Stuart S. Stryker, who served in World War II, and Specialist Robert F. Stryker, who served in Vietnam. Redesignated as the Stryker Brigade Combat Team in June 2002 (also called Stryker Brigade Combat Team one), the 3d Brigade underwent a field training exercise early in 2003. The unit trained on the new armored vehicles; retained some "in-lieu-of" equipment; and underwent successful squad, platoon, and company evaluations in 2003. With this, Transformation of the Army entered the second, or Interim Force, phase.[28]

While work on the Interim Brigade Combat Team moved forward, the Army started developing an Interim Division. As a February 2001 draft organizational and operational plan outlined, the division would provide the joint force commander with a strategically responsive, early-entry ground force that would be optimized for offensive operations and could support operations in any operational environment, such as a major theater of war or small-scale contingency.[29] Equipped with Interim Armored Vehicles, the division would be organized around three brigade combat teams, one air cavalry brigade, a division artillery of three battalions of 18 M777s each and one battery of nine High Mobility Artillery Rocket

Systems M142 launchers, one engineer regiment, and one division maneuver sustainment brigade. Division troops would consist of a military intelligence battalion, a signal battalion, and an air defense artillery battery.[30] As organized, division would be deployable within 120 hours, capable of fighting across the full spectrum of conflict, and normally deployed as part of a joint task force. Equally important, the division would expand the core capabilities of the Initial and Interim Brigades, be combat operational on arrival in theater, have an offensive orientation, and have overmatching operational and tactical mobility.[31]

From the perspective of the Army, the Interim Forces would provide operational and strategic advantages. An October 2000 Army Transformation briefing explained that the Interim Forces would ensure combat overmatch for American forces until the Objective Force capabilities could be fielded beginning in 2008 and would not be an experimental force for testing concepts. They would be fully trained and deployable and would provide warfighting capability.[32] Equally important, the Interim Force would give the Army the ability to get forces on the ground quickly with the requisite combat power to influence a potential crisis. Although the Interim Force, including an interim armored cavalry regiment, would fill a capability gap with a highly deployable force, most of the Army would still consist of Legacy Forces until the Army started introducing the Objective Force in 2010.[33]

As a concept for the Interim Division emerged, the Army began work on the Objective Force. The development and fielding of the Future Combat System formed the heart of the Objective Force. The Future Combat System would consist of agile and fast unmanned and manned platforms such as unmanned aerial vehicles and field artillery that would be tied together by a sophisticated communications system and automation.[34] After fielding the Future Combat System during the second decade of the 21st Century, the Army would transform its Legacy and Interim Forces into the Objective Force over a period of several years—focused on achieving capabilities rather than being platform driven as the Army had been for years. The Objective Force would make the Army the world's preeminent land force for a broad range of missions—from support, including homeland security, to decisive warfighting—at every point

on the military spectrum and would also include multi-functional and specialized units, such as a Strike Unit of Action, consisting of aviation, intelligence, target acquisition, and fires.[35]

An operational concept for fighting with the Objective Force unfolded over a period of several months beginning in 2000 and continuing into 2001. Although all levels of command remained undefined, two basic conceptual echelons emerged by November 2001—Unit of Employment and Unit of Action. Comparable to a division and above organization, a Unit of Employment would be an offensively oriented, versatile, multi-dimensional force capable of performing a variety of roles and missions. For example, it would perform tasks assigned to Army of Excellence divisions and higher echelons, link Army ground and joint air forces, and orchestrate joint campaigns as required. Tailored to the mission, a Unit of Employment would also resource and execute combat operations; designate objectives; coordinate with multi-service, interagency, multinational, and non-governmental activities; and employ long-range fires, aviation, and sustainment. The Unit of Employment would also provide command, control, communications, computers, intelligence, surveillance, and reconnaissance as well as tactical direction to Units of Action. In addition, the Unit of Employment would provide forces to Units of Action to augment their organic forces based on its mission and tactical requirements and would be capable of performing joint operations.[36]

A Unit of Action or Brigade Combat Team would have a fixed organization, be the tactical formation of the Objective Force, and be comparable to brigade and lower echelons in the Army of Excellence. As outlined in the draft November 2001 TRADOC Pamphlet 525-3-91, *The Objective Force*, a Unit of Action would be the smallest combined arms unit that could be committed independently. It would close with the enemy and destroy it with integrated fire, maneuver, and tactical assault. The core of the Unit of Action would be three combined arms combat battalions. However, the modularity and Objective Force were only concepts as late as 2003.[37]

As the force structure for the Objective Force began taking shape in 2001, the Army envisaged a new operational environment. Unlike the Army's existing force that was designed, equipped, and

trained to confront an enemy that conducted highly centralized military operations, Objective Force units would face an entirely different operational environment in the 21st Century.[38] At one end of the spectrum of conflict, creative and adaptive opponents would employ strategies to destroy American resolve by attacking the homeland, killing innocent civilians, and conducting prolonged operations. At the other end was the possibility of a major theater war. While the enemy would still retain the ability to fight in massed formations, American military forces could no longer depend on the enemy to array its forces in predictable formations. The enemy would seek advantages of weather and terrain, take sanctuary in complex terrain, employ terrain masking, and protect high-payoff targets by shielding them among non-combatants. Behind this wide spectrum of conflict would be the information revolution and technological advances that promised breakthroughs in surveillance and communications to create immense bases of knowledge for military planning and execution unprecedented in scope, volume, and accuracy.[39]

To fight successfully in the new operational environment, the Army would have to see first, understand first, act first, and finish decisively. To see first meant detecting, identifying, and tracking the individual components of enemy units and preventing the enemy from doing the same against Army forces. To understand first focused on following and anticipating the enemy's intentions. To act first involved initiating decisive engagement at the Army's chosen time and place, while to finish decisively denoted well-timed assaults, exploiting successes, and denying the enemy the opportunity to regroup or to continue the fight.[40]

Addressing this new battlefield, Major General Michael D. Maples, who was the Commandant of the Field Artillery School from 2001 to 2003, talked about the increased requirement for true synergy between fire support and maneuver. In the September–October 2002 *Field Artillery*, he wrote, "A commander may employ his maneuver force to attain positions of tactical advantage in order to employ his fires most effectively. In other circumstances, it may be the effects of fires that will permit the effective maneuver of forces."[41]

Tasked by the US Army Training and Doctrine Command to serve as the center for fires and effects, the Field Artillery School

developed the concept of networked fires in 2002 to provide the required synergy between the maneuver arms and fire support.[42] As explained by US Army Training and Doctrine Command Pamphlet 523-3-90, networked fires would be a triad of relevant sensors, effects capabilities, and battle command that would enable dynamic on-demand lethal and nonlethal fires as well as effects to be applied at the time and place of the commander's choosing. To accomplish this, all sensors and shooters would be linked through the battle command system, which would permit vertical and horizontal integration and select the appropriate lethal or nonlethal effect upon receiving target information from the sensors. Ultimately, networked fires would focus on the effects and not the platform by applying the right delivery system or mix of systems to achieve the desired effect, called effects-based fires.[43]

Adopting new indirect fire systems and munitions would facilitate effects-based fires. To do this, the Army would eliminate Legacy Force systems, such as the M102 towed 105-millimeter howitzer, the M109A6 (Paladin) self-propelled 155-millimeter howitzer, the M198 towed 155-millimeter howitzer, and the Multiple Launch Rocket System, from the Army's arsenal as the new systems came on board. Over a period of years, the total number of fire support platforms would be reduced from 10 in the Current Force structure to 4 in the Objective Force. When the transition had been completed by 2032, the field artillery force would consist of the Future Combat System Non-Line-of-Sight-System Cannon, the Future Combat System Non-Line-of-Sight Launch System (a rocket system), the High Mobility Artillery Rocket System, and the Crusader. If the 82d Airborne Division and the 101st Air Assault Division remained unique, the school planned to keep the M119A1 towed 105-millimeter howitzer or replace it with a follow-on weapon system. Additionally, the school stressed the importance of precision and smart munitions—primarily the Excalibur Unitary munition for 155-millimeter howitzers, the Multiple Launch Rocket System Smart Tactical Rocket, and the Army Tactical Missile System.[44]

Despite the promising future, Transformation of the Army dealt the Field Artillery a serious blow.[45] Late in 1999, the Army terminated the Multiple Launch Rocket System Smart Tactical

Rocket and Army Tactical Missile System IIA programs to help fund forming the medium weight brigades and procuring appropriate weapon systems; additionally, it made the Army Tactical Missile System II the carrier for Brilliant Anti-armor submunition and even contemplated discontinuing the Crusader because it was too heavy and cumbersome.[46]

General Shinseki backed the Crusader because he liked its capabilities and its resupply vehicle, though he disliked their collective weight of more than 100 tons. Because General Shinseki wanted them to be an integral member of the Army's dominant maneuver force, the Army restructured the Crusader program in December 1999. It reduced the weight of the howitzer and its resupply vehicle to make them more strategically deployable without losing their key performance parameters to keep them a part of the modernizing the Field Artillery. In other words, the Army intended to field the lighter Crusader and the M270A1 under development to the Legacy Force even though most of it would be composed of M109A6 howitzers and M270 launchers.[47]

While digitization was a critical aspect of the transformation effort and ensured a place for the Advanced Field Artillery Tactical Data System in the long-term, the Army and the Field Artillery did not anticipate losing the Crusader as soon as they did. The Army designated the Crusader as a Legacy to Objective Force system based on its 2000–2001 redesign to satisfy weight concerns that emerged in 1999; however, the debate over the system's future arose again in 2002.[48] As some critics in the Department of Defense suggested, the system represented a Cold War weapon and "old-think approach to warfare" and should be eliminated as the Army transitioned to the medium weight force. Advocates still maintained that the Crusader had a place in the Army's weapon inventory. In reality, the 55-ton howitzer and its 45-ton resupply vehicle lacked the desired strategic mobility and were more attuned to Cold War than projected future requirements.[49]

In the midst of this debate, Secretary of Defense Donald Rumsfeld canceled the Crusader program on 8 May 2002. He believed that it did not fit with the new threats of cyber war and terrorism, desired even more nimble and mobile forces for the 21st Century,

and planned to transfer the savings created by its cancellation to new technologies.[50] This permitted the Department of Defense and the Department of the Army to reallocate the funding from the terminated Crusader to support the Transformation of the Army. The extra money would be used to accelerate the development of the Future Combat System Non-Line-of-Sight Cannon and Future Combat System Non-Line-of-Sight Launch System, which were vital aspects of transformation; the Excalibur 155-millimeter family of precision munitions; the precision Guided Multiple Launch Rocket System rocket; the High Mobility Artillery Rocket System; and the M777 155-millimeter towed howitzer. The emphasis on developing such munitions and light, mobile weapon systems reflected the lessons learned from military operations in Operation Enduring Freedom in Afghanistan where the accuracy and responsiveness of precision weapons had been critical and had been impressive and where mobility reigned supreme.[51]

As the Crusader developmental program and the proposals for new weapon systems with strategic mobility indicated, the Transfor-

Figure 4: M109A6 self-propelled 155-millimeter howitzer.
Source: US Army photo by Staff Sergeant Jon Cupp.

mation of the Army altered the direction of field artillery modernization. General Shinseki planned to create a modular Army equipped with medium weight systems with strategic deployability and the attributes of Cold War heavy armored systems. Strategically deployable, survivable, and lethal field artillery systems would replace the heavy systems fielded during the Cold War; would be the wave of the future; and would arm new, lethal, modular organizations. A new Field Artillery would arise that would contrast remarkably with its Cold War ancestor.

Changing of the Guard

Upon becoming the Chief of Staff of the Army in August 2003, General Peter J. Schoomaker likewise acknowledged the pressing requirement to make the Army more responsive to United States national security requirements of the 21st Century. He noted the positive work accomplished through mid-2003, understood the imperative to fight the global war on terrorism, recognized the need to accelerate transformation, and added his twist to the process.

As of 2003, the post-Cold War Army lacked the required flexibility and responsiveness to meet worldwide crises. In support of military operations during the past five years, for example, the Army had to modify its corps and divisions by dismantling or reorganizing them for operations in the Balkans, Afghanistan, and the Philippines. This often left behind forces that were essentially inoperable. Using existing formations required time-consuming restructuring before deploying. This difficulty coupled with the need to employ land forces immediately with little time to reorganize caused General Schoomaker to alter the transformation pace and direction that General Shinseki had started in 1999 and would take years to complete. Schoomaker replaced the Legacy Force and the Interim Force with the Current Force. He also replaced the Objective Force with the Future Force and started quickening the pace of fielding select Future Force capabilities to enhance the Current Force so that it would be relevant and ready to conduct major combat operations across the full spectrum of conflict. The most critical feature of Schoomaker's effort was reorganizing the Army's force structure around the modular combat brigade team.[52]

General Kevin Byrnes, commanding general of the US Army Training and Doctrine Command, noted that in 2003, General Schoomaker made a significant departure from General Shinseki's Legacy Force, Interim Force, and Objective Force concepts. In 1999, the Army created a leisure transformation process that ran from the Legacy Force to Interim Force to the Objective Force and that would last into the third decade of the 21st Century. Given the 1999–2001 international political scenario, this seemed to be satisfactory. The 11 September 2001 terrorist attacks in New York City and Washington DC reaffirmed the imperative to transform and also provided a sense of urgency. The Army had to initiate change faster than initially anticipated without risking the Current Force for the Future Force. Future capabilities had to be developed more rapidly and integrated into the Current Force rather than at some indeterminate time in the future.[53]

Later in 2003, the Capabilities Development Directorate at US Army Training and Doctrine Command's Futures Center described the process of implementing Schoomaker's Current Force to Future Force initiative. First, the Army had to identify promising capabilities that were under development and get them to the field rapidly. For example, unmanned aerial vehicles and robots under development might not have the desired capabilities until 2010, but they could be employed by current leaders to furnish improved capabilities while the objective system was being developed. Second, the Army needed to integrate lessons learned from Operation Iraqi Freedom, Operating Enduring Freedom in Afghanistan, and other operations into doctrine, organization, training, leadership, and materiel more rapidly and also become more joint-oriented than previously.[54]

As it sped up the process to introduce new technology, the Army began implementing lessons learned from recent combat operations by restructuring brigades, divisions, corps, and echelons-above corps. Revamping its main combat unit, the division, was a high priority. Throughout most of the 20th Century, the division served as the Army's primary fighting organization. Formed with a standard number of brigades or regiments and a division base of specialty troops, the division fought battles to gain tactical advantage under the command of a corps. Although its battles typically took place over considerable space, the division's brigades operated

close to each other and depended on each other for reinforcement. Normally, the brigade had three or four combat maneuver battalions and received its specialty support from division-level units, such as division artillery. Even though doctrine stressed that brigade organization should be flexible, the tendency for habitual relationships between the combat brigades and their supporting units led to *de facto* fixed organizations that proved to be valuable in combat.[55]

Building on tactical experience from the last years of the 20th Century and wanting more flexibility for a force projection army, the Army abandoned the division as its primary fighting unit. Approved by the Chief of Staff of the Army in 2003, the combined arms maneuver brigade would replace the division, including the Interim Division under consideration, as the main combat unit. It would be self-contained and have three variants: a heavy (armored/mechanized) brigade, an infantry brigade, and a Stryker brigade. These modular maneuver brigades would be approximately the size of 2003 task-organized brigades; would be stand-alone warfighting elements; would have organic maneuver, fires, reconnaissance, and logistics subunits; and would have a fixed table of organization and equipment. For fire support, the Infantry Brigade Combat Team would have 16 towed 105-millimeter howitzers (the M119 until a better towed 105-millimeter could be developed), one AN/TPQ-36 radar, four Lightweight Countermortar Radars under development, one Profiler system that was a state-of-the-art meteorological system, and two Improved Positioning Azimuth Systems which were self-contained azimuth positioning systems for survey. The Heavy (later renamed Armored) Brigade Combat Team would have 16 self-propelled 155-millimeter howitzers (Paladin), an AN/TPQ-37 (Version eight) radar, an AN/TPQ-36 radar, four Lightweight Countermortar Radars, one Profiler, and two Improved Positioning Azimuth Systems. Equipped with the M198 towed 155-millimeter howitzer as an interim solution until the M777 towed 155-millimeter howitzer could be fielded, the Stryker Brigade Combat Team would comprise the third standard maneuver brigade.[56]

The Army began converting to modular Brigade Combat Teams in 2003 with the goal of completing the conversion for the active force and the National Guard force by 2010. The 3d Infantry Divi-

sion, which had just returned in September 2003 from a deployment to Iraq, converted to the modular brigade concept and successfully tested it in March 2004 at the National Training Center, Fort Irwin, California. Subsequently, the Army switched the 101st Airborne Division in 2004 and 10th Mountain Division in 2005 to modular brigades. By the end of 2006, the Army had 44 Brigade Combat Teams in the active force with more being formed and 28 Brigade Combat Teams in the Army National Guard. In view of this restructuring, Major General David Valcourt, who was the Fort Sill (Oklahoma) Commanding General and Commandant of the Field Artillery School from 2003 to 2005, made the formation of fires battalions for the Brigade Combat Team as the Field Artillery's first priority.[57]

Although forming organic fires battalions for the Brigade Combat Team had the potential to create synergy between maneuver and fire support, modularization had a negative side. By dissolving corps artillery and division artillery, modularization eliminated senior field artillery headquarters relationships and responsibility at the corps and division levels. Further, it assumed that the Brigade Combat Team could provide sufficient readiness and administrative oversight for their organic fires battalions and that the fires brigades could function as a force field artillery headquarters. Also, the creation of a brigade combat team with its organic fires battalion placed responsibility for fire support training on the brigade commander, who was neither trained nor resourced to train field artillery officers and Soldiers in their core competencies. It moved the field artillery battalion commander to the maneuver brigade to become a staff officer as well as the fire support coordinator. This left battery commanders without any direct senior leadership.[58]

If the transformation proceeded as planned, the Army would have four brigade combat team (initially called Units of Action) variants by 2018: the Heavy (Armored) Brigade Combat Team, the Infantry Brigade Combat Team, the Stryker Brigade Combat Team, and the Future Combat System Brigade Combat Team with an organic battalion of 18 Future Combat System Non-Line-of-Sight cannons divided into three batteries of six cannons each, 60 Future Combat System Non-Line-of-Sight Launch Systems (a rocket system), unmanned aerial vehicles, and multi-mission radars. The Future Combat

System Brigade Combat Team would have fully equipped units and advanced command and control capabilities and would be deployable on C-130, C-17, and C-5 aircraft to provide the desired responsiveness, deployability, agility, and versatility to meet full-spectrum operations worldwide. After all these modular brigades became operational, the Army would shift from a division-based to a brigade-based force capable of being tailored rapidly and effectively to close with and destroy the enemy. Each Brigade Combat Team could operate individually or collectively under control of a division headquarters.[59]

As outlined in the 23 January 2004 Unit of Employment Operations White Paper and refined in the 20 March 2004 Unit of Employment White Paper, the Army meanwhile planned to create modular headquarters for commanding the Brigade Combat Teams by restructuring its divisions, corps, and echelons above corps. They would be streamlined into two echelons: the Unit of Employment (UEy) and Unit of Employment (UEx). The UEy would serve as the theater, operational-level, land force and joint support organization; and the UEx would function as the primary warfighting headquarters above the Brigade Combat Teams. Most likely commanded by a lieutenant general, the UEy would consolidate most functions performed by the corps and Army service component commands into a single operational echelon and would be the primary vehicle for Army support to the regional component commander's area of responsibility. Equally important, the UEy that was approved for standing up in November 2004 would be modular with the ability to be tailored, would command land forces in major operations, would support the rest of the joint team, would provide army capabilities to the combatant commander, and would tailor and support the UEx that had been approved for standing up in September 2004.[60]

The Unit of Employment Operations White Paper also outlined the UEx structure. As envisioned, the UEx would lack a fixed structure beyond its headquarters, because it would be completely modular and could be deployed as a pure headquarters without subordinate units. As a result, its supporting brigades—an aviation brigade, a battlefield sustainment brigade, a maneuver enhancement brigade, a fires brigade, and a battlefield sustainment brigade—would be attached or assigned depending on the operations. Each brigade would

have organic signal and sustainment capabilities. In addition, the UEx could control a mix of Heavy, Infantry, and Stryker Brigade Combat Teams for different missions as well as six or more Brigade Combat Teams in protracted stability operations. Given its modularity, the UEx could adjust its organization for each operation. When the restructuring was complete, the Army would have Brigade Combat Teams and UEx and UEy units of employment to replace the existing brigade, division, corps, and army echelons of command.[61]

The Army further modified the UEy and UEx in 2005. It designated the UEy as an Army-level organization with a lieutenant general in command and the UEx as either a division- or corps-level command under a major general or a lieutenant general depending on its mission. As further explained late in 2005, the three-star UEx would be organized as an operational level unit, could function as the headquarters for a joint force land component, could provide command and control for two or more two-star UExs, and could function as an Army force as part of a joint force. The two-star UEx would still be modular, would be the warfighting headquarters, and could control up to six Maneuver Brigade Combat Teams.[62]

In 2006, the Army inched closer to completing work on the UEy and UEx. During the year, the Army developed a corps design (UEy) with a headquarters, a special troops battalion, and a tactical command post. The design also provided for a Fires and Effects Cell (also called a fire support cell) to integrate lethal and nonlethal fires; provide target production; and receive, prioritize, and action subordinate requests for fires and effects, among other responsibilities. The Army never completed work on the corps design as initially intended. In November 2007, the Chief of Staff of the Army decided to make the corps a tactical headquarters rather than an operational headquarters as had been the initial aim. This forced the Field Artillery School and other Army agencies to start over on the corps design in 2008. They made it a tactical and operational organization for command and control of major combat operation functions, comparable to the old corps.[63]

Meanwhile, the US Army Training and Doctrine Command finished the modular (UEx) division headquarters design and force structure complete with a main command post, a tactical command

post, a special troops battalion, and Fires and Effects Cell that would provide services similar to the corps fires cell. Representatives presented it to the Commanding General of the Combined Arms Center, Fort Leavenworth, Kansas, Lieutenant General David H. Petraeus, on 2 August 2006 for review and approval. General Petraeus approved it and the US Army Training and Doctrine Command then sent the design to Forces Command and the Army's divisions for staffing. The design added new capabilities, such as electronic warfare, psychological warfare, and information operations, to more traditional division functions.[64] In mid-2007 following intense discussions, the Army approved the division redesign complete with maneuver enhancement, reconnaissance, surveillance, target acquisition, aviation, fires, and sustainment brigades and without a division artillery to coordinate and train subordinate field artillery battalions in the Brigade Combat Teams.[65]

As delineated in the 2004 Army Transformation Roadmap, the fires brigade played a critical role in the modular division although it might not be stationed with the division. It would plan, prepare, execute, and assess combined arms operations to provide close support and precision strike for the joint force commander, the division, and the Brigade Combat Teams. The fires brigade could be task-organized with additional units, such as rocket and cannon battalions, depending on the situation. Its organic units included a headquarters and headquarters battery, a Fires and Effects Cell for planning and executing lethal and nonlethal effects, a support battalion for logistical support, a signal company, a target acquisition battery with four AN/TPQ-37 Firefinder radars and two Lightweight Countermortar Radars, and an unmanned aerial vehicle company. With its organic rocket battalion—either Multiple Launch Rocket System or High Mobility Artillery Rocket System—the fires brigade could provide long-range fires to support the division in shaping the battlespace and conducting counterstrikes. However, the bulk of the fires from the fires brigade would come from assigned assets. Typically, this would be two rocket battalions and two cannon battalions. In some instances, the fires brigade would reinforce the Brigade Combat Teams with fires.[66]

To accomplish its close support mission, the fires brigade would normally employ a mix of cannon, rocket, and missile systems. This

mix provided the brigade with the ability to furnish lethal effects while simultaneously limiting collateral damage; they also provided precision close support, among other functions. For such effects, the brigade would have to depend on joint fires. To eliminate this dependency and gap in fire support, the Army allotted armed unmanned aerial vehicles to provide the fires brigade with the precision organic capability to support shaping and close support operations. They also could penetrate threat airspace during day and night operations in all kinds of weather. As outlined in the December 2004 operational concept, the armed unmanned aerial vehicle would provide flexible, responsive precision close support fire to destroy critical enemy capabilities and shape subordinate unit operations. Equally important, the fires brigade's armed unmanned aerial vehicles would provide flexible, responsive physical damage assessment of attack operations and long-range target acquisition capabilities.[67]

The first fires brigade that was not organic to the division—stood up on 16 December 2004—was assigned to the 4th Infantry Division (Mechanized), Fort Hood, Texas, with the 2d Battalion, 20th Field Artillery Regiment (Multiple Launch Rocket System) as an organic element. In 2004–05, the Field Artillery School anticipated a total of 12 fires brigades in the Total Force. Although General Valcourt consistently stated that in a perfect world each division would have a fires brigade, circumstances determined otherwise. Force structure constraints dictated a smaller number of fires brigades than the number of divisions. As the fires brigades were stood up, the Army deactivated division artilleries, corps artilleries, and Army National Guard brigade headquarters. Recognizing the importance of the fires brigade to division commanders for training and readiness, the Army acknowledged the need for more than initially projected in 2004–05. The Total Army Analysis 2015 established the requirement for three more brigades to meet the increasing demand for their services. Funding constraints prevented the Army from getting the three additional fires brigades, forcing it to settle for two. As of May 2011, the Army had seven fires brigades in the active force and seven in the reserve force for a total of 14 brigades. These supported 10 active component divisions and eight reserve component divisions.[68]

Thus, during the final years of General Schoomaker's tenure and nearing the end of the first decade of the 21st Century, the Army had

moved farther down the road of transformation by outlining concrete force structure and system acquisition plans to restructure the force radically. Through critical restructuring actions, the Army proposed to abandon the existing fixed division and brigade structure for divisions, which had the ability to be modified as required, and discarded the division as the primary combat unit for the modular Brigade Combat Team. Modularity promised to give the Army more flexibility than previously by permitting it to task-organize without tearing apart existing units and to organize forces for a specific mission.

Systems for Transformation

New weapons systems formed a key aspect of the Transformation of the Army. In 1999, General Shinseki initiated a plan to equip the Interim Brigade Combat Team with a family of medium-weight armored vehicles, called the Interim Armored Vehicle, and the Objective Force with the Future Combat System. This plan would create medium weight weapon systems that were as mobile as the light systems and as lethal as the heavy systems, would support power projection, and would create an army that could dominate the Information Age battlefield of the 21st Century.

As the centerpiece of its near-term transformation effort, the Army needed to acquire the Interim Armored Vehicle, which would be capable of immediate employment upon arrival in the theater of operations and would maximize commonality. To accomplish this, the Army hosted vehicle demonstrations in December 1999 and January 2000 at Fort Knox, Kentucky. Manufacturers displayed their medium weight armored vehicles to give a sense of what was available and possible. Nine contractors exhibited 35 different systems. Of these nine, only three manufacturers submitted tracked systems, and the only American firm was United Defense L.P., which produced nine variants of the M113 personnel carrier and the M8 armored gun system—a light tank system that the Army had canceled on the eve of production.[69]

Following up, the Army held a series of June 2000 events to grade the performance and endurance of the 35 systems by running them through various tests to identify the most suitable one. As Lieutenant Colonel Donald F. Shenk, the Interim Armored Vehicle

Program Manager at the Tank-automotive & Armaments Command, Dearborn, Michigan, explained, the Army used the tests to identify a family of vehicles that was air transportable, was capable of immediate employment upon arrival in the theater of operations, and had the greatest degree of commonality. Other desired characteristics included low sustainment costs, fuel economy, and maintainability.[70]

Deciding on the vehicle provoked a controversy. Even before the official selection process began, General Shinseki expressed his opinion in October 1999—indicating that he preferred a wheeled vehicle as a solution. This challenged the cultural bias against wheeled vehicles because the Army had favored tracks for combat vehicles at least since World War II. Tracked vehicle proponents feared that wheeled vehicles would be favored in the Interim Armored Vehicle competition at Aberdeen Proving Ground, Maryland, and argued that tracked vehicles with their low ground pressure and greater traction offered better cross-country capabilities than wheeled vehicles. In the meantime, wheeled vehicle proponents pointed out that wheeled vehicles were simpler to maintain, were more reliable, and offered speed and agility while the supporters of tracked vehicles insisted that the Army would be foolish to go with wheeled vehicles just for their speed when they were vulnerable to getting stuck in mud and slowed down by rocks and other terrain over which tracks would glide. Reflecting a moderate position, Lieutenant Colonel Dana Pittard of the 3d Brigade, 2d Infantry Division that was converting to the Initial Brigade Combat Team organization at Fort Lewis, Washington, articulated his view in October 2000. He espoused adopting the best vehicle—whether it ran on wheels or tracks. Discussions through much of 2000 noted both merits and liabilities for each type of vehicle. Likewise, initial testing demonstrated the wheeled vehicle's ability to travel faster on the road and the tracked vehicle's cross-country superiority but failed to determine a clear winner, according to Colonel Shenk. Essentially, adopting either one meant tradeoffs.[71]

After assessing the various candidates for its Interim Armored Vehicle, the Army announced its decision on 17 November 2000. It chose the Light Armored Vehicle III that was built by General Motors Defense and General Dynamics Land Systems, was already in

production, and was employed by the US Marine Corps, the Canadian forces, the Saudi Arabian military, and the Australian army as the Interim Armored Vehicle platform. The company would manufacture its Light Armored Vehicle III in two variants: the infantry carrier vehicle and the mobile gun system. Both would be wheeled. The Light Armored Vehicle III would offer commonality and be the baseline for eight additional configurations (the mortar carrier vehicle; the anti-tank guided missile vehicle; the reconnaissance vehicle; the fire support vehicle; the engineer squad vehicle; the commander's vehicle; the medical evacuation vehicle; and the nuclear, biological, and chemical reconnaissance vehicle) to reduce the logistical burden.[72] Moreover, both variants could move at 60 miles per hour and travel in convoys at 40 miles per hour to provide the Interim Brigade Combat Team with tactical speed on the battlefield. Other benefits included strategic mobility via a C-130, low sustainment costs, and quiet operation that would permit stealthy movement in battle.[73]

A little more than two years after it selected the Light Armored Vehicle III as the Interim Armored Vehicle, the Army saw the fruits of its labors in 2002. As mentioned earlier in the chapter, the Army named the vehicle Stryker after two Medal of Honor recipients.[74] On 12 April 2002, General Shinseki accepted the first vehicle on behalf of the Army. Slated to be the workhorse of the Interim Brigade Combat Team, the vehicle represented the first of 2,000 to be delivered over the next decade. The system would provide the Interim Brigades with more firepower and protection than existing vehicles but would be more deployable than the M2 Bradley Fighting Vehicle and the M2 Abrams that were currently in the inventory.[75] At the acceptance ceremony, General Shinseki noted, "It [the Stryker] resonates with what we expect it will give to the Army—a quick strike capability with greater staying power."[76]

Millennium Challenge 2002, a joint Army-Air Force exercise, reinforced General Shinseki's optimism by demonstrating the Stryker's deployability. During the July–August 2002 exercise, the Army airlifted a company of four Strykers via C-17 from Fort Lewis to an intermediate staging base. Then they were loaded onto C-130s and airlifted to an airfield in the middle of the National Training Center, Fort Irwin, California, where the Army conducted a joint interoperability exercise with the Marine Corps. From the Army's

perspective, the exercise reaffirmed the vehicle's deployability even though some material deficiencies were noted that required fixing.[77] The vehicle was a battlefield "enabler," according to the Army.[78] Echoing this, General Shinseki remarked at the 4 September 2002 Association of the US Army meeting, "Stryker's performance during Millennium Challenge at the National Training Center demonstrated the bridge for bringing together our rapidly deploying and versatile light forces and our lethal, survivable heavy forces."[79]

Additional tests buttressed General Shinseki's observation. During a series of operational evaluations in 2003, the Stryker demonstrated its strategic mobility once again. Arrowhead Lightning I, an operational evaluation of the Stryker vehicle and the Stryker Brigade Combat Team conducted at the National Training Center, employed six Air Force National Guard C-130 aircraft to fly 16 sorties on 1 April 2003 from the Southern California Logistics Airport to Bicycle Lake Army Airfield, a dirt landing strip at the National Training Center, then 21 more sorties on 2 April 2003. Altogether the Air Force National Guard transported 30 fully loaded Stryker vehicles with their crews to participate in a 10-day operational evaluation of the Stryker Brigade Combat Team (3d Brigade, 2d Infantry Division) to determine the vehicle's operational readiness. Subsequently, the Stryker team transported Stryker vehicles by land, air, and sea to the Joint Readiness Training Center at Fort Polk, Louisiana, to participate in Arrowhead Lightning II. As a part of the test, the Army shipped 130 Stryker vehicles to the Fort Sill railhead facility; they arrived on 26 and 27 April 2003. After loading the vehicles onto railcars, Fort Sill and Fort Lewis personnel shipped them to Fort Polk. Observations from this certification exercise indicated that the Stryker vehicle and the brigade performed well and met the Army's criteria and along with Millennium Challenge ended any opposition to the Light Armored Vehicle III serving as the Interim Armored Vehicle.[80] Subsequently, Stryker vehicles and brigades started deploying to Iraq in December 2003 in support of Operation Iraq Freedom. Later, the Field Artillery School received six Strykers in April 2004 and November 2004 for training purposes.[81]

Meanwhile, work on the Future Combat System for the Objective Force moved forward with the goal of introducing leap-ahead

technologies and operational capabilities. To field the Future Combat System, the Army and Defense Advanced Research Projects Agency launched a collaborative effort in May 2000 to define and demonstrate the Future Combat System. The Future Combat System would supplant the Stryker and be the primary weapon/troop carrying platform for the Objective Force. As the centerpiece of the Objective Force, the Future Combat System would be a family of vehicles with four primary functions of indirect fire, direct fire, infantry carrier, and sensor; have manned and unmanned variants; and be a system of battlefield capabilities. Ultimately, the Future Combat System would make the heavy forces lighter and the light forces more lethal, reduce logistical demands, function in the operational environment of the future, enable the Objective Force to dominate ground combat across the entire spectrum of operations, and enhance the Army's ability to conduct decisive tactical maneuver.[82]

In May 2002, a vital component of the Future Combat System program received an unexpected windfall when Secretary of Defense Donald Rumsfeld terminated the Crusader program. He used savings from the terminated program to accelerate development of the Future Combat System cannon for the Objective Force.[83] Out of this development emerged a concept technology demonstration program. United Defense and General Dynamics were the principle contractors to examine technological possibilities, furnish a material solution for the cannon, deliver block one capability by Fiscal Year 2008, and develop a strategy to achieve the objective solution. Six months later, the Army completed a study to determine the cannon's requirements. Then in December 2002, the Army established a maximum range of 30 to 40 kilometers, a minimum range of 3 to 4 kilometers, and a rate of fire of 6 to 10 rounds a minute plus automatic ammunition handling of all current and developmental munitions, interoperability with other Future Combat System systems, and C-130 deployability.[84]

Late in 2002 and into early 2003, the Army outlined various options to field the block one Future Combat System Cannon, officially called the Future Combat System Non-Line-of-Sight Cannon. Initially, the Army had four potential self-propelled variants—a tracked and a wheeled 105-millimeter howitzer and a tracked and

a wheeled 155-millimeter howitzer. While either caliber was viable and while either tracks or wheels were also viable, the Army planned to select the best existing design features to field a demonstration model by October 2003 to serve as the basis of the block one cannon.[85]

To meet the deadline, the Field Artillery School merged the four variants early in 2003. Based on additional study, the school produced one option—a 155-millimeter caliber weapon system with a band track. Major General Michael D. Maples, who was the Commandant of the Field Artillery School from 2001 to 2003, explained the concept and the rationale for the selection on 29 January 2003. A single piece of steel-reinforced rubber would replace the conventional articulated steel tracks and thus offer increased mobility over wheeled versions during cross-country operations, be lighter than a wheeled variant, and meet the Future Combat System operational requirements for highway speed. The 155-millimeter caliber also would provide greater lethality and shoot more munition types.[86] General Maples cautioned, "This. . .is not a recommendation to make a final decision on caliber or chassis design."[87]

Within a few months, contractor United Defense Industries introduced and tested a cannon prototype at Yuma Proving Ground, Arizona. The prototype featured a modified XM777 155-millimeter howitzer tube mounted on a platform that had been designed by United Defense's Ground Systems Division, a fully automated ammunition loading system, and a magazine that held 24 100-pound projectiles. The platform used a band-track system and was propelled by a hybrid electric diesel engine to provide improved mobility and reduced fuel consumption. In August 2003, the prototype successfully fired its first round. By the end of October 2003, the prototype had fired 140 rounds.[88]

Meanwhile in March 2003, the Army acknowledged the difficulty of designing the Non-Line-of-Sight Cannon that would be deployable in a C-130 aircraft and searched for satisfactory compromises. A cannon that fully complied with the Future Combat System operational requirements would far exceed the weight restriction of 20 tons and thus would not be C-130 deployable. In view of this, the Army conducted numerous analyses during the rest of 2003 to find

a design that would meet the transportability requirements but retain the desired combat requirements. Some suggested design compromises were to eliminate automated resupply, reduce the caliber of the 155-millimeter tube to decrease the range capability, use a 105-millimeter tube instead, limit the armor, and deploy the cannon with a limited amount of fuel and ammunition on board. As might be expected, the Army found these concessions to be unsatisfactory.[89]

In December 2003, the Army formed a team of experts from government and private industry to examine capability versus transportability. A month later, the team reported significant shortfalls in expected capabilities of combat platforms that could be moved on C-130s. It became clear that some requirements had to be modified to achieve C-130 transportability.[90] Recognizing the difficulty of achieving the weight limitations, the Program Manager for Future Combat System, Unit of Action, Brigadier General Charles Cartwright, stopped work on the 20-ton version in November 2004 in favor of work on a 24-ton version.[91]

Meanwhile in May 2004, the Army and Field Artillery made a key decision on the caliber of the cannon. Based on careful analysis, they opted for a 38-caliber, 155-millimeter howitzer. The 155-millimeter howitzer tube was 58 percent more effective against personnel targets than the 105-millimeter tube under consideration and 82 percent more effective against materiel targets than a 105-millimeter tube. Also, the Army and Field Artillery selected the 38-caliber tube over the longer 39-caliber tube—trading four kilometers of range using the M549 rocket-assisted projectile to save 1,367 pounds. This would make the cannon C-130 deployable with about 25 percent of its basic load of ammunition and still satisfy operational requirements for transportability, lethality, survivability, and sustainability.[92]

As the Army examined the transportability and caliber issues, it restructured the Future Combat System program to meet congressional guidance and get new technology to the force faster. Restructuring would accelerate the most critical and promising technologies within the program so the Army could more quickly insert Future Combat System technology into the operational force.[93] Equally important, the cannon became the lead Future Combat System manned ground vehicle variant.[94]

After two years of developmental work on the cannon, Congress reduced funding for the Future Combat System program in 2007, prompting the Army to restructure its modernization efforts again. It reduced the number of Future Combat System platforms from 18 to 14 and extended the timeline for buying and fielding the systems to stay within budget.[95] As initially planned, the first Future Combat System Brigade Combat Team would have initial operational capability in 2010, with the prototype Non-Line-of-Sight Cannon being delivered in 2008. Although the fielding schedule was still being worked on, 2007 briefings showed changes. The initial operational capability for the first Future Combat System Brigade Combat Team would be 2014 under the new timeline, with full operational capability in 2017; the Non-Line-of-Sight Cannon was still the lead variant in the Future Combat System family of systems; the cannon would have a common chassis with the Future Combat System family of vehicles and have similar interoperability, mobility, and survivability characteristics; and the cannon would leverage work done with the Crusader program.[96]

In 2008, Non-Line-of-Sight Cannon passed crucial milestones. BAE Systems placed the cannon on the Future Combat System manned ground vehicle that was the common platform for the eight manned variants. A unique mission module would be mounted and shown for the first time at the National Mall, Washington, D.C., in June 2008. After final laboratory testing on the prototype, BAE delivered it to the Army test site in August 2008 and the Army fired the first round on 17 September 2008. The Army continued testing through the rest of the year and planned to receive four more prototypes for testing.[97] Major General Peter M. Vangjel, who was the Commanding General of the Fires Center of Excellence from 2007 to 2009, commented in December 2008 about the cannon's significance: "It is therefore imperative that we support NLOS-C."[98]

Notwithstanding this success, General Vangjel's strong support, and the overall solid progress of the Future Combat System development program, Secretary of Defense Robert Gates announced on 6 April 2009 that he would restructure program. He intended to accelerate select technologies to the Brigade Combat Teams and planned to cancel the manned ground vehicle component of the pro-

gram with its eight separate tracked combat vehicle variants built on a common chassis to replace the M1 Abrams tank, the M1 Bradley infantry fighting vehicle, and the M109 Paladin self-propelled howitzer. As he explained, the manned ground vehicle program did not adequately reflect counterinsurgency and close-quarters combat lessons from Iraq and Afghanistan. Secretary Gates further criticized the Future Combat System program because it did not include mine-resistant, ambush-protected vehicles. Following Secretary Gates's announcement, the Department of Defense issued an acquisition decision memorandum on 23 June 2009 that halted the Future Combat System program and cancelled work on the Non-Line-of-Sight Cannon to save money.[99]

Work on the Future Combat System Non-Line-of-Sight Launch System accompanied development of the Non-Line-of-Sight Cannon. Brigadier General Toney Stricklin, who was the Assistant Commandant of the Field Artillery School from 1997 to 1998, outlined the school's vision of the future for fire support in the May–June 1998 *Field Artillery*. Among other things, he proposed an advanced fire support system that would be a family of precision missiles. They would be capable of attacking with preci-

Figure 5: Non-Line-of-Sight Cannon. *Source:* US Army photo courtesy of Tank-automotive and Armaments Command.

sion or loitering over the target area before attacking with precision and would not require a large, heavy, expensive and crew-intensive launch platform.[100]

Out of this vision evolved the Defense Advanced Research Projects Agency NetFires technology demonstration program. Lockheed-Martin, Raytheon, and Boeing Corporation began work in 1998 to establish an initial concept. In 1999, the Depth and Simultaneous Attack Battle Laboratory at Fort Sill became the US Army Training and Doctrine Command's proponent to give the Defense Advanced Research Projects Agency and the contractor teams the information needed to develop critical design parameters and system characteristics. One year later in August 2000, Lockheed-Martin and Raytheon started fabricating the system for a Precision Attack Missile and a Loiter Attack Missile. NetFires—later renamed the Future Combat System Non-Line-of-Sight Launch System to avoid confusion with Fort Sill's Networked Fires concept—would consist of a container/launch unit with 15 containerized missiles and an on-board computer and communications system. The Non-Line-of-Sight Launch System would deliver the Loiter Attack Missile with a range of 70 kilometers plus a loitering time of approximately 30 minutes and the Precision Attack Missile with a maximum range of 40 kilometers.[101]

Over a period of several years beginning in 2001, the Non-Line-of-Sight Launch System development program designed, fabricated, tested, and demonstrated container-launched missiles that would provide massive, responsive, precision firepower early in a conflict. The system would be shipped in its launching container; would require no additional launch support equipment; and could be fired remotely from a truck, a variety of other platforms, or the ground. The missiles would be ready to fire almost immediately—a much faster response time and a higher potential rate of fire than possible with current howitzers or missile launchers—and would provide a precision non-line-of-sight capability. Equally important, it would be one of 18 Future Combat Systems core systems and would be organic to the Future Combat System Brigade Combat Team in the Objective Force.[102]

Although development was progressing on the container/launch unit and the missiles for operational testing in 2010 and full

operational capability in 2013, Congress considered terminating the program but decided to modify acquisition. The Defense Authorization Bill for Fiscal Year 2005 subsequently cut the program's funding by $15 million, accelerated work on the Precision Attack Missile, and slowed work on the Loiter Attack Missile. The bill retained the Loiter Attack Missile in the science and technology base for further maturation and permitted moving the Precision Attack Missile further into development because its technology was easier to integrate with the Current Force than the Loiter Attack Missile.[103]

Following the funding modification, the Army revamped its fielding plan with the intent to field the Precision Attack Missile and container/launch unit by 2008. To get it to the field as soon as possible, the Army accelerated development in phases or blocks, with prototypes developed in each one. Moving into the next phase or block meant that the prototype had to meet specific performance parameters. Also, as one of the first three Future Combat System systems to be employed in the Current Force, the Non-Line-of-Sight Launch System with the Precision Attack Missile would be incorporated into the fires battalion of the Heavy (Armored) Brigade Combat Team. This organization later would be transformed into a modular brigade and finally became the Future Combat System Brigade Combat Team in 2014.[104]

Notwithstanding developmental progress after 2005, the Department of Defense announced an abrupt change in the Non-Line-of-Sight Launch System. After the Precision Attack Missile failed to hit four of six targets during a test in January–February 2010, the Army determined fixing the system's problems would delay the program more than a year. Further, a review of the precision munitions portfolio determined that the missile was unaffordable and would not provide a cost-effective precision fire capability. Due to these various factors, the Army opted to pursue other capabilities to engage a moving target in all weather conditions in order to fulfill the operational requirement defined for the Non-Line-of-Sight Launch System. The Department of Defense concluded that the system was no longer required. In view of this, Secretary of the Army John H. McHugh recommended cancelling the program. The Undersecretary of Defense for Acquisition, Technology, and Logis-

tics, Ashton Carter, approved and authorized the program cancellation on 13 May 2010.[105]

At the beginning of the 21st Century, the Non-Line-of-Sight Cannon System and the Non-Line-of-Sight Launch System promised to revolutionize the branch, give it unprecedented lethality and tactical mobility, make it deployable for power projection, and be a vital part of the modular force. The demise of these systems during the first decade of the century left the branch with the less futuristic M777 and the High Mobility Artillery Rocket System—and without the potential for medium-weight weapon systems that were critical parts of transformation. The M777 cannon and the High Mobility Rocket System offered strategic mobility but did not make a radical, innovative departure from their respective predecessors, which were the M198 towed 155-millimeter howitzer and the Multiple Launch Rocket System. The Field Artillery's future that envisioned pioneering weapon systems arming a modular force had disappeared. Modularization would go on without key field artillery systems.

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Chapter 4

A New Century and the War on Terrorism

On a calm, beautiful 11 September 2001 morning, Americans started their normal weekday in New York City and Washington D.C. As the 9/11 Commission Report of 2004 indicated, some were making their way across lower Manhattan, New York City, to the Twin Towers in World Trade Center complex where they were employed. About 200 miles to the south in Washington D.C., civilian and military personnel began their busy days in the Pentagon. Across the Potomac River, Congress reconvened after a summer break while the President of the United States, George W. Bush, jogged to open his day while visiting Sarasota, Florida. None of these people—or Americans in general—even remotely considered the possibility of a terrorist attack.

On 11 September 2001, 19 al-Qaeda terrorists brought the tranquility of the day to an abrupt halt when they flew airplanes into American landmarks in suicidal attacks. Two airplanes, American Airlines Flight 11 and United Airlines Flight 175, crashed into the North and South towers of the World Trade Center respectively. Within two hours, both towers collapsed—causing the partial or complete collapse of other World Trade Center complex buildings and significant damage to 10 major buildings in the vicinity. The third airplane, United Airlines Flight 77, slammed violently into the Pentagon, killing passengers as well as civilians and military personnel in the building. The fourth airplane, United Airlines Flight 93, plowed into a field near Shanksville, Pennsylvania, after passengers overwhelmed the hijackers and prevented the flight from reaching its destination, which was assumed to be the White House. All onboard were killed. Approximately 3,000 people died in the attacks, including the 19 hijackers. The attacks sent many people to fiery and untimely deaths and propelled the country toward a war on terrorism with the support of the international community, which also expressed outrage over the attacks.

Global War on Terrorism and the Field Artillery

President Bush and his staff responded resolutely to the attacks. On 11 September 2001, he told his advisors that the United States would not only attack the perpetrators but also any countries that harbored them. This put Afghanistan, Pakistan, and Saudi Arabia on alert for possible American military action. The following day, President Bush refined his position. In a 12 September 2001 meeting with the National Security Council, he stressed that the United States was "at war with a new and different kind of enemy" and urged the council to develop a strategy to eliminate the terrorists and punish those who supported them; he gradually forged a coalition of nations to destroy al-Qaeda, the sponsor of the attacks, and its supporters.[1]

Beginning early in October 2001, the Coalition launched Operation Enduring Freedom, a military campaign against the Taliban regime in Afghanistan that backed al-Qaeda. US forces relied on special operation forces and air power for fire support in the initial stages because field artillery officers and Soldiers in the 10th Mountain Division (Light) and the 101st Airborne Division (Air Assault) deployed without their field artillery. The intention was to keep the American logistical footprint as small as possible, because American leadership believed that the mission could be accomplished with organic mortars together with Army, Air Force, Marine, and Navy aviation assets. Even though mortars and aviation provided effective fire support, Operation Enduring Freedom generated an intense professional dialogue about the absence of field artillery during the initial days of fighting and the short-coming of joint fires for troops in close contact. In March 2002, Operation Anaconda, the final large-scale combat operation of Operation Enduring Freedom, was an overwhelming success by destroying the last remnants of the Taliban. It also served as a prime example of the limitations of airpower. During Operation Anaconda as in previous operations, ground forces relied on Air Force A-10 aircraft and Army AH-64 Apache helicopters and mortars for close support. All provided effective fires, but troops on the ground recognized the need for responsive close support from field artillery—unavailable during the conflict. All participants in Operation Enduring Freedom agreed

that Soldiers and Marines required effective fires in all weather and in all terrain, and this meant field artillery fires. Based on this, 82d Airborne Division fire supporters (field artillery officers and Soldiers) arrived in June 2002 with their M119 towed 105-millimeter howitzers and 120-millimeter mortars to replace the fire supporters from the 10th Mountain Division (Light) and the 101st Airborne Division (Air Assault).[2]

Notwithstanding the lack of field artillery in its early days, Operation Enduring Freedom of 2001–02 produced impressive results. By the end of 2002, the Taliban and al-Qaeda were no longer capable of conducting major military operations. In view of this, Secretary of Defense Donald H. Rumsfeld declared in May 2003 that major combat operations in Afghanistan had been completed. American forces would begin rebuilding the country while maintaining peace and order. Unfortunately, 2001–02 operations only served as the opening of a lengthy nation building and counterinsurgency campaign that continued into the second decade of the 21st Century to establish democracy as an alternative to Islamic extremism.[3]

Meanwhile, Saddam Hussein refused to comply with United Nations resolutions to disarm and eliminate his weapons of mass destruction. When he and his sons Uday and Qusay refused to leave Iraq, President Bush and American allies initiated military action, called Operation Iraqi Freedom, to remove Saddam Hussein from power. On 19 March 2003, Coalition military forces launched a decapitation strike with cruise missiles and bombs dropped by F117 aircraft against Saddam and his top lieutenants while Coalition air forces struck long-range artillery emplacements, air defense sites, and surface-to-surface missile sites. Patriot air defense missiles, meanwhile, intercepted and destroyed two Iraqi missiles.[4]

The following day on 20 March 2003, Coalition forces that included more than 400,000 US military personnel stood ready to end the tyrannical rule of Saddam Hussein.[5] US Central Command assembled US Army forces under the V Corps that was commanded by Lieutenant General William S. Wallace. The V Corps—initially composed of the 3d Infantry Division (Mechanized), 101st Airborne Division (Air Assault), and a brigade of the 82d Airborne Division and later adding the 4th Infantry Division (Mechanized)—attacked.

To the east, the I Marine Expeditionary Force struck across the Kuwait-Iraq border to secure the Rumaylah Oil Field and then advanced along Highway 8 to An Nasiriyah, crossed the Euphrates River, and moved to Baghdad as American and Australian Special Forces secured Iraq's western desert to suppress Scud missile attacks on Israel. Meanwhile, the British 1st Armoured Division and the British 3d Commando Brigade secured the area around Basra.[6]

On 20 March 2003, a field artillery bombardment along the Kuwait-Iraq border paved the way for the maneuver forces, which were led by three heavy brigade combat teams from the 3d Infantry Division (Mechanized); together they assaulted into Iraq. The 2d Battalion, 4th Field Artillery Regiment (Multiple Launch Rocket System) from Fort Sill's 214th Field Artillery Brigade opened the ground war when it fired Army Tactical Missile System I and IA (long-range precision field artillery missiles) at enemy corps, division, and corps artillery command posts stretching from Al Basrah to An Nasiriyah to Amarah. After this opening salvo, the battalion launched more missile strikes against Iraqi 11th Infantry Division air defense artillery and counterbattery assets near An Nasiriyah. During the initial attacks of the ground war, the battalion fired 63 Army Tactical Missile System strikes into Iraq and destroyed political targets, such as Ba'ath Party and Fedayeen Saddam Headquarters, enemy air defense sites, and command and control centers deep within enemy territory up to 200 kilometers. Meanwhile, the 41st Field Artillery Brigade and 1st Battalion, 39th Field Artillery Regiment (Multiple Launch Rocket System) of the 3d Infantry Division (Mechanized) fired preemptive counterfire missions against the Iraqi 11th Infantry Division and 14th Infantry Division artilleries and the Iraqi 6th Tank Division artillery positioned from Al Basrah to An Nasiriyah. These fires shaped the battlefield by destroying critical command and control nodes and enemy headquarters.[7]

Early the following day on 21 March 2003, the 3d Infantry Division's (Mechanized) ground attack under the cover of long-range missile fires began in earnest. The 3d Infantry Division (Mechanized) had the goal to advance as rapidly and expeditiously as possible to Baghdad—deliberately bypassing cities and securing bridges for follow-on forces.[8]

From the initial destruction of border observation posts to silencing enemy indirect fire systems, massed fires from the 3d Infantry Division's (Mechanized) organic M109A6 self-propelled 155-millimeter howitzers (Paladins) and Multiple Launch Rocket System M270A1 launchers, close air support, and air interdiction allowed the division to maneuver freely after crossing into Iraq on 21 March 2003.[9] Once the breach had been made, the division raced north along the Euphrates River on roads toward An Nasiriyah. As the division's 3d Brigade Combat Team approached Tallil Airbase outside of An Nasiriyah to lure Iraqi forces into a trap, it ran into unexpected stiff resistance from the Iraqi 11th Infantry Division. The 3d Infantry Division's (Mechanized) Paladins (M109A6 self-

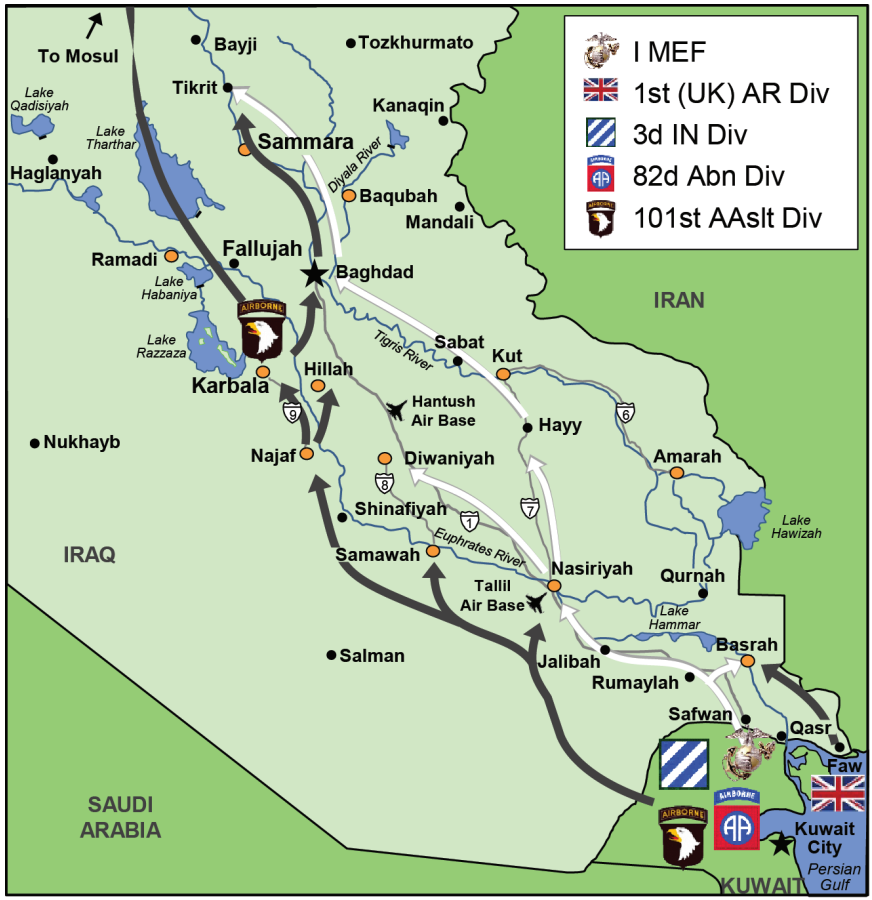

Figure 6: Operation Iraqi Freedom map.

Source: Produced by Army University Press, Fort Leavenworth, Kansas.

propelled 155-millimeter howitzers) from the 1st Battalion, 10th Field Artillery Regiment and 1st Battalion, 41st Field Artillery Regiment furnished direct support to the division's 3d Brigade Combat Team and the 1st Brigade Combat Team while the division's 1st Battalion, 39th Field Artillery Regiment (Multiple Launch Rocket System) provided counterfire. Combined, maneuver and field artillery forces defeated elements of the Iraqi 11th Infantry Division on 21–22 March 2003 at Tallil Airbase, capturing enemy prisoners of war in the process. After taking control of the bridges around the city that spanned the Euphrates River, the 3d Infantry Division (Mechanized) continued its race toward Baghdad—leaving the I Marine Expeditionary Force's Task Force *Tarawa* to seize An Nasiriyah on 23 March 2003.[10]

As elements of the 3d Infantry Division (Mechanized) assaulted Tallil Airbase, the 3d Infantry Division's (Mechanized) 3d Squadron, 7th Cavalry and the 2d Brigade Combat Team raced through the desert northward beyond An Nasiriyah toward As Samawah and An Najaf, which composed the outer ring of defense surrounding Baghdad and was defended by the Republican Guard.[11] With reinforcing fires from the 2d Battalion, 4th Field Artillery Regiment (Multiple Launch Rocket System) from the 214th Field Artillery Brigade, the cavalry squadron made the first contact with enemy defenses at As Samawah and was joined by the brigade combat team. Together, they encountered fierce enemy resistance that included mortar and field artillery fire. Near As Samawah, A Battery, 1st Battalion, 9th Field Artillery Regiment from the 3d Infantry Division (Mechanized) engaged human waves of Fedayeen paramilitary fighters at 1,400 meters on 22 March 2003 as it supported Task Force *1-64*'s mission to clear enemy bunkers and forces. Meanwhile the division's 1st Battalion, 39th Field Artillery Regiment (Multiple Launch Rocket System) fired rockets in support of the cavalry squadron that was fighting a tenacious enemy willing to go to its death. After about two days of intense fighting that witnessed the enemy employing innocent men, women, and children as human shields, these elements of the 3d Infantry Division (Mechanized) secured As Samawah on 24 March 2003 and left enemy guerrilla fighters as the only resistance. This prompted Central Command to commit a brigade from

the 82d Airborne Division to mop up the remaining resistance and protect the 3d Infantry Division's (Mechanized) lines of communication so that the division could continue its drive north toward Karbala and then Baghdad.[12]

To the north of As Samawah in An Najaf that also sat astride the Euphrates River with several key bridges across the river, about 3,000 soldiers from Saddam Hussein's Al Qut Division armed with rocket-propelled guns and AK-47 rifles as well as paramilitary forces waited for the 3d Squadron, 7th Cavalry, 1st Brigade Combat Team, and the 2d Brigade Combat Team. Providing fire support, American field artillery employed Multiple Launch Rocket System fires in danger close missions (shooting at enemy targets less than 450 meters from friendly forces) with great effectiveness. This action kept friendly soldiers alive to engage enemy soldiers who had come out of their defensive positions to attack the Americans. Coupled with close air support and direct fires from the maneuver arms, rocket fires from the 1st Battalion, 39th Field Artillery Regiment (Multiple Launch Rocket System) of the 3d Infantry Division (Mechanized) destroyed enemy strongholds, including one city block that contained a Ba'ath Party headquarters building and troop barracks, approximately 2,000 Fedayeen fighters, and around 100 vehicles; they also took possession of the bridges to the north and south of the city, with fighting tapering off by 27 March 2003.[13]

Before victory could be claimed at An Najaf, a blinding sandstorm with accompanying rain squalls blasted the area from Baghdad to the Persian Gulf on 24–27 March 2003. Winds reached a speed of 45 miles per hour and covered everything with a thick coat of sand. Field artillery officers and Soldiers from the 1st Battalion, 10th Field Artillery Regiment of the 3d Infantry Division (Mechanized) referred to those days, especially 25–26 March 2003, as the Mars Days because the orange glow created by the blowing dust resembled a science fiction movie scene of life on distant planets.[14]

Despite its potential to stop operations, the storm presented a critical tactical opportunity. Besides permitting Central Command to refit, refresh, and resupply its ground forces and establish a large logistical base, it allowed the Coalition's long-range unmanned aerial vehicles to watch the Iraqis concentrate their forces and then

begin redeploying them toward the V Corps and the I Marine Expeditionary Force. Coordinates that were passed from unmanned aerial vehicles allowed high-flying B-1 bombers and fighter bombers to attack Iraqi forces with infrared-guided bombs that could see through the blowing sand.[15]

During the sandstorm, field artillery systems furnished effective fires. The 2d Battalion, 4th Field Artillery Regiment (Multiple Launch Rocket System) of the 214th Field Artillery Brigade and other field artillery units conducted numerous missions in support of the 3d Infantry Division (Mechanized), the 101st Airborne Division (Air Assault), and the I Marine Expeditionary Force. To maintain operational tempo, for example, the 2d Battalion, 4th Field Artillery Regiment (Multiple Launch Rocket System) fired more than 50 missile strikes at various targets. One fire mission from the battalion came in support of the 3d Squadron, 7th Cavalry that was feinting to cross the Euphrates River near An Najaf to draw Republic Guard forces out of Baghdad. The feint worked; field artillery fires destroyed a large number of enemy vehicles moving south from Baghdad under the cover of the storm to reinforce An Najaf.[16]

As the sandstorm lifted, the 101st Airborne Division (Air Assault) relieved the 1st Brigade Combat Team and the 2d Brigade Combat Team of the 3d Infantry Division (Mechanized) at An Najaf on 28 March 2003 so that they could continue their march on Baghdad. Here, the airborne division experienced its first major combat during Operation Iraqi Freedom.[17]

During the battle for An Najaf, the 101st Airborne Division's (Air Assault) 1st Brigade Combat Team's and 2d Brigade Combat Team's field artillery effectively employed indirect fires against confirmed enemy targets, enemy snipers, and observers on rooftops. For example, the division detached C Battery from its general support 1st Battalion, 377th Field Artillery Regiment, a M198 towed 155-millimeter artillery unit, to support its own M119 towed 105-millimeter firing batteries from the 3d Battalion, 320th Field Artillery Regiment, the 1st Battalion, 320th Field Artillery Regiment, and 2d Battalion, 320th Field Artillery Regiment. The division pushed these batteries right behind the armor formations to the outskirts of the city to engage the enemy at relatively short ranges and ensure fire support coverage of the entire city.[18]

While elements of the 101st Airborne Division (Air Assault) fought around An Najaf, the 82d Airborne Division destroyed remnants of Republic Guard and Saddam Fedayeen forces that were disrupting lines of communication along Highway 8 in As Samawah. During that fight, fire support from the 2d Battalion, 319th Field Artillery Regiment's two M119 towed 105-millimeter howitzer batteries repeatedly executed danger close missions by attacking enemy targets within 450 meters of friendly forces.[19]

As the 82d Airborne Division battled around As Samawah, the 3d Infantry Division (Mechanized) pushed toward the Karbala Gap. The Gap was about 50 miles south of Baghdad between the Salt Sea (Lake Razaza) to the west and the Euphrates River to the east. Defended by the Baghdad Division and elements of the Nebuchadnezzar Division, the Gap provided the only open approach to Baghdad that would avoid the urban sprawl in the Euphrates River Valley and serve as a solid supply route. To break through the Gap, the V Corps conducted five simultaneous attacks. The 3d Infantry Division (Mechanized) attacked along the Euphrates River toward Al Hillah to draw Iraqi forces away from the Gap where the main attack would cross the Euphrates River, while the 3d Squadron, 7th Cavalry moved to the mouth of the Gap. The 101st Air Assault Division continued fighting in An Najaf to secure it as the 82d Airborne Division maintained its attack at As Samawah. An element of the 101st Air Assault Division meanwhile conducted an armed reconnaissance to the south of the Salt Sea.[20]

Early in April 2003—under the cover of violent counterfire missions from V Corps field artillery and the effective employment of precision munitions—the 1st Brigade Combat Team, the 2d Brigade Combat Team's Task Force 4-64, and the 3d Brigade Combat Team from 3d Infantry Division (Mechanized) attacked the Karbala Gap. As the 2d Brigade Combat Team of the 3d Infantry Division (Mechanized) drew enemy forces away from the Karbala Gap toward Al Hillah supported by violent fires from the 1st Battalion, 9th Field Artillery, the brigade combat teams and task force attacked through the Karbala Gap toward Baghdad to the east of the Euphrates River. In the meantime, M270A1 launchers from the 3d Infantry Division's (Mechanized) 1st Battalion, 39th Field Artillery

Regiment engaged nine enemy targets in the town of Karbala with rockets. At the same time, the division's 1st Battalion, 41st Field Artillery Regiment bombarded enemy positions in the town and the Karbala Gap on 1 April 2003 with 155-millimeter rounds.[21] Over a period of 12 hours, field artillery fires destroyed 6 T-72 tanks, 13 armored personnel carriers, and 15 air defense weapons. This action devastated the Medina Division of the Republican Guard and enemy defenses in general. As a team, M270A1 launchers in the meantime combined with Air Force close air support to destroy 60 enemy vehicles and 15 field artillery weapons, set the conditions for encircling Baghdad, and establish the setting for the eventual collapse of the Iraqi government.[22]

As the 3d Infantry Division (Mechanized) attacked through the Karbala Gap, the 101st Airborne Division's (Air Assault) 1st Brigade Combat Team and the 2d Brigade Combat Team eliminated remaining guerilla resistance to the south at An Najaf. The brigades employed armor, field artillery fire support, and army aviation while methodically moving through the city. They eliminated resistance; destroyed ammunition, equipment, and weapons; and seized key strong points then secured the city early in April 2003.[23]

Subsequently, the 101st Airborne Division (Air Assault) launched an attack on Al Hillah (ancient Babylon) to the north of An Najaf. Division artillery provided nine batteries in support of the 3d Brigade Combat Team's direct support battalion. Specifically, the 3d Battalion, 320th Field Artillery Regiment received reinforcing fires from the 1st Battalion, 320th Field Artillery Regiment; a battery from the 2d Battalion, 320th Field Artillery Regiment; and C Battery, 1st Battalion, 377th Field Artillery Regiment. Before the 3d Brigade Combat Team attacked Al Hillah on 8 April 2003, these field artillery units massed rounds on single targets, fired as many as eight batteries simultaneously, and moved within the outskirts of the city. This permitted the 105-millimeter howitzers to range the entire city in support of the maneuver arms and played a key role in defeating enemy forces in the city.[24]

The 82d Airborne Division, meanwhile, protected vulnerable supply lines created by the rapid advance of the 3d Infantry Division (Mechanized) and 1st Marine Expeditionary Force from attacks by remnants of Republican Guard and Saddam Fedayeen

forces. With support from the 307th Engineers, the 2d Battalion, 319th Field Artillery Regiment established two battery fire bases three kilometers southwest of As Samawah and received reinforcing infantry to help with battery defense if required. Immediately after occupying its position, B Battery, 2d Battalion, 319th Field Artillery Regiment opened fire on enemy mortars and positions on 29 March 2003. The battalion later furnished fire support when the division's 2d Battalion, 325th Airborne Infantry Regiment assaulted the city after crossing the Euphrates River. The battalion fired more than 1,000 rounds in support of the liberation of As Samawah on 2 April 2003.[25]

As the 82d Airborne Division finished liberating As Samawah and 101st Airborne Division (Air Assault) eliminated the remaining resistance at An Najaf and Al Hillah, the 3d Infantry Division (Mechanized) attacked Baghdad on 3 April 2003 with a field artillery preparation from organic assets and counterfire from the 214th Field Artillery Brigade and Army Tactical Missile Systems from the 41st Field Artillery Brigade. Close air support and Multiple Launch Rocket System and cannon fires supported the division's 1st Brigade Combat Team attack on the Saddam International Airport, later renamed Baghdad International Airport. The 1st Battalion, 41st Field Artillery Regiment from 3d Infantry Division (Mechanized) fired 26 missions on enemy strongholds, killing two T-72 tanks, destroying numerous bunkers and buildings, and suppressing enemy positions. Meanwhile, the division's 1st Battalion, 39th Field Artillery Regiment and the 214th Field Artillery Brigade's 2d Battalion, 4th Field Artillery (Multiple Launch Rocket System) engaged Special Republican Guard forces on the airfield complex. Multiple Launch Rocket System fires followed by cannon fires immediately preceded Task Force *3-69*'s attack. Along with other attacks, this effort helped consolidate US forces around Baghdad and the airport. On 10 April 2003, the 3d Infantry Division (Mechanized) and the I Marine Expeditionary Force completed defeating enemy forces in the city, relying on fire support for counterfire and close support to the maneuver arms.[26]

In just 18 days, the V Corps battled its way from the Kuwait-Iraq border to Baghdad; major combat action ended on 10 April 2003.[27] Many people thought that the fight would be long and that the enemy

would possibly employ weapons of mass destruction. However, it was a swift victory for Coalition forces—with American field artillery performing brilliantly, according to the Center for Army Lessons Learned at Fort Leavenworth, Kansas. The 3d Infantry Division (Mechanized) fired almost 14,000 155-millimeter rounds, including more than 120 Sense-and-Destroy-Armor precision munitions. The 101st Airborne Division's (Air Assault) field artillery shot 516 rounds, while the 2d Battalion, 319th Field Artillery Regiment of the 82d Airborne Division fired more than 4,000 rounds. Most of those rounds came in support of light infantry in urban operations.[28]

Reflecting on his division's operations, the Commanding General of the 3d Infantry Division (Mechanized), Major General Buford Blount III, gave credit to his fire support. Joint fires and field artillery paved the way for success and permitted his division to defeat the enemy and move from the Kuwait-Iraq border to Baghdad, where it occupied the Baghdad International Airport.[29]

The 3d Infantry Division (Mechanized), the 101st Airborne Division (Air Assault), and the 82d Airborne Division fought their way along the Euphrates River to Baghdad and the 4th Infantry Division (Mechanized) rushed forward from Kuwait as a follow-on force in April 2003. Simultaneous with these efforts to help secure Iraq after law and order had collapsed, other Coalition combat forces invaded Iraq. Composed of the 1st Marine Division, Task Force *Tarawa*, the 3d Marine Aircraft Wing, and the British 1st Armoured Division, the I Marine Expeditionary Force under the command of Lieutenant General James Conway crossed the Kuwait-Iraq border on 21 March 2003. Covering the ground forces, field artillery fires from the 11th Marine Regiment engaged the Iraqi 51st Mechanized Infantry Division and the Iraqi III Regular Army Corps artillery, including the corps command and control node and long-range fires capabilities; the Iraqi 11th Infantry Division; and the Iraqi 6th Armored Division. The Marines defeated the Iraqis and secured the nearby oil infrastructure. Meanwhile, I Marine Expeditionary Force concentrated deep shaping fires on the Iraqi IV Regular Army Corps near Amarah and the Baghdad Republican Guard Infantry Division near Al Kut on its drive toward An Nasiriyah as the British 1st Armoured Division fought for Al Basrah.[30]

In the midst of this fighting, Task Force *Tarawa* received an order to conduct a relief in place of 3d Infantry Division (Mechanized) in the vicinity of Tallil Airbase and the Highway 1 bridge across the Euphrates River west of An Nasiriyah. On the morning of 23 March 2003, lead elements of the task force reached the city, where light fighting was anticipated. Instead, the Marines encountered fierce combat, depending on the 1st Battalion, 10th Marine Regiment for fire support. The battle raged the next day with fire support coming from the 1st Battalion, 10th Marine Regiment and I Battery, 3d Battalion, 10th Marine Regiment. On 25 March 2003, a raging sandstorm restricted fire support to field artillery fires. Once unmanned aerial vehicles could get into the air on 26 March 2003 and provide accurate targeting information, the 1st Battalion, 10th Marine Regiment broke up an enemy attack of 2,000 and killed about 200 enemy soldiers. Fighting reached a crescendo on 26 March 2003, with fire missions declining the rest of the month. Only a few pockets of resistance around An Nasiriyah remained, and those were cleared out by the first week of April 2003.[31]

During the conflicts, the 3d Infantry Division (Mechanized) had seized Highway 1 bridges over the Euphrates River to the west of the city and the bridge northwest of the city. Taking advantage of the situation, the 1st Marine Division led by the 3d Light Armored Reconnaissance Battalion and the 5th Regiment Combat Team continued its drive north toward Ad Diwaniyah. On 23 March 2003, the division crossed the Euphrates River and pressed along Highway 1 toward Ad Diwaniyah. The following day, a blinding sandstorm reduced visibility to nearly zero, preventing close air support. Fire support from the 11th Marine Regiment protected the division's lead elements from mortar and surface attack that day. During the next six days, the 11th Marine Regiment faced deteriorating weather conditions caused by the sandstorm, enemy mortar attacks, and repeated probes by Fedayeen death squads. Despite the challenges, the regiment continued to provide counterfire and suppressive fires along the division's main supply route, Highway 1, to keep it open. On 31 March 2003, the division seized the Hantush Airstrip on Highway 1 near Ad Diwaniyah as enemy resistance weakened. One day later, the 5th Regiment Combat Team pushed eastward from Ad

Diwaniyah along Highway 27 that linked Highway 7 with Highway 6 and captured a vital crossing over the Saddam Canal. On 2 April 2003, the regiment seized the bridge across the Tigris River so that the division could skirt around Al Kut from the west.[32]

Simultaneously, the 1st Marine Division's 1st Regiment Combat Team and the 7th Regiment Combat Team moved north along Highway 6 to Al Kut. The 1st Regiment Combat Team fixed the Al Kut defenders from the south as the 7th Regiment Combat Team attacked from the north. Once these units drew near to Al Kut, fierce fighting broke out on 3 April 2003. The 11th Marine Regiment field artillery destroyed enemy field artillery batteries, fortified positions, and a Baghdad Republican Guard regimental headquarters. They also helped crush the last remaining conventional capability around the city and cut the line linking Baghdad with Al Basrah. After participating in isolating the city, the 1st Marine Division turned its attention on 5 April 2003 to Baghdad; meanwhile, the 5th Regiment Combat Team took the lead and drove up Highway 6 with massed fire support from the 2d Battalion, 11th Marine Regiment and the 3d Battalion, 11th Marine Regiment as required.[33]

Upon reaching the approaches to Baghdad on 5 April 2003, Marine field artillery participated in cordoning off the city and provided counterfire against Iraqi artillery. Anticipating that the city would be rigorously defended, Marine fires quickly decimated Iraqi defenses, causing them to crumble. By 10 April 2003, Marine field artillery had few targets to engage and fighting was effectively over as Saddam's regime collapsed. The Marines then were ordered to Tikrit, where they quickly neutralized enemy forces there. The conventional war was over.[34]

In a relatively short period of time, US military forces and American allies brought Saddam's regime to its knees. Beginning during the latter days of March 2003 and ending during the first days of April 2003, they aggressively drove from the Kuwait-Iraq border and decisively defeated Iraqi ground forces that resisted their advance. The war reinforced the imperative of combined arms operations in which field artillery and maneuver arms formed an impressive team.

Time of Reflection

On the heels of the 2003 combat operations came reflection about the Field Artillery's ability to provide responsive indirect fires. After reading many after action reports from Operation Iraqi Freedom, Major General Michael D. Maples, who was the Commandant of the US Army Field Artillery School from 2001 to 2003, commented about Field Artillery's contributions. In the September–October 2003 *Field Artillery*, he wrote, "Artillery played a key and essential role. Every commander cited artillery as indispensable during the fight."[35] In a brief report addressing this observation, the Center for Army Lessons Learned concurred, "Maneuver realizes the importance of FS [fire support] and how an effective integration of FS can add to the overall scheme of maneuver. Maneuver, at first, was hesitant to mass FA [field artillery] fires but after initial conflicts would not go into areas unless it was preceded by FA prep."[36]

Repeatedly, field artillery units shifted fires around battlefields to permit the maneuver arms to advance or destroy the enemy.[37] In its after action report, the 3d Infantry Division (Mechanized) pointed out, "Field artillery, close air support (CAS), and air interdiction (AI) were instrumental in allowing the freedom of maneuver."[38] During the battle of As Samawah, for example, the 82d Airborne Division recounted close support's ability to fix the enemy in place so that it could not flee. Once the enemy had been fixed in place, the division brought in close air support if additional fires were required to complete its destruction. "Any enemy trying to escape was immediately identified by KW [OH-58 Kiowa Warrior helicopters] who could either adjust artillery to destroy the escaping element or attack the escaping element directly," the 82d Airborne Division recorded.[39] However, the division explained, "During combat operations in As Samawah, ground-based fire support assets were the only reliable fire support system capable of responding to the dynamic nature of the enemy situation."[40] Responsive fires came within minutes after a call for fire.[41]

In a memorandum to the commander of the 325th Airborne Infantry Regiment of the 82d Airborne Division, Lieutenant Colonel Steven J. Smith of the 2d Battalion, 319th Airborne Field Artillery

Regiment reinforced the importance of field artillery fire support. Colonel Smith wrote that the use of field artillery indirect fires during the battle of As Samawah was critical because they set the conditions for the offensive operations to follow. "The Artillery was able to destroy a TST [time-sensitive target] that could have been lost if we waited for fixed or rotary wing assets; OH58's simply did not have the firepower to destroy the target."[42]

Writing in the September–October 2003 *Field Artillery*, the 3d Infantry Division (Mechanized) artillery commander, Colonel Thomas G. Torrance, and the Deputy Fire Support Coordinator for the 3d Infantry Division (Mechanized), Lieutenant Colonel Noel T. Nicolle, expressed comparable thoughts about close support. "Despite the belief by some that the Field Artillery. . .has 'walked away from the close fight,' maneuver commanders in the 3d Infantry Division will argue otherwise—13,923 155-mm rounds and 794 MLRS [Multiple Launch Rocket System] rockets. . .in OIF back[ed] them up."[43]

In some instances, however, the maneuver arms did not require massed fires. In a lengthy 29 April 2003 after action report, the 1st Battalion, 9th Field Artillery Regiment of the 3d Infantry Division (Mechanized) noted, "The Battalion was able to provide effective observed fires on most Iraqi targets with only battery-level missions. The Iraqi force was spread across the battlefield in small pockets of resistance rather than large mechanized forces in well-prepared defenses."[44] In many instances, a battery one-volley or two-volley caused the enemy to surrender. The battalion only massed battalion-level fires on radar acquisitions sent from division artillery.[45]

Counterfire also proved just as effective. In a brief report following the war, the 101st Airborne Division (Air Assault) recorded, "Cannon artillery and counter fire operations were repeatedly of major value in support of maneuver forces and in destroying enemy mortars and artillery."[46] Similarly, Chief Warrant Officer 3 Brian L. Borer and Lieutenant Colonel Nicolle, both from the 3d Infantry Division (Mechanized), wrote that during Operation Iraqi Freedom, the 3d Division Artillery engaged in an overwhelming successful counterfire effort. In 21 days, they processed more than 1,800 hostile acquisitions with no record of 3d Division Soldiers killed due to Iraqi mortar, cannon or rocket fire.[47] They noted that the 3d Divi-

sion Artillery fired 74 general support counterfire missions with an estimated battle damage assessment of more than 150 enemy artillery systems destroyed and 700 enemy killed in action.[48] After the war the Assistant Division Commander of the 3d Infantry Division (Mechanized), Brigadier General Lloyd J. Austin III, pointed out that his division fired 91 counterfire missions in 21 days to support the close fight.[49]

The V Corps Commanding General, Lieutenant General William S. Wallace, commented that the Multiple Launch Rocket System was very effective in counterfire. "Every time the enemy tried to mass his artillery, he got whacked with something," he recounted in an interview with the editor of the *Field Artillery*.[50]

Although doctrine called for high-angle fires in an urban environment, field artillery officers and Soldiers preferred low-angle fires from field artillery systems as their method of choice. On 21 July 2003, the 82d Airborne Division wrote that 105-millimeter fires used in conjunction with accurate target location were effective and limited collateral damage. During combat action in As Samawah, 82d Airborne Division elements employed field artillery and organic mortars in and around built-up areas with great effectiveness. In the battle for Baghdad, indirect fires also helped reduce enemy strongpoints in buildings that could not be taken out by direct fires alone. For example, Task Force *3-15* of the 3d Infantry Division (Mechanized) that fought along Highway 8 in Baghdad employed indirect fires to destroy enemy-occupied buildings and secure their objectives with a minimal casualty rate. Limited visibility and close-in fighting compelled the task force to use danger close missions. During the battles, it started danger close missions at 400 to 600 meters in front of friendly forces and walked the rounds to within 200 meters in order to destroy enemy positions. This was done by keeping the friendly forces buttoned up and situationally aware of the mission.[51]

As a few field artillery officers noted, urban conditions in Iraq permitted employing low-angle field artillery systems in urban warfare. Except for Baghdad, most buildings in Iraqi cities were no more than three stories in height and did not require high-angle fires from mortars to fire over them. The longer range of low-angle

fires from field artillery systems decreased the number of moves, permitted indirect fire coverage, and provided greater accuracy than mortars. Although they recognized the value of field artillery in an urban environment, field artillery officers conceded that unique challenges still existed; they urged more study and review before making indirect fires from field artillery systems a critical part of urban warfare doctrine.[52]

Equally important, field artillery units delivered fires at a higher rate and greater volume per system than their Operation Desert Storm predecessors in 1991. While 54 M109A6 (Paladin) self-propelled 155-millimeter howitzers fired 13,941 rounds, eight M198 towed 155-millimeter howitzers shot 516 rounds. Sixty-two M119 towed 105-millimeter howitzers hurled 4,107 projectiles at enemy targets. On average, the 155-millimeter howitzers responded to a call for fire in less than one minute. In comparison, their Operation Desert Storm predecessors took around three minutes to engage the enemy after a call for fire. Seventy-three M270A1 launchers fired 857 rockets and 414 Army Tactical Missile Systems I, with the missiles engaging a target in less than seven minutes on average after a call for fire. This was 53 minutes faster than Army Tactical Missile System I attacks in Operation Desert Storm. From 20 March 2003 to 10 April 2003, field artillery units fired more than 450 Army Tactical Missile Systems (I and Ia) in support of joint combat operations. They also launched 13 Quick Reaction Unitary Army Tactical Missile Systems as part of the initial battlefield preparation prior to the ground campaign.[53]

During the early years of the 21st Century, the Army adopted the Quick Reaction Unitary Army Tactical Missile System, which was developed based on lessons learned in Kosovo in 1999. In that conflict, it became clear that commanders required a long-range weapon with precision attack capabilities to deliver a single 500-pound high explosive warhead using Global Positioning System guidance to engage a point target with minimal collateral damage in areas of dense foliage, deep snow cover, and built-up urban environments. The Quick Reaction Unitary Army Tactical Missile System delivered interim capabilities until the Army Tactical Missile System Ia Unitary could be fielded in the next couple of years. It provided the corps and joint task force commander with the capability to attack

time-sensitive targets where collateral damage, fratricide, bomblet dud rates, or aircraft risk might be a concern and participated in the initial battlefield preparation that allowed the Operation Iraqi Freedom ground campaign to begin in March 2003.[54]

Just as important, the Army Tactical Missile System provided all-weather fire support. During the Mother of All Sandstorms (24–27 March 2003) with 100-meter visibility and winds gusting up to 50 knots with thousands of Iraqi paramilitary in the area, "Ground-based indirect fires (Army Tactical Missile System) were absolutely critical," according to Brigadier General Austin.[55] This organic fire support capability allowed the ground commander to maneuver his forces out of contact while setting the conditions for his next fight and gave him the flexibility to adapt to overcome the actions of an interactive, thinking enemy.[56]

In fact, during the Mother of All Sandstorms, the 3d Infantry Division (Mechanized) depended on indirect fires to kill the enemy. The maneuver arms caused the enemy to move so that intelligence assets could identify the enemy's exact location. Once this had been accomplished, indirect fires from field artillery and mortars destroyed the enemy.[57] Along these lines, Lieutenant Colonel Terry Ferrell of the 3d Squadron, 7th Cavalry, the 3d Infantry Division (Mechanized) noted that the only system capable of assisting the squadron in adverse weather conditions was the M270A1 launcher. Also, the M119 towed 105-millimeter howitzer provided accurate indirect fires in support of maneuver forces 24 hours a day with no limitations due to weather.[58] As General Blount and other senior officers pointed out, massed Army field artillery fires, regardless of the weather, remained the key to victory as they had been in past wars.[59] To complement this impressive capability, US Marine field artillery systems battered the enemy with 19,587 rounds.[60]

A relatively new organization, the Fires Effects Coordination Cell facilitated massing fires for the maneuver commanders in all weather. The cell was first envisioned by Major General Leo J. Baxter, who was the Commandant of the Field Artillery School from 1997 to 1999, and put into operation by his successor, Major General Toney Stricklin (1999 to 2001). It provided the same functions as the fire support element but added new ones. Besides

coordinating indirect fires, the cell had the ability to conduct information operations, furnish deep operations previously done by the corps Deep Operations Coordination Cell, and coordinate nonlethal effects using electronic warfare and nonlethal munitions. These functions previously were beyond the purview of the fire support element at the brigade.[61]

During Operation Iraqi Freedom, however, the Fires Effects Coordination Cell did not function as intended by Generals Baxter and Stricklin. General Wallace noted that though it performed well, nonlethal effects such as civil affairs and information operations needed to be integrated into the cell. "The FECC [Fires Effects Coordination Cell] should be the manager of all effects on the battlefield," he said.[62]

As much as doctrine proved to be sound and the Fires Effects Coordination Cell functioned well, Operation Iraqi Freedom also validated the effectiveness of field artillery systems that had been introduced since Operation Desert Storm of 1991. Fielded after Operation Desert Storm, the M109A6 Paladin self-propelled 155-millimeter howitzer delivered responsive accurate fires within a couple of minutes of receiving a call-for-fire, stayed abreast of the maneuver forces, and had the ability to shoot from anywhere.[63] Colonel Torrance and Lieutenant Colonel Nicolle of the 3d Infantry Division

Figure 7: Bradley Fire Support Team (BFIST) vehicle.
Source: US Army photo by Sergeant First Class Gerald Mitchell.

(Mechanized) wrote, "The combat performance of the M109A6 Paladin was magnificent. It is an extremely capable system that consistently put rounds downrange in less than two minutes after mission receipt, even while on the march."[64]

Other major field artillery systems received equally positive reviews. In the September-October 2003 *Field Artillery*, Torrance and Nicolle commented: "The M7 BFIST [Bradley Fire Support Team vehicle] performed brilliantly. For the first time, the artillery community has a vehicle that allows FISTs [Fire Support Teams] to keep up with their maneuver counterparts and remain in the fight."[65] The M7 Bradley Fire Support Team Vehicle gave the company fire support officer the ability to remain well forward in maneuver formations without compromising safety and initiated 407 of the 657 direct support fire missions for the 3d Infantry Division (Mechanized). In view of this, the division declared the M7 to be a winner.[66] In counterfire fights, the M270A1 launcher that was just being fielded also lived up to its advance billing. Capable of being configured to shoot Army Tactical Missile System missiles, M270A1 launchers permitted V Corps artillery to engage deep targets accurately and more responsively than close air support. During the "Shock and Awe" attack that opened Operation Iraqi Freedom combat operations, Quick Reaction Unitary Army Tactical Missile System missiles destroyed enemy army headquarters with precision and served well in deep operations.[67] The High Mobility Artillery Rocket System also made its debut. Linked with Firefinder AN/TPQ-36 and AN/TPQ-37 radars, the system provided fires for special operations forces as they maneuvered on the western front, while the Sense-and-Destroy Armor Munition brought cannon field artillery into the precision age.[68]

Another major new system since Operation Desert Storm, the Advanced Field Artillery Tactical Data System demonstrated its utility. From the 3d Infantry Division (Mechanized) artillery's perspective, the system passed with "flying colors."[69] It permitted passing fire commands digitally and rapidly to provide timely, accurate, and lethal fires in support of maneuver forces.[70] V Corps artillery also pointed out that the Advanced Field Artillery Tactical Data System "performed well throughout the operation."[71] Along the same

lines, the 3d Infantry Division (Mechanized) noted that the system "proved battle worthy in technical and tactical fire direction."[72]

Notwithstanding this, the system exhibited deficiencies as did other field artillery systems. Advanced Field Artillery Tactical Data System hardware was cumbersome, and its software also caused some problems.[73] Every time a new problem with the software arose, the contractor created a new patch or version. Multiple software versions added to the issues. Discussing this, the 3d Battalion, 320th Field Artillery Regiment, noted, "If an NCO [noncommissioned officer] leaves for Drill Sergeant, Recruiting or some other duty that takes him out of Field Artillery for a year or more, he must be retrained upon his return because of the new version or patches that have come out."[74] This prompted the battalion to write that the Advanced Field Artillery Tactical Data System and the artillery community needed to "slow down on the patches and look at a replacement."[75] Another unit, 2d Battalion, 319th Field Artillery Regiment, pointed out that because of the numerous software changes and upgrades, operators had not been able to master the system's many functions and troubleshooting procedures.[76] In sum, the Advanced Field Artillery Tactical Data System needed to be more user-friendly to reduce operational unit training time. The 1st Battalion, 9th Field Artillery Regiment expressed comparable thoughts in its after action report. They indicated the system lacked the ability to perform fire missions at optimal speeds and noted that its software was not efficient and its hardware was not powerful enough. However, they noted that overall the system functioned well.[77]

Munitions and weapons also displayed shortcomings that required modifying. In an after action report after the offensive from the Kuwait-Iraqi border to Baghdad, V Corps commented that current Multiple Launch Rocket System range and precision limitations "do not allow for firing in the proximity of friendly troops or in areas of potential collateral damage. This unnecessarily makes close air support a more viable option for the maneuver commander."[78] Expediting the production and delivery of the Guided Multiple Launch Rocket System Unitary and the Dual-Purpose Improved Conventional Munition, both under development, would improve range and precision. Reflecting this line of thinking, the 3d Infantry Division

(Mechanized) also urged increasing the range of cannon and rocket artillery, which were consistently outranged by Iraqi field artillery; further, they recommended developing more precision munitions that would greatly enhance flexibility and lethality.[79]

Notwithstanding the limitations of the Advanced Field Artillery Tactical Data System and the Dual-Purpose Improved Conventional Munition, the 2003 invasion and rapid advance to Baghdad demonstrated that the Field Artillery was indispensable. Regardless of the weather, field artillery cannons, rockets, and missiles provided effective and responsive counterfire and close support to silence enemy indirect and direct fire systems so that the maneuver arms could move relatively unscathed. Meanwhile the Sense-and-Destroy-Armor Munition, the Army Tactical Missile System I and IA, and the Quick Reaction Unitary Army Tactical Missile System furnished precision capabilities to minimize collateral damage, engage small targets, and complement massed fires. In short, combat operations validated 1990s modernization efforts that had improved field artillery mobility and lethality.

The Insurgency and the Field Artillery

The insurgency that followed the 2003 Iraq invasion and Operation Enduring Freedom in Afghanistan had a threefold impact on the Field Artillery. First, it forced the Army to accelerate fielding of precision munitions, such as the Precision Guidance Kit, the Excalibur 155-millimeter precision munition, and the Guided Multiple Launch Rocket System munition. These would make the Field Artillery more lethal on the 21st Century battlefield and minimize collateral damage that undermined the American effort to gain the support of the Iraqi people. The Army also needed to accelerate fielding of sensors with the ability to locate targets precisely. Second, the insurgency emphasized nonstandard missions, such as civil affairs and patrolling, at the expense of fire support. Lacking opportunities to provide fire support, field artillery officer and Soldier core competencies deteriorated, which prompted the Field Artillery School to initiate programs to restore skills. Third, the Army required joint fires observers to coordinate close air support and joint fires in Iraq and Afghanistan.

Although it had been working to introduce precision munitions since the 1970s, the Army only produced a limited number and types. For example, the laser-designated Copperhead 155-millimeter munition employed during Operation Desert Storm had a slow response time, and the Sense-and-Destroy-Armor Munition that was initially designed to attack Soviet armor was expensive. Restrictive American rules of engagement during Operation Enduring Freedom and Operation Iraqi Freedom were designed to minimize noncombatant injuries and death as well as collateral damage to non-military targets. Aware of this concern, adversaries dispersed their forces and often occupied positions in or near populated areas to discourage the Americans from employing field artillery. Such tactics placed a premium on precision munitions to engage enemy targets and forces without collateral damage. As a result, the Army accelerated developing and fielding of these munitions.

Because the high cost of Sense-and-Destroy-Armor Munition restricted its use during Operation Iraqi Freedom, the Army pursued a less expensive precision munition. On 20 November 2003, the Commanding General of the US Army Training and Doctrine Command tasked the US Army Field Artillery Center and Fort Sill to head a working group of military and industry representatives to conduct the Precision Effects Study. The study determined current or near-current precision engagement solutions and selected those with the best payoff for field artillery and mortar assets, with the goal of fielding the new technology within 24 to 36 months.[80]

Although various suggestions emerged, the course-correcting fuse, renamed Precision Guidance Kit in 2005, offered much promise. Based on analysis of the proposed solutions during the first part of 2004, the center concluded that the Precision Guidance Kit would vastly improve the accuracy of 105-millimeter and 155-millimeter projectiles by using the Global Positioning System to provide location during flight and make trajectory corrections as required. The fuse would also drive down the size of the logistical tail by reducing the number of rounds required for each engagement, would transform a “dumb projectile” into a “smart projectile,” and would be cost effective.[81]

As of 2006, the Army planned to field the Precision Guidance Kit in three increments. Increment I would permit the projectile

to hit within 50 meters of the target, address urgent operational needs in the Global War on Terrorism, and be fielded in 2010. Increment II would minimize Global Positioning System interference and jamming; improve accuracy to 30 meters; address the entire 155-millimeter family of platforms, munitions, and propellants; and be fielded in 2013. Increment III would add the 105-millimeter family of platforms, munitions, and propellants and would be fielded in 2014.[82]

Developmental problems forced the Army to push back fielding. After the Precision Guidance Kit fuse failed early in 2010, a team organized to investigate the situation pointed to design problems and recommended terminating the program or letting it slip so that fielding would be later than initially planned. In December 2010, the Army Systems Acquisition Review Board approved allowing the program to slip to make minor design changes and then field the Precision Guidance Kit Increment I in 2014 rather than 2010 as initially scheduled. The other increments would be fielded subsequently.[83]

Meanwhile, the Department of the Army G-3 directed an urgent material release on 17 May 2011 that accelerated fielding Increment I with reduced reliability to support Operation Enduring Freedom in Afghanistan. Based on a successful flight test in August–September 2011, the Army decided in March 2012 to fast-track fielding Increment I from 2014 to 2013. This decision gave the Precision Guidance Kit two developmental tracks—the baseline program and the urgent material release program. As the Army fielded the urgent material release in 2013–2014, it continued developing the baseline fuse with the objective of introducing it in 2020.[84]

Determined to increase the range of its cannon artillery without sacrificing accuracy, the Army concurrently explored adopting the XM982 Excalibur Extended Range Guided Projectile. As initially planned in 1995 and 1996, Excalibur would be a fire-and-forget projectile with a Global Positioning System receiver and unit guidance package that would allow the projectile to fly extended ranges (50 kilometers) to shape the close battle and improve survivability because it would be able to hit within six meters of the target. The projectile's modular design would permit carrying the Dual-Purpose Improved Conventional Munition for area targets; the Sense-and-

Destroy-Armor Munition for counterfire against self-propelled artillery or armor; or the Unitary Munition, a single high-explosive warhead for soft or hard precision targets. After it was fielded, Excalibur would give the Field Artillery improved fire support capabilities; be compatible with all digitized 155-millimeter howitzers, including the Crusader self-propelled 155-millimeter howitzer under development; reduce fratricide; and be fielded with the Dual-Purpose Improved Conventional Munition in 2006, the Sense-and-Destroy-Armor Munition in 2007, and the Unitary in 2010.[85]

Several years into development, insufficient funding and the early 2000 termination of the Sense-and-Destroy-Armor Munition program prompted the Army to limit Excalibur's initial development to the Dual-Purpose Improved Conventional Munition. However, priorities shifted due to the fear of duds and collateral damage, the need for precision, and the Transformation of the Army process that was underway, especially the creation of the Initial Brigade Combat Team. In December 2000, Major General Toney Stricklin, the Commandant of the US Army Field Artillery School from 1999 to 2001, recommended switching Excalibur's initial development from the

Figure 8: M777 towed 155-millimeter howitzer.
Source: US Army photo by Chuck Wullenjohn.

Dual-Purpose Improved Conventional Munition, which often left unexploded bomblets, caused collateral damage, and was perceived to be too dangerous to civilians and soldiers alike. He suggested switching to the Unitary warhead. Concurring with General Stricklin, the Excalibur Program Manager subsequently deferred work on the Dual-Purpose Improved Conventional Munition warhead in January 2001 and designated the Unitary as the primary Excalibur warhead because it would produce low collateral damage. This decision raised Unitary's importance after it had languished as a low priority for years.[86]

To get Excalibur to the field as quickly as possible to meet requirements generated by the Global War on Terrorism, the Office of the Secretary of Defense subsequently tasked the Program Manager for Excalibur to accelerate fielding by employing "spiral development."[87] This approach would deliver sequential, increasing capability over time until the objective requirements were met. As announced by the Army Acquisition Executive on 28 August 2002, Unitary Excalibur Increment I would be fielded to the M777 towed 155-millimeter howitzer in 2006. Increment II or the enhanced Unitary Excalibur with more capabilities would be fielded to the Future Combat System Cannon under development in 2008, while Increment III would satisfy the original munition requirements and would be fielded in 2010 or 2011.[88]

Studies in 2002 and 2003 validated Unitary Excalibur development. As a precision munition, it destroyed point targets and high-value area targets at extended ranges in complex terrain and urban environments from dispersed locations and would fill existing deficiencies, such as the inability to destroy point targets and restrict collateral damage. In view of the current operational environment in Afghanistan and Iraq, such capabilities would be crucial for US joint military forces to succeed.[89]

As the studies indicated, Excalibur offered other distinct advantages. The June 2002 Achieving Transformation in Fire Support Study determined that the firepower of existing Army field artillery systems would be improved much more with precision munitions, such as the Excalibur and the Guided Multiple Launch Rocket System munition, than by investing in Crusader, which was being developed as the next-generation self-propelled 155-millimeter how-

itzer. Also, the July 2002 Alternative Indirect Fire Study concluded that Excalibur Unitary was more effective against a wider variety of targets and at a greater range than current munitions—even when used with current target acquisition capabilities. The warhead would be less expensive because it could be used in smaller numbers than non-precision munitions. Subsequently, the March 2003 Non-Line-of-Sight Mix Study noted that Excalibur Unitary would greatly enhance the lethality of the current cannon force and validated the need for the munition. Ultimately, Excalibur and other precision munitions would provide more capability at equal or less cost than fielding the Crusader.[90]

Along with the studies, the Coalition Forces Land Component Command endorsed the urgent needs statement for the Excalibur in August 2004—creating the requirement to rush the munition to the operational forces. Although the product of the accelerated program would not satisfy the objective round capabilities, it met the urgent needs statement and created a parallel development program for Excalibur. Essentially, the urgent needs statement required splitting Increment I into two parts. Increment Ia-1, the urgent requirement munition, would provide the theater forces with an immediate need capability and have less capability. Increment Ia-2, the objective program, would have improved reliability and improved countermeasures and would be fielded to M777A2 155-millimeter towed howitzer and Paladin units.[91]

The urgent requirement Excalibur quickly demonstrated its value in combat. Following new equipment training, the 1st Cavalry Division conducted the first operational firing of the munition on 5 May 2007 at a well-known insurgent safe house in Baghdad, Iraq. Elements from the 1st Squadron, 7th Cavalry Regiment teamed with the 1st Battalion, 82d Field Artillery Regiment to destroy the safe house with one Excalibur round. At the end of 2007, other American operational units had fired the urgent requirement Excalibur in Operation Iraqi Freedom, while Canadian forces had fired it in Operation Enduring Freedom in Afghanistan. In February 2008, American forces began firing the urgent requirement Excalibur in Operation Enduring Freedom when units equipped with the M777A2 deployed to Afghanistan.[92]

Improvement efforts with the Multiple Launch Rocket System meanwhile focused on enhancing munitions to give them better range and precision. Although the Multiple Launch Rocket System performed well in Operation Desert Storm in 1991, its rockets and their submunitions raised serious questions. During the war, many Iraqi artillery assets outranged their Coalition counterparts, including Multiple Launch Rocket System munitions. Also, the high dud rate of Multiple Launch Rocket System submunitions raised concerns about the safety of soldiers passing through the impact areas. Together, the proliferation of long-range rocket systems and the high dud rate led to the requirement for an Extended Range Multiple Launch Rocket System rocket with a range of 45 kilometers and a lower submunition dud rate.[93]

After the Army started producing the extended-range rocket with the M77 Dual-Purpose Improved Conventional Munition in 2001 to meet the range requirements identified in Operation Desert Storm, it began developing an extended-range Guided Multiple Launch Rocket System rocket that could be fired from the M270A1 launcher under development and the High Mobility Artillery Rocket System M142 launcher also under development. The accuracy of the traditional free-flight Multiple Launch Rocket System rocket degraded as the range to the target increased. In contrast, the guided rocket's Global Positioning System-aided inertial navigation system improved accuracy from a minimum range of 15 kilometers to a maximum of 60 to 70 kilometers to attack area and point targets. The range depended on warhead weight and type of propellant. The guided rocket would also enhance the ability to conduct precision strikes, reduce the number of rockets required to defeat a target, and give the rocket an additional 15-kilometer range beyond the Extended Range Multiple Launch Rocket System rocket. Such a range would permit hitting more targets and make the weapon system more survivable, because the rocket launcher could be positioned farther from the target. However, technical problems in 2000 and rising production costs caused the program to slip, with the initial operational capability moved from 2000 to 2006.[94]

A restructured schedule prompted the Army to hold a Special Army Systems Acquisition Review Council in November 2001 to

justify further development. As an integral part of the review, the 1982 Nunn-McCurdy Act required the Army to determine if a system was essential to national security, calculate whether an alternative with equal or greater capability was available, ascertain if the program was adequately staffed to control costs, and assess if unit costs were reasonable. If the Army failed to answer the questions satisfactorily, development would be stopped. After the review favorably answered the questions, development continued.[95]

Even before operational testing could be completed on the Guided Unitary Multiple Launch Rocket System rocket, Lieutenant General Thomas F. Metz, the Commander of the Multi-National Forces in Operation Iraqi Freedom and also Commander of the US Army III Corps, sent the Army an operational needs statement for the rocket on 28 March 2004. After the Army denied the request on 13 September 2004, General Metz sent the Army an urgent needs statement for the rocket on 12 October 2004. He indicated that his forces required a precision, all-weather, low-caliber, high-explosive Multiple Launch Rocket System munition to integrate into joint fires in an urban environment, attack high pay-off targets, and provide large area coverage and that the Guided Multiple Launch Rocket System Unitary rocket met those requirements.[96]

On 6 January 2005, the Army endorsed General Metz's request and accelerated work on the rocket to provide it sooner than 2006.[97] On 9 and 10 September 2005, B Battery, 3d Battalion, 13th Field Artillery Regiment fired a six-rocket mission at an insurgent safe house in an urban environment at 53 kilometers. They destroyed it, killing insurgents in the process, and shot another two-round mission in the same area that killed more insurgents. One day later, A Battery, 3d Battalion, 13th Field Artillery Regiment shot six rockets at a bridge and destroyed it. In all instances, collateral damage to surrounding buildings was almost non-existent, according to participants.[98]

For precision munitions such as the Guided Unitary Multiple Launch Rocket System rocket to perform to their capabilities, they required sensors with the ability to locate a target precisely. Early in the 1990s, fire supporters employed the Ground/Vehicular Laser Locator Designator to lase targets for precision munitions, meaning the Copperhead laser-designated munition. Because it weighed 107

pounds, the system reduced the mobility of light fire support teams, did not meet their needs, and was not man-portable. In response to the noted deficiencies, the US Army Field Artillery School acquired the tripod-mounted Lightweight Laser Designator Rangefinder to replace the Ground/Vehicular Laser Locater Designator. In its target location configuration, the Lightweight Laser Designator Rangefinder weighed about 20 pounds, had the ability to locate targets accurately out to 10 kilometers, and could see the battlefield with a near all-weather capability at shorter ranges.[99] In 2002, the Army fielded 15 low-rate initial production rangefinders to the 82d Airborne Division in Afghanistan after years of developmental work and completed fielding of full-rate production rangefinders in 2011.[100]

Seeking performance improvements and further weight reduction to enhance mobility for light units in view of Afghanistan combat operations, the Army introduced the improved accuracy tripod-mounted Lightweight Laser Designator Rangefinder II (named to distinguish it from the Lightweight Laser Designator Rangefinder I). Fielding began in 2011 to units supporting Operation Enduring Freedom in Afghanistan.[101]

The mounted Fire Support Sensor System complemented this effort. It integrated the laser designation module from the Lightweight Laser Designator Rangefinder onto the Long-Range Advanced Scout Surveillance System. The Army mounted the system on Knight and Bradley fire support vehicles and started fielding in 2006. With the Fire Support Sensor System, the Army possessed the most capable observation, target location, and designation sensor on the battlefield.[102]

Besides encouraging an accelerated pace for developing and acquiring precision munitions and sophisticated sensors with the ability to locate targets precisely, the insurgency in Iraq and Afghanistan prompted the Field Artillery School to reexamine its field artillery training for field artillery Soldiers. Beginning early in 2005, the Field Artillery School observed that core competencies of officers attending the Field Artillery Captain's Career Course had been degraded. A school survey revealed that 90 percent of the students had not participated in qualification-table training and that 50 percent had not executed fire missions since attending the Field

Artillery Basic Officer Leader Course as second lieutenants. This forced career course instructors to furnish remedial training so that the students could satisfactorily complete the course. Recognizing the seriousness of the training issues, the Assistant Commandant of the School, Colonel James M. McDonald, signed a memorandum of instruction on 28 November 2005 to redesign the Field Artillery Captain's Career Course. In a bold move, Colonel McDonald stopped teaching the course to modernize it by eliminating Soviet-style tactics from the curriculum. The collaborative process involved the entire school and included students with insurgency experience as well as input from the field. The redesign endeavor optimized the course to ensure that the right competencies were being taught to prepare officers for insurgency warfare, that the most effective teaching methodologies were being utilized, and that the most effective training aids were being employed.[103]

Redesigning the school's curriculum went beyond modernizing the 2005–2006 Field Artillery Captain's Career Course under Colonel McDonald. With the 2003 rise of the insurgency in Iraq, field artillery Soldiers devoted the bulk of their time to nonstandard missions, such as patrolling, providing base defense, and convoy operations. Because only a few field artillery units provided fire support, field artillery core competencies atrophied. As outlined in the 20 July 2006 Army Campaign Plan Update, the Vice Chief of Staff of the Army, General Richard A. Cody, understood the effect of nonstandard missions. He directed the US Army Training and Doctrine Command to assess the competency of field artillery lieutenants to determine if nonstandard missions in Operation Iraqi Freedom and Operation Enduring Freedom had degraded their basic branch skills and if they required additional or refresher training. Along with other Army leaders, General Cody understood the perishability of field artillery core skills; he noted they needed to be used to be retained.[104]

Tasked by General Cody to look at the skill levels of lieutenants, the US Army Training and Doctrine Command expanded the review to include staff sergeants, sergeants first class, captains, and majors and directed the Field Artillery School to determine the impact of nonstandard missions. The Field Artillery School surveyed field artillery tactical commanders, school instructors, and Field Ar-

tillery Captain's Career Course students in July 2006 to determine how seriously field artillery skills had been degraded. The survey indicated that although nonstandard missions reinforced basic leader skills, they caused lieutenants to lose branch technical skills of fire direction, fire support, and weapon-specific platoon leader skills.[105] The survey also found that nonstandard missions eroded core skills for noncommissioned officers and hampered unit readiness. Major General David C. Ralston, who was the Commanding General of the US Army Field Artillery Center and Fort Sill from 2005 to 2007, concluded in a 7 August 2006 memorandum to General Cody that officers and noncommissioned leaders at all levels had experienced the atrophy of field artillery skills.[106]

In his memorandum, Major General Ralston outlined ways to address the problem. He suggested the Field Artillery School could increase the length of the Field Artillery Captain's Career Course to allow more time to retrain senior lieutenants and captains in branch core competencies after having limited or no tactical experience with these functions since graduating from the basic course. Also, the school proposed to bring entire battalions back to proficiency after spending 18 or more months performing non-field artillery missions by sending mobile training teams to unit locations as required, a resource intensive solution, or by using the Fires Knowledge Network to provide web-based "reach back" training to Soldiers and units in the field.[107]

To implement the potential retraining options, Major General Ralston chartered the Field Artillery War on Terrorism Reset Task Force on 23 August 2006 to develop a plan to reset the Field Artillery force through institutional and unit training as proposed to General Cody. Regarding institutional training, the Noncommissioned Officer Education System, the Officer Education System, and the Warrant Officer Education System were to focus on core field artillery and leader skills more than they had done—without expanding training time or increasing training costs because the Army would reject such measures. In March 2007, the Noncommissioned Officer Academy incorporated a four-day, live-fire exercise into its Basic Noncommissioned Officer Course for Military Occupational Specialties 13B30 (Cannon Crewmember) and 13M30 (Multiple

Launch Rocket System Crewmember); during the exercise, students would practice core competency tasks of training their subordinates to execute field artillery tasks.[108]

Meanwhile, the Field Artillery School energized its master gunner program to help offset the war on terrorism's adverse impact on core field artillery skills. In 1997–1998, the Army created the master gunner position as part of reforming the noncommissioned officer force structure. The Army required the master gunner to be a sergeant first class with at least one year of experience as a firing or ammunition platoon sergeant and directed the individual to serve as the commander's and command sergeant major's weapon system expert on training, safety, and maintenance operations. Assigned to the battalion's S-3 (operations), the person assisted in training, crew certifications, and other duties. Specifically, the master gunner executed certifications, certified commanders and senior leaders, supervised section or crew certifications of launcher/howitzer sections, and helped train Soldiers to function on their particular weapon system. As of 2005, master gunners served in Military Occupation Specialties 13B (Cannon Crewmember) and 13M (Multiple-Launch Rocket Crew Member). Despite the demanding responsibilities and required expertise, the master gunner never received any formal instruction and relied on self-study to develop individual skills.[109]

When the Global War on Terrorism adversely impacted the Field Artillery, the Army realized the need to provide training for master gunners. The Field Artillery Master Gunner Division had been organized in 2005 to help train master gunners and digital master gunners as well as help field artillery units maintain proficiency. Beginning in 2006, the division conducted a two-week course for master gunners on cannon and rocket systems and for digital master gunners on fire direction systems. The courses taught current doctrine, training management, crew-served weapons, and small arms. Field artillery-specific instruction taught master gunners and digital master gunners how to implement unit training and certification programs; they were the weapon system experts for all assigned weapons of the units, including small arms, or were the unit's fire direction experts.[110]

The restructuring team from the Field Artillery School and Noncommissioned Officer Academy also focused on master gunner responsibilities for preparing the Soldier for the Noncommissioned Officer Education System. The unit master gunner (a sergeant first class) and the section chiefs would ensure that the Soldier received quality 10-, 20-, and 30-level Military Occupational Specialty training to prepare the individual for the Primary Leader Development Course, officially renamed the Warrior Leader Course by the School and Academy in 2005. During this course, the Soldier (corporal or specialist) would receive additional 30-level training in preparation for eventual attendance at the Basic Noncommissioned Officer Course, unofficially called the Noncommissioned Officer Intermediate Course by the school and academy, and the Advanced Noncommissioned Officer Course, unofficially called the Noncommissioned Officer Advanced Course by the school and academy.[111]

Major General Peter M. Vangjel, who succeeded Major General Ralston as the Commandant of the Field Artillery School from 2007 to 2009, shared his predecessor's view that fortifying the master gunner program and Noncommissioned Officer Education System courses was a step in the right direction to train Soldiers in field artillery core competencies. Supporting Major General Vangjel's Field Artillery Campaign Plan, the Directorate of Training and Doctrine in the Field Artillery School and the Noncommissioned Officer Academy designed a plan to increase Field Artillery Noncommissioned Officer Education System course lengths to reset Soldiers in core skills; improve skill proficiency; incorporate additional training, such as nonlethal fires; and address current and emerging core competency requirements.[112]

Approved by Major General Vangjel, the plan addressed several key issues. Course length for the eight Field Artillery Military Occupational Specialties would expand as much as three weeks. Expansion was the most critical for 13B Cannon Platoon Sergeant and 13D Field Artillery Tactical Data Systems Specialist in the Advanced Noncommissioned Officer Course and in 13B Cannon Section Chief and 13F Fire Support Specialist in the Basic Noncommissioned Officer Course. Regardless of the course, expansion emphasized mastering rather than just becoming acquainted with skills and aimed to

develop critical thinking and adaptive, flexible leadership. According to the Command Sergeant Major Dean J. Keveles, the Commandant of the Noncommissioned Officer Academy, the longer courses helped restore core field artillery skills and made graduates more adaptable to a complex operating environment of the first decade of the 21st Century.[113]

The expanded Noncommissioned Officer Academy courses that were approved by the US Training and Doctrine Command on 10 July 2008 and began in 2009 played a vital role in transforming noncommissioned officer education. On 1 October 2009, the Academy's Basic Noncommissioned Officer Course was redesignated as the Advanced Leader Course and its Advanced Noncommissioned Officer Course was redesignated as the Senior Leader Course. Beyond the name changes and increasing course length by an average of two weeks to accommodate more training, the course focus shifted from squad to squad/platoon in the Advanced Leader Course and from platoon to platoon/battery in the Senior Level Course.[114]

Meanwhile, the Field Artillery School tackled the atrophy of officer corps skills. In 2008, the Field Artillery Captain's Career Course went through its third major redesign to keep it relevant with the contemporary operating environment. The first February 2006 redesign, directed by Colonel McDonald, had answered the challenges, demands, and skills required by the contemporary operating environment in Iraq and Afghanistan. The second redesign that Major General Ralston implemented in February 2008 met the challenges of a corps of young officers who lacked field artillery experience, aligned the program of instruction with emerging doctrine, and revamped training to stay abreast of the changing contemporary operating environment. It also added a new command and control module, more in-depth instruction on coordinating nonlethal fires, updated counterinsurgency theory as well as planning and application instruction, and integrated more practical exercises to upgrade core competency skills. This was particularly critical for students who did not have fire support opportunities in their initial assignments in Iraq or Afghanistan.[115]

Even though the Field Artillery Captain's Career Course redesigns since 2006 had kept pace with emerging doctrine, three critical

gaps still existed in 2008 that led to a third redesign. Surveys conducted in December 2007 identified that two out of three captains who reported to the course had not performed traditional company-grade field artillery tasks or basic field artillery skills that they had learned in the Basic Officer Leader's Course; deployments stressed non-standard missions at the expense of core field artillery missions. In 2008, almost 60 percent of the captains who attended the Field Artillery Captain's Career Course had not performed a traditional field artillery job, lacked competency in core field artillery skills and the skills to be integrators of nonlethal fires as required by Field Manual 3-0, and required assignment-oriented training.[116]

To close these training gaps, the Field Artillery School increased the length of the Field Artillery Captain's Career Course in 2008. The first class under this third redesign was conducted starting in 2009. The previous 20-week course only familiarized students with many skills. This was particularly true concerning resetting field artillery captains with their core competencies—the most pressing concern being the atrophy of lethal skills. In view of this, Major General Vangjel supported a two-phase expansion program for the career course. The first phase or short-term fix would expand the course to 24 weeks. The additional weeks would immerse student officers in practical applications to develop needed skills to become experts at coordinating lethal fires at the battalion level and delivering lethal fires at the battery level. The first phase of expansion would fix two of the three gaps—core competency and assignment-oriented training. The second or long-term solution would extend the course to 36 weeks and address the gap of integrating nonlethal fires. According to Major General Vangjel, integrating nonlethal fires was a required core competency—a sentiment that was echoed by the Combined Arms Center Commander, Lieutenant General William B. Caldwell IV, at the Fires Seminar in 2008. However, costs prevented expanding the course to 36 weeks.[117]

Revamping and expanding the training to 24 weeks to ensure competency in core skills paid dividends for officers. By 2012, captains received five weeks of US Army Training and Doctrine Command common core; four weeks of gunnery, advanced fire direction officer responsibilities, Advanced Field Artillery Tactical Data

System, and weapons training; and 14 weeks of tactical and staff instruction. This instruction provided situation-based practical exercises on field artillery core competencies and other learning methodologies to develop agile and adaptive leaders for the full-spectrum battlefield who were technically proficient to serve as a battery commander, a battalion/brigade fire support officer, a field artillery battalion fire direction officer, or a battalion/brigade/brigade combat team staff officer. They also learned to coordinate lethal and nonlethal fires at the battalion level, with an emphasis on lethal effects that included employing precision munitions and providing fire support coordinator tasks and responsibilities.[118]

Meanwhile, the Field Artillery School restructured unit training to ensure that it met the organization's needs for trained field artillery officers and Soldiers. In a 2 October 2006 briefing to the US Army Training and Doctrine Command Deputy Commanding General, Lieutenant General Thomas F. Metz, the school outlined using paper-based training support packages, mobile training teams, video teleconferences, and web-based distance learning packages, among other means, for unit training. For unit-oriented reset training to succeed, each unit had to determine its needs so that the school could identify training products, assets, and methods; obtain funding; and prioritize training.[119]

While reset institutional training was still a one-size-fits-all approach, reset unit training support required a totally different methodology. The training revolved around reach-back services and mobile training teams. As it evolved in 2006 and 2007, reach-back capabilities exploited the Internet. Soldiers could access more than 1,000 hours of interactive multi-media training subdivided by military occupational specialty and skill level by logging onto the Army Knowledge Network, later renamed Army Knowledge Online. For more robust training, the school provided mobile training teams. Unlike the normal mobile training team that taught a specific program of instruction regarding new equipment, reset mobile training was geared to individual unit needs. For example, one team taught refresher training on manual gunnery and the Advanced Field Artillery Tactical Data System to the 18th Fires Brigade at Fort Bragg, North Carolina. Another team trained the 2d

Battalion, 8th Field Artillery Regiment at Fort Wainwright, Alaska, in manual gunnery, survey, the Advanced Field Artillery Tactical Data System, and the countermortar radar. Other teams conducted similar training with the 2d Battalion, 320th Field Artillery Regiment at Fort Campbell, Kentucky; 4th Battalion, 320th Field Artillery Regiment at Fort Campbell; and 4th Battalion, 319 Field Artillery Regiment in Afghanistan.[120]

The Field Artillery Master Gunner Division that had recently moved from the school's Directorate of Training and Doctrine to the 428th Field Artillery Brigade also sent reset mobile training teams to units. During 2007, the division helped field artillery certification and qualification by using the coach-teach-mentor methodology. While visiting a unit, the division's team mentors established a certification plan. After meeting with the unit's leadership, the team conducted workshops with the master gunner, operations sergeant, and platoon sergeants; meanwhile the digital master and his noncommissioned officers participated in a workshop to reset their skills. On the last day of training, the team divided unit personnel into working groups to facilitate developing a draft digital cannon or Multiple Launch Rocket System certification program. The Field Artillery Master Gunner Home Page complemented this initiative. The page had all points of contact and up-to-date examples of unit certification programs and standing operation procedures as well as changes in the Field Artillery. Also, the division supported the two-week Field Artillery Master Gunner and Digital Master Course that taught current doctrine, training management, crew-served weapons, and small arms to cannon and rocket crewmembers and cannon and rocket fire direction specialists.[121]

Reset efforts continued unabated in 2008. Mobile training teams supplied training to noncommissioned officers in all military occupational specialties, trained the trainer, and developed subject matter expertise to help field artillery units regain core skills. For example, one mobile training team focused on training master gunners to ensure that the commander had a weapon system expert on training, safety, ammunition, and resupply and maintenance operations and to give a battalion an individual with the skills to help reset the unit. Besides training master gunners, mobile training teams

provided reset training to 15 active component and National Guard battalions as well as 18 batteries at unit home station and in theater. The training included field artillery safety, manual gunnery, the Advanced Field Artillery Tactical Data System, the Improved Position and Azimuth Determining System, Military Occupational Specialty 13B Cannon Crewmember, and M198 155-towed artillery specific crew drill.[122]

With help from the US Army Training and Doctrine Command, Major General Vangjel funded two contract mobile training teams—the Battery and Below Mobile Training Team and the Collective Training Evaluation Team—at the end of 2008. This was a major breakthrough for the reset effort. Through the end of the year, the school paid for reset mobile training teams by taking resources from other activities to fund the team. In some instances, the school took mobile training team instructors from the instructional base. By funding two contract mobile training teams, the school ended the practice of stripping resources from one activity to support another; instead, it now had dedicated reset mobile training teams.[123]

Both teams had the mission of restoring fires warfighting skills and field artillery core competencies and began conducting training in 2009. While the Battery and Below Mobile Training Team focused on leader training and train-the-trainer instruction covering cannon battery operations, the Collective Training Evaluation Team concentrated on collective and leader training on core field artillery skills and tasks at the platoon, battery, and battalion levels. Specifically, the teams deployed to the home station and developed, planned, and executed platoon, battery, and battalion fire support element/fire support team, combat observation lasing team, and fire direction center training. Such training enhanced the unit's ability to operate within a full-spectrum environment.[124]

Over the next three years, both training teams furnished invaluable unit reset training that continued to be a high priority for the Field Artillery School and underwent a critical reorganization. Budget cuts in 2011 forced the school to merge them to form the Field Artillery Mobile Training Assistance Team that continued the mission of its predecessor organizations.[125]

Meanwhile, Operation Iraqi Freedom and Operation Enduring Freedom in Afghanistan demonstrated the warfighting potential of integrated joint fires. Coordinating joint attack of targets, synchronizing fires with maneuver, providing land fires to support aviation, achieving synergistic fires and effects, executing time-sensitive targeting, and deconflicting joint fires required joint standards and joint training. Major General Michael D. Maples, the Commandant of the Field Artillery School from 2001 to 2003, noted late in 2003 that to achieve the intent of emerging doctrine and realize the full potential of indirect fires and effects initially discussed in the Field Artillery School in the 1990s, the Army and joint forces would need to train extensively on the integration, coordination, and application of joint fires. This would require a universal observer from any service or special operation forces who would be capable of applying any effect from any service in any environment. Renamed the joint fires observer in 2005, the observer would be a trained service member who would request, adjust, and control surface-to-surface fires to include field artillery, mortar, and naval gunfire. Additionally, this individual would be authorized to provide targeting information and conduct terminal guidance operations in support of Types 2 and 3 close air support when a joint terminal attack controller was not physically located with the forward observer and when the situation required immediate assistance from available close air support.[126]

Because the maneuver arms were not able to access joint fires in the form of close air support in Iraq and Afghanistan due to shortages of joint terminal attack controllers, the Air Force and Army increased their efforts to train joint fires observers. The Air Force planned to increase the number of joint terminal attack controllers in sufficient numbers to have one at the maneuver company by 2012 by training more at Nellis Air Force Base, Nevada. In contrast, the Army envisioned using the joint fires observer at the maneuver platoon level as the eyes of the joint terminal attack controller in the field. Recognizing that the joint fires observer course conducted by the 57th Operations Group at Nellis Air Force Base would not produce sufficient numbers of graduates to satisfy its requirements, the Army resolved to train its own. As agreed upon by the Air

Force and Army, Fort Sill developed a joint fires observer course. After the Joint and Combined Integration Directorate conducted a successful pilot course at Fort Sill in September 2005 using resources from the 138th Fighter Wing of the Oklahoma Army National Guard, the Army and Air Force signed a 14 November 2005 memorandum of agreement to support the Fort Sill course. Thus, two joint fires observer courses—one at Nellis Air Force Base and one at Fort Sill—existed in 2005. Two years later in 2007, Nellis Air Force Base stopped teaching its course. To compensate, Fort Sill increased its capacity to train joint fires observers employing Joint and Combined Integration Directorate resident and mobile training.[127]

Brigadier General Thomas S. Vandal, who was the Commandant of the Field Artillery School from 2010 to 2011, was influenced by the lessons learned from the Afghanistan and Iraq combat operations and the requirement for more joint fires observers than the mobile and resident training teams could provide. As a result, he introduced an initiative in mid-2011 to add joint fires observer familiarization training in the school. As a result, the school developed a 20-hour online joint fires observer course for all second lieutenants and integrated an overview of joint fires observer training into the Basic Officer Leader's Course; however, these actions did not produce certified joint fires observers. Later, Brigadier General Brian J. McKiernan, who was the Commandant of the Field Artillery School from 2012 to 2013, added a joint fires observer assignment-oriented training course following the Basic Officer Leader's Course for second lieutenants who had graduated from the basic course and were assigned to a brigade combat team. Assignment-oriented training began in January 2012 and produced certified observers. Constrained by limited resources, only 48 second lieutenants received assignment-oriented training in 2012 and 2013.[128]

Recognizing the need for more joint fires observers, Brigadier General Christopher F. Bentley, who became the Commandant of the Field Artillery School in June 2013, integrated joint fires observer training into the Basic Officer Leader's Course in July 2014 to certify second lieutenants as joint fires observers. However, the inclusion of this training forced the school to decrease gunnery instruction, causing gunnery scores to drop. Subsequently, the school modified

joint fires observer training to familiarization training that was less extensive than certification training and increased its gunnery training. Regardless, joint fires observer training in the basic course complemented the Joint and Combined Integration Directorate's resident and mobile training teams joint fires observer training.[129]

As the joint fires observers training reflected, the war on terrorism of the first decade of the 21st Century significantly influenced the Field Artillery. It accelerated fielding precision munitions that were not scheduled to be introduced until the second decade of the 21st Century and forced the Field Artillery School to enhance training in core field artillery skills that had deteriorated in Iraq and Afghanistan because of the deleterious impact of nonstandard missions on officers and Soldiers. The war also stimulated the Field Artillery to develop the joint fires observer. The wars in Iraq and Afghanistan basically pushed the Field Artillery into an age of precision munitions and joint operations.

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Chapter 5

More Modernization

The Global War on Terrorism and Transformation of the Army prompted the Field Artillery to extend its modernization effort beyond adopting precision munitions and creating the joint fires officer. The Field Artillery introduced new targeting systems for counterfire and sensors for locating targets accurately, developed a precision fires training program, embraced nonlethal fires and effects as a core competency for officers and soldiers to complement lethal fires and effects, and continued improving precision munitions and weapon platforms. Just as important, the branch implemented force structure changes by reinstituting division artillery.

Lethal and Nonlethal Targeting

During Operation Enduring Freedom in Afghanistan, the operational environment emphasized mobility and the escalating requirement to replace aging AN/TPQ-36 and AN/TPQ-37 Firefinder radars with their limited scan capabilities. Responding to these priorities, the Army initiated work to replace the older equipment with state-of-the-art radars. To decrease developmental costs, the Futures Development and Integration Center at Fort Sill, Oklahoma, opted to modernize the Q-36 radar as the Enhanced AN/TPQ-36 (EQ-36) truck-mounted radar with a range of 500 meters to 60 kilometers. The center also wanted to reduce crew size requirements as compared to the Q-36 and Q-37 radars and ensure the replacement was capable of detecting projectiles fired from mortar, field artillery, and rocket systems and employing a 90-degree or 360-degree sector search.[1]

Before work on the radar could be completed, an urgent material release request in 2008 caused the Army to field the less capable Quick Response Capability EQ-36 radar to support Operation Iraqi Freedom and Operation Enduring Freedom. In 2010, the Army sent Quick Response Capability EQ-36s to Iraq and Afghanistan to effectively pinpoint incoming threat indirect fire for counterfire.[2]

Subsequently in 2011, the Army changed the EQ-36 radar's designation to the AN/TPQ-53 and made it a program of record radar. Mounted on a five-ton truck, the Q-53 reduced operational and support costs from those of the Q-36 and Q-37 radars, had a range of 500 meters to 60 kilometers, could be emplaced in five minutes, could be displaced in two minutes, had an auto-leveling system, had a crew of four, had 90-degree and 360-degree search capability, and was linked by digital tactical radios to the Advanced Field Artillery Tactical Data System for mission processing.[3] The Army began fielding the Q-53 radar in 2016 as a replacement to the legacy Q-36 and Q-37 radars.[4]

Although it planned to replace the Firefinder Q-37 radar—first fielded in the 1970s and modernized several times—the Army acknowledged during the first decade of the 21st Century that the Q-37 would be around for several more years despite its obsolescence and associated sustainment expenses. To extend the aging Q-37's usable life, the Army upgraded it for employment by the Heavy and Stryker Brigade Combat Teams and the fires brigades by incorporating reliability and maintainability initiative kits in 2011 to 2012; the kits would reduce sustainment costs and increase the system's life span beyond its scheduled retirement date of 2019.[5]

The Army simultaneously pushed to introduce the Lightweight Countermortar Radar to complement the larger Q-36, Q-37, and Q-53 radars. Because the existing Q-36 and Q-37 radars lacked the ability to scan 360 degrees and did not have the mobility required to accompany light and early entry forces, the Special Operations Forces expressed a critical need for a lightweight countermortar radar capable of scanning 360 degrees to detect short-range mortars rapidly for counterfire. This led to the development of the Quick Response Capability Lightweight Countermortar Radar (AN/TPQ-48), which was specially designed to support the Special Operations Forces and Ranger units. A man-portable system with a range of 1,000 to 7,000 meters, the Q-48 could search 360 degrees to detect and track mortar fire within 100 yards of their points of origin—permitting counterfire to destroy fleeing improvised shooters, including those in urban areas.[6]

In 2004, the Army started fielding the Q-48 to Special Operations Forces in Iraq and Afghanistan and initiated development of the

Q-49 (Q-48 Version II), a successor system. With a target location error of 100-plus meters, the Q-48 radar met the immediate needs of deployed US Special Operations Command forces to locate mortars; however, improved accuracy would be needed for future versions. Fielded in 2005–2006, the Q-49 provided more rugged hardware and better software to locate a target within less than 75 meters to facilitate counterfire against enemy indirect fire systems.[7]

Two years later in 2008, US Army Training and Doctrine Command Program Office Sensors at Fort Sill wrote and staffed a document to develop the Lightweight Countermortar Radar (AN/TPQ-50/Q-48 Version III) to track threat indirect fire systems and provide greater force protection capabilities. The Q-50 could be mounted on a vehicle, a feature that facilitated movement between two points and permitted rapid operational configuration. After successful February and March 2012 testing at the Yuma Proving Ground, Arizona, the Army fielded the Q-50 radar beginning in 2013.[8]

Figure 9: AN/TPQ-50 countermortar radar.
Source: US Army photo by Staff Sergeant Steven Littlefield.

As of 2013, the Field Artillery had five target acquisition radars—Q-36, Q-37, Q-48/49, Q-50, and Q-53, with a modernization plan for each. To guide radar acquisition in an era of constrained resources, the Field Artillery recognized the imperative to streamline radar acquisition. This led to a 2013 strategy to reduce the number of radars and provide a way forward to accomplish the branch's core mission of detecting and tracking rockets, mortars, and cannon projectiles. In the near term (2015–2019), the Army planned to merge the short-range Q-48/49 radars (not programs of record) into the program of record Q-50 radar for short-range detection, retire the Firefinder Q-36 and Q-37 radars, and leave only the Q-53 for long-range target acquisition. This would reduce field artillery radars from five to two—the Q-50 and Q-53 that were already fielded. These radars provided the Field Artillery with 360-degree target acquisition capability, increased range, improved mobility, improved deployability, and decreased sustainment requirements compared with previous radars. They also gave the branch network capabilities to employ multiple counterfire radars to detect a target for more precise target location, reduced target location error, and made counterfire even more lethal. However, they could only detect a shooting indirect fire system. Silent systems remained invisible.[9]

Modernizing the Bradley Fire Support Team vehicle for the heavy forces and the Knight vehicle for the heavy and light forces complemented the new radars. Late in the 1970s, a US Army Training and Doctrine Command working group, Close Support Study Group II, met to optimize observed fire support for the maneuver forces. Besides reaffirming that the Fire Support Team created in the mid-1970s was still needed to integrate fire support with the maneuver arms at the company level, the group recommended fielding a mobile fire support vehicle that would ensure reliable, secure communications and be able to stay abreast of the maneuver forces.[10]

After funding had become available in the 1990s and the maneuver arms had received their Bradleys, the Army started equipping the Field Artillery with the Bradley with a fire support mission package as a replacement for the M981 Fire Support Vehicle. As of 1995–1996, combat and materiel developers envisioned two models—the M7 and M7A1. While the M7 would integrate a fire sup-

port mission package onto a modified Bradley A2 Operation Desert Storm chassis, the M7A1 would be more advanced and incorporate a fire support mission package on a digitized Bradley M3A3 chassis. After several years of developmental work and funding-driven program changes, the project manager redesignated the M7A1 as the Bradley Fire Support Team Vehicle (M2A3) and fielded it to counterattack units starting in 2004 as a complement to the M7 that entered the Army's inventory in 2000.[11]

Cognizant of the M7's limitations, the Army opted in 2010 to upgrade the Bradley M2, M3, and M7 to the M2A2 Operation Desert Storm-Situational Awareness configuration. This program brought the M7 close to the A3 by integrating the latest digitized electronics to provide optimal situational awareness, network connectivity, and enhanced communications hardware. This gave the Field Artillery two modernized Bradley Fire Support Team Vehicle variants with the ability to designate targets accurately for precision munitions.[12]

Designed to maximize the employment of precision munitions, the Combat Observation Lasing Team also employed the M981 Fire Support vehicle. Besides lacking mobility and stealth, the M981 that had been designed for armored and mechanized forces presented a unique signature for the light forces that used the High Mobility Multipurpose Wheeled Vehicle as their scout vehicles. In response to this discrepancy, the US Army Training and Doctrine Command approved a change to the Fire Support Vehicle Operational Requirements Document that the Field Artillery School initially wrote in April 1997. The edited version would leverage fire support vehicle technology for the heavy and light forces. In the revised document, the Field Artillery School retained the Bradley Fire Support Team Vehicle for the heavy forces and recommended integrating the fire support mission equipment package onto a High Mobility Multipurpose Wheeled Vehicle chassis—known as the Striker—for the Combat Observation Lasing Team in the heavy and light forces. This would provide the team with unprecedented mobility, flexibility, and stealth. Also, the Striker would be less conspicuous because it would present a common signature with other High Mobility Multipurpose Wheeled Vehicle-equipped light forces, save Bradley assets for fire support teams, and reduce operating costs for the Combat Observation Lasing Team.[13]

Early in 1999, the Army type-classified the system as the M707 Striker (mounted on the M1025 High Mobility Multipurpose Wheeled Vehicle). The Army fielded it to the 82d Airborne Division in 2002 and to other active component units and Army National Guard units in 2003–2004. As noted earlier, the Army renamed the Striker as the Knight in 2002 to avoid confusion with the Stryker Brigade Combat Team.[14]

In December 2005, the Program Manager Office determined that the M1025 High Mobility Multipurpose Wheeled Vehicle and its replacement, the M1114 High Mobility Multipurpose Wheeled Vehicle, could not support the Knight program. Because of armor added to protect against improvised electronic device attacks in Iraq, neither vehicle with the field artillery mission equipment package would be safe to operate. The increased vehicle weight created excessive operating restrictions. In January 2006, the Futures Development and Integration Center at Fort Sill urged finding a suitable replacement. Subsequently on 17 April 2006, the Army G-3/5/7 validated Third Army's operational needs statement to provide the 10th Mountain Division with five Knight systems on a more survivable platform than the existing one. This encouraged the Product Manager Fire Support Systems to change the platform of the M707 Knight system from the M1114 to the M1117 Armored Security Vehicle.[15]

Subsequently, the Army purchased eight M1117 Armored Security Vehicles and designated them as the M1200 Armored Knight, equipping them with laser designators for precision targeting for employment by the Combat Observation Lasing Team. In October 2007, the 10th Mountain Division received five M1200s. One month later, the 101st Airborne Division took delivery of its first four M1200 vehicles. The Army began fielding the vehicles in February 2008 to Armored Brigade Combat Teams, Infantry Brigade Combat Teams, Stryker Brigade Combat Teams, and battlefield surveillance brigades; deliveries continued into 2013.[16]

Although developing a strategic fielding plan for new target acquisition radars for counterfire and updating Bradley Fire Support Team and Knight Vehicles were critical for precision targeting, the Field Artillery still required the ability to locate the target accurately. Early in 2014, Brigadier General Christopher F. Bentley, Comman-

dant of the Field Artillery School and Chief of Field Artillery for the Army from 2013 to 2014, remarked that accurate target location was the branch's number one priority. Led by Brigadier General Bentley, the Fires Center of Excellence at Fort Sill and the Field Artillery School conducted a thorough examination of accurate predicted fires that were developed by the German army in World War I and that the American army had adopted after the war.[17]

During the early years of the 21st Century, the Fires Center of Excellence and the Field Artillery School recognized that Global Positioning System, digitized field artillery systems, and near-precision and precision munitions allowed the Field Artillery to be precise in all aspects of the five requirements for accurate predicted fires (accurate target location, firing location, weapon and ammunition information, accurate meteorological information, and accurate computational procedures). As Brigadier General Bentley pointed out on 6 May 2014, automated systems and near-precision and precision munitions permitted modifying the term from the five requirements for accurate predicted fire to the five requirements for accurate fire. Technology allowed the Field Artillery to be precise. The branch no longer needed to predict where a near-

Figure 10: M1117 Armored Security Vehicle.
Source: US Army photo by Staff Sergeant Kimberly Hackbarth.

precision or precision munition would hit, which was a significant change from the 100-year-old process of forecasting the impact points of ballistic munitions.[18]

Raising target location standards accompanied transforming the five requirements for accurate predicted fire to the five requirements for accurate fire. As the Field Artillery School explained in the fall of 2014, precision targeting was "non-negotiable."[19] With this vision, the school created the ratio of 80:10:10. The school determined that forward observers had to acquire an accurate grid coordinate 80 percent of the time. This meant achieving a Category I (6-meter target location error) and a Category II (15-meter target location error) or a precision grid coordinate 80 percent of the time, achieving a Category IV (50-meter target location error) 10 percent of the time, and achieving a Category V/VI (200-meter target location error) 10 percent of the time. The school clarified, "This 80:10:10 ratio defines for us as professional Artillerymen the term accurate in the first requirement for accurate Fires. It also defines for us, as a profession of arms, how we train, certify and deliver accurate target locations in support of strategic, operational and tactical Fires."[20]

For the dismounted forward observer to provide accurate target location and size, the Field Artillery School and Brigadier General Bentley acknowledged the importance of taking advantage of portable target designator systems already fielded and those scheduled for fielding in the near future. As the Global War on Terrorism demonstrated, the Field Artillery furnished responsive, effective fires with the Guided Multiple Launch Rocket System Unitary employing deliberate targeting methods while the Air Force utilized the Joint Direct Attack Munition effectively for deliberate targeting. Deliberate targeting involved attacking targets that were detected, identified, and developed in sufficient time to schedule actions in a tasking cycle. In contrast, dynamic targeting at the Army battalion and below involved attacking fleeting targets quickly. Although the Precision Strike Suite for Special Operations Forces could refine grid coordinates for precision strikes, it generally resided at levels above the dismounted forward observer. Also, some dismounted forward observers preferred maps, binoculars, and compasses rather

than automated targeting designators. This limited the ability to obtain a precise coordinate location and minimized the effectiveness of coordinate locating munitions or precision munitions, which were employed frequently in deliberate and dynamic targeting missions and implementing the 80:10:10 targeting ratio.[21]

Influenced by this deficiency, the Army and Field Artillery reaffirmed the necessity to employ sensors capable of pinpointing a target location for a precision munition to hit. On 21 September 2010, the Army and the Field Artillery launched action to upgrade the Lightweight Laser Designator Rangefinder 2 that was being fielded; the equipment could be employed by mounted or dismounted forces and had the ability to locate a target accurately for precision munitions. However, the designator required improved accuracy to support current and future precision munitions. To support this requirement, the Army adopted the Lightweight Laser Designator Rangefinder 2H and retrofitted the Lightweight Laser Designator Rangefinder 1 and 2 as the 2H. Fielded beginning in 2014, the new system permitted the dismounted soldier to call for fire with precision munitions and reduced target location error from approximately six meters to two meters.[22]

Figure 11: Lightweight Laser Designator Rangefinder.
Source: US Army photo by Technical Sergeant Brian E. Christiansen.

The pursuit of accurate target location and size also prompted development of a Joint Effects Targeting System for the dismounted forces. In June 2004, the Army/Marine Corps Board directed the services to develop a common laser-targeting device requirement. In response, the Army began developmental work on the handheld, binocular-like Joint Effects Targeting System. The system would consist of a Target Location Designation System and a Target Effects Coordination System. A forward observer equipped with the Joint Effects Targeting System with Target Location Designation System capabilities could recognize targets out to ranges of 3,000 meters during the day and 1,300 meters during the night—with sufficient accuracy to employ precision munitions without mensuration. The Target Effects Coordination System software would provide blue force situational awareness on friendly and hostile military forces and communications interface with effects providers. In October 2006, the Department of Defense designated the Army as the lead for the system. The Army awarded developmental contracts in March 2013 and scheduled fielding for 2016, but technical and budgetary challenges pushed fielding back to 2018.[23]

Until the Joint Effects Targeting System could be fielded, the Army relied on the Quick Reaction Capability Hand-Held Targeting Device starting in 2013. It provided the dismounted forward observer with the ability to designate targets accurately within the standards required to employ precision munitions. The device bridged the gap between the existing target designation capability of 2013 and the futuristic Joint Effects Targeting System.[24]

The Army developed and fielded the Fire Support Sensor System as it introduced the Lightweight Laser Designator Rangefinder 2H for the mounted and dismounted forward observer and as it worked to acquire the Joint Effects Targeting System for the dismounted forward observer. In 2005, the Army began fielding the Fire Support Sensor System by fitting the system on the Knight vehicle employed by Combat Observation Lasing Teams. Beginning in 2007, the Army integrated the Fire Support Sensor System onto the M3A3 Bradley Fire Support Team Vehicle. While radars gave the Field Artillery improved counterfire capabilities on a mobile battlefield as well as networked capabilities, the target sensors gave the Field Artillery the

ability to locate a target more accurately and facilitate exploiting precision munitions to complement unguided munitions.[25]

Precision munitions including the Guided Multiple Launch Rocket System rocket and the Excalibur 155-millimeter munition, the reduction of the number of howitzers and rocket launchers in service, and the requirement to reduce or eliminate collateral damage highlighted the need to reduce the target location error through improved sensors and appropriately trained Soldiers who would use them.[26] As early as Operation Iraqi Freedom in 2003, the Army acknowledged that it lacked the ability to mensurate coordinates by absolutely measuring the height, latitude, and longitude of a point on the earth; these skills were critical to reduce target location error and ensure effective employment of coordinate-seeking or precision munitions. At the time, the Army relied on the Air Force to derive mensurate coordinates. Generally, it took up to 24 hours from the time that target information reached the Air Force until it came back to the Army for engaging. Pushing to reduce the turnaround time, the 75th Field Artillery Brigade and the 1st Cavalry Division developed a process in 2005–2006 to mensurate coordinates using Rainstorm, a National Geospatial-Intelligence Agency-validated tool. This reduced turnaround time to minutes.[27]

However, a critical capability gap still existed. The Army lacked institutional training for target coordinate mensuration (the process to locate a target precisely), weaponeering (the process to determine the quantity of a specific type of lethal or nonlethal weapon required to achieve a specific level of damage to a given target), and collateral damage estimation (the process for estimating collateral damage and casualties from conventional weapons and precision, unguided, and cluster munitions). To eliminate this gap, the Army designated the Fires Center of Excellence at Fort Sill as its functional manager for precision fires. Then in 2008, the Fires Center of Excellence made the Joint and Combined Integration Directorate its lead agency for developing a precision fires training program for target coordinate mensuration, weaponeering, and collateral damage estimation; graduates would be certified by the National Geospatial-Intelligence Agency, a combatant command, or a combat support agency.[28]

After several months of hard work, the Joint and Combined Integration Directorate implemented a basic precision fires training program in September 2010. This program trained fire supporters to conduct target coordinate mensuration**,** weaponeering, and collateral damage estimation through three venues. The first venue utilized primary military education for Military Occupational Specialty 13F Fire Support Specialist, Military Occupational Specialty 131A targeting warrant officers, and Military Occupational Specialty 13A field artillery officers to provide this training so that operational units could employ precision and conventional indirect fires accurately, achieve first-round target effects, and mitigate collateral damage. For the second venue, functional courses trained Military Occupational Specialist 13F Fire Support Specialists and Military Occupational Specialty 131A warrant officers who did not receive this training as part of their primary military education, as well as other services, partner nations, and individuals in targeting positions. Mobile training teams, the third venue, furnished unit training. Precision fires training in 2011 satisfied joint standards requirements and led to certification in target mensuration or collateral damage estimation or both. The National Geospatial-Intelligence Agency accredited the Target Coordinate Mensuration program in 2011, and the Joint Targeting School accredited the Collateral Damage Estimation program that same year. These gave the Army the ability to certify soldiers and others in target coordinate mensuration and collateral damage estimation.[29]

Armed with these certifications, the Fires Center of Excellence expanded its precision fires training. Directed by Major General David D. Halverson, its commanding general, the Fires Center of Excellence added precision fires courses in the Warrant Officer Instruction Branch and the Noncommissioned Officer Academy in 2012. The Warrant Officer Instruction Branch taught a Target Mensuration Only (taught only mensurating target coordinates) and Weaponeering in the Warrant Officer Basic Course as well as Target Mensuration Only in the Warrant Officer Advance Course. Both courses provided Collateral Damage Estimation instruction, while the Noncommissioned Officer Academy integrated Target Mensuration Only into its Military Occupational Specialty 13F Advanced Leader Course and the Military Occupational Specialty 13F Senior

Leader Course and added Weaponeering and Collateral Damage Estimation to its Military Occupational Specialty 13F Senior Leader Course. In the meantime, functional courses taught by the Field Artillery School and mobile training teams bridged the gap for soldiers who did not have precision fires training in their professional military education.[30]

Subsequently, the Field Artillery School increased its precision fires training even more under Brigadier General Bentley's guidance. In October 2013, the school set Target Mensuration Only and Collateral Damage Estimation certification as a requirement for graduation from its warrant officer courses.[31]

As precision fires training requests from the field increased, the Joint and Combined Integration Directorate's Targeting Division meanwhile developed a course of action to increase the number of trained personnel while maintaining its ability to support resident training and mobile training teams. After a series of 2012 meetings, Brigadier General Thomas S. Vandal, Field Artillery School Commandant, decided to give Target Mensuration Only and Weaponeering instruction responsibility to the Warrant Officer Instruction Branch and the Noncommissioned Officer Academy. Directorate precision fires course instructors trained and certified instructors. This allowed Joint and Combined Integration Directorate precision fires instructors to focus on resident and mobile training team courses.[32]

Concurrently, the Joint and Combined Integration Directorate obtained assistance from the Field Artillery Commandant's Office to market its unit precision fires program so that soldiers in operational units would have the opportunity to become certified Target Mensuration Only instructors. Thanks to this initiative, operational units could certify soldiers in Target Mensuration Only while also providing a certified analyst capable of maintaining currency.[33]

On 1 February 2013, the 101st Air Assault Division developed the first unit precision fires program capable of creating analysts outside of the Joint and Combined Integration Directorate's precision fires courses. This capability allowed the unit and the Army to save training dollars because it did not require precision fires mobile training teams. With the success of the 101st Air Assault Division's program, 1st Armored Division, 10th Mountain Divi-

sion, 82d Airborne Division, 4th Infantry Division, and 1st Cavalry Division established their own unit precision fires programs to certify analysts and maintain the capability to grow and sustain Target Mensuration Only.[34]

Besides developing a precision fires training program to train soldiers to deliver precision munitions at Fort Sill and in operational units, the Field Artillery's role in nonlethal targeting greatly expanded during the first decade of the 21st Century.[35] Since the 1990s, maneuver commanders had looked to their fire supporters to integrate lethal and nonlethal effects; however, combat operations early in the 21st Century took the Field Artillery beyond an informal arrangement for integrating lethal and nonlethal effects to one based on formal doctrine. Doctrine required field artillery officers and soldiers to look across a broad spectrum of targeting by integrating information operations, electronic attack, psychological operations, military deception, public affairs, and other nonlethal effects as required to complement lethal precision or conventional fires and to change their mindset. Field artillery officers and soldiers had to determine whether lethal effects or nonlethal effects would meet the desired effect rather than narrowly focusing lethal fires and effects as had been the practice for years.[36]

In response, the Field Artillery School developed a three-week Tactical Information Operations Course for brigade and below. The course taught students to identify the target then select the appropriate lethal or nonlethal effects that would achieve the commander's desired result. Geared for staff sergeants through lieutenant colonels, the course focused on basic information operations, including electronic warfare, cultural awareness, and operational security.[37]

Concurrently, the Field Artillery School added other nonlethal courses. In 2005, it introduced a Joint Fires and Effects Course. Although funding constraints forced the school to stop teaching the course in 2013, the initial offering covered the skills and processes to apply and integrate the full range of operational lethal and nonlethal fires and effects; it also prepared students for the effects-based approach methodology to combat operations. A few years later in 2007, the Field Artillery School created a Fire Support Coordinator Course to equip fire support coordinators with the right skills to

integrate lethal and nonlethal effects. Despite the course's success over its two years, budget cuts forced the school to eliminate both the class and its mobile training team counterpart during the latter months of 2011. To mitigate the training gap, the school incorporated one week of fire support coordinator training into the Field Artillery Captain's Career Course. The school also added lethal and nonlethal fires and effects into the Noncommissioned Officer Education System and Warrant Officer Education System.[38]

At the same time, the Field Artillery ventured into electronic warfare as a part of its nonlethal mission. On 30 October 2003, the Department of Defense concluded that electronic warfare capabilities had to be improved to meet advances in the application and the use of the electromagnetic spectrum to deny adversarial situational awareness, disrupt command and control, and develop targeting solutions to defeat weapons while protecting the United States' electronic capabilities from being successfully attacked. Subsequently on 15 May 2004, the US Army Training and Doctrine Command Commanding General designated the Combined Arms Center Commanding General at Fort Leavenworth, Kansas, as the Army's specified proponent for electronic warfare. Then on 23 November 2004, the Combined Arms Center Commanding General, Lieutenant General William S. Wallace, selected the US Army Field Artillery Center and Fort Sill as the lead for the Army's electronic warfare attack for brigade, division, and corps. Working with the Combined Arms Center, Fort Sill developed a plan early in 2005 to revitalize electronic warfare within the Army; establish roles and responsibilities for electronic warfare functions; and begin the process of updating electronic warfare doctrine, organization, training, material, leadership, personnel, and facilities. Initial analysis indicated that the responsibilities between information officers and fires coordinators were not clear, that joint electronic attack planning and coordination were largely ignored, and that there were multiple proponents for various aspects of electronic warfare. Equally important, electronic attack training did not meet current doctrine or organizations; and fire support coordinators lacked training on integrating and synchronizing electronic warfare assets. Only formal training could overcome these deficiencies.[39]

Based on this conclusion, the Vice Chief of Staff of the Army, General Peter W. Chiarelli, took action. In May 2006, he directed the Army G-3 to establish electronic warfare as an enduring core warfighting competency within the Army and directed the G-3 to develop an electronic warfare force structure and operational concepts to strengthen the Army's strategic vision and support the ground force component commander. This would enhance the Army's ability to counter electronic threats proactively, help integrate lethal and nonlethal capabilities across the Army, and mitigate the threat that America's enemies would employ electromagnetic spectrum, such as improvised explosive devices that had been so deadly in the War of Terrorism.[40]

To meet the immediate requirement for electronic warfare personnel, the Combined Arms Center directed the US Army Intelligence Center and School at Fort Huachuca, Arizona, and the Fires Center of Excellence at Fort Sill (known as the US Army Field Artillery Center and Fort Sill until 2005) to create electronic warfare courses. In 2006, the Intelligence School developed a Tactical Electronic Warfare Practioners Course that awarded an additional skill identifier 1K and focused on countering radio-controlled improvised explosive devices. Meanwhile, the Field Artillery School conducted a pilot Army Operational Electronic Warfare Course in October 2006 and January 2007 to train electronic warfare officers to plan, integrate, synchronize, and execute electronic warfare according to the commander's scheme of maneuver. This course awarded an additional skill identifier 1J.[41]

The Army Operational Electronic Warfare Course served as a bridging strategy until an electronic warfare force structure could be stood up. In preparation for a proposed electronic warfare functional area, the Combined Arms Center directed the Fires Center of Excellence in August 2008 to construct an electronic warfare officer functional course, an electronic warfare integrator course for warrant officers, and an electronic warfare integrator course for enlisted personnel. This would permit the Army to field its own electronic warfare personnel to replace those provided by the Air Force and Navy.[42]

In concert with this tasking, the Fires Center of Excellence taught four electronic warfare courses to satisfy Functional Area 29

training requirements for officers, Military Occupational Specialty 290A for warrant officers, and Military Occupational Specialty 29E for enlisted soldiers by 2011. While the Army Operational Warfare Electronic Warfare Course still provided an additional skill identifier 1J to furnish deploying units with battalion and brigade electronic warfare personnel, the Functional Area 29 course prepared officers to serve as Army electronic warfare officers from the brigade to the Army Service Component command level. The course also provided training in the essential core skills necessary to perform electronic warfare functions in support of the commander's concept of the operations. Additionally, it prepared electronic warfare officers to participate in electronic warfare operations at the tactical, operational, and strategic levels in a variety of Army and joint organizations. Meanwhile, the Electronic Warfare Warrant Officer Technician Military Occupational Specialty 290A course trained warrant officers to serve as electronic warfare integrators; and the Electronic Warfare Sergeant Noncommissioned Officer Course Military Occupational Skill 29E prepared enlisted soldiers to serve as Army electronic warfare specialists.[43]

However, the Field Artillery and Field Artillery School were only responsible for electronic warfare for a few years. In 2011, the Army transferred electronic warfare from the fires warfighting function to the mission command warfighting function as part of its Army Doctrine 2015 effort. Though the Fires Center of Excellence, Field Artillery School, and Field Artillery were no longer responsible for electronic warfare, their responsibility for nonlethal fires and effects remained.[44]

To this end, the Combined Arms Center Commanding General, Lieutenant General William B. Caldwell IV, and the Fires Center of Excellence Commanding General, Major General Peter M. Vangjel (2007–2009), addressed the importance of nonlethal effects. Lieutenant General Caldwell told leaders at the 2008 fires conference that providing nonlethal effects was now a core competency of field artillery officers and soldiers. In his vision of the future, Major General Vangjel reinforced this competency.[45] A few years later, the August 2012 version of Army Doctrinal Publication 3-09 explained that the fires warfighting function included deliberate and dynamic

targeting to achieve lethal and nonlethal effects against ground targets.[46] Army doctrine solidified the responsibility for field artillery officers and soldiers to supply lethal and nonlethal effects equally as well. Field artillery officers and soldiers no longer had the option to consider nonlethal fires and effects. According to doctrine, they had to view it as a viable option and not as an afterthought as the practice had been for years.[47]

Making nonlethal fires and effects a core competency for field artillery officers and soldiers reflected the Field Artillery's significant transformation during the first two decades of the 21st Century. For the previous two centuries, the Field Artillery focused on massed, lethal fires and effects to destroy targets and demonstrated little concern for collateral damage and noncombatant deaths. Because of increasing concern about collateral damage, field artillery officers and soldiers were forced to look across a broad spectrum of targeting; this required a new mindset. They had to consider nonlethal fires and effects as a viable alternative to lethal fires and effects.

Munitions, Platforms, and Command and Control

Concurrent with its doctrinal transformation, the Field Artillery needed to replace cluster munitions with munitions that did not produce collateral damage as well as field updated precision munitions, upgrade firing platforms, and modernize mission command systems. These measures would ensure that the branch would remain competitive in a world of rapidly changing technology and emerging threats.

Over the years, cluster munitions generated controversy. They dispensed a large number of submunitions imprecisely over an extended area; lacked self-destruct capability; had the potential to remain hazardous for decades; and produced collateral damage to infrastructure, Soldiers, and civilians. Armies first used them in World War II, and at least 21 countries had employed them since. In the 1960s and 1970s, the United States used them in Southeast Asia. The International Committee of the Red Cross estimated that 9 to 27 million cluster munitions remained unexploded in Laos alone. In the years since, the Soviets had utilized them in Afghanistan in the 1970s and 1980s, while the British employed them in the Falk-

land Islands in the 1980s. Subsequently, the United States employed cluster bombs in Afghanistan and Iraq in the first decade of the 21st Century during its Global War on Terrorism.[48]

Frustrated with the futile attempts to prohibit or restrict the use of cluster munitions, a group of nations led by Norway reached an agreement to ban them. In December 2008, 94 countries signed the Convention on Cluster Munitions, which banned their development, production, acquisition, transfer, and stockpiling. By December 2009, 103 countries had signed the convention. The United States, Russia, China, Israel, Egypt, India, and Pakistan, however, did not participate in the talks that led to the agreement and abstained from signing the convention.[49]

In fact, the United States initially resisted bans against employing cluster munitions. As early as May 2008, Acting Assistant Secretary of Political-Military Affairs Stephen Mull said the United States relied on cluster munitions as an important part of its defense strategy and preferred pursuing technological fixes to ensure that unexploded munitions would not be viable once a conflict was over. Moreover, if cluster munitions were eliminated, he argued, more money would be spent on new weapon systems, ammunition, and logistical resources to replace them. The United States further stated that most militaries would increase the use of massed field artillery and rocket barrages, which would increase the destruction of infrastructure.[50]

US leaders acknowledged that unexploded cluster munitions could cause unintended harm to civilians and civilian infrastructure and recognized worldwide opposition to the Dual-Purpose Improved Conventional Munition that was an American field artillery cluster munition. Instead of eliminating the munition, the Department of Defense changed its cluster munition policy to require the military to design and procure cluster munitions with a 99-percent reliability rate, meaning that one percent or less of its bomblets would not detonate after they were dispensed from the carrier shell. In its 19 June 2008 Policy on Cluster Munitions and Unintended Harm to Civilians memorandum, the Department of Defense officially announced a moratorium on the production and employment of cluster munitions that would leave more than one percent duds after arm-

ing. As soon as possible but no later than one year from 9 July 2008, the military and combatant commands would commence removing all cluster munitions from the active inventory that exceeded operational planning requirements or for which there would be no operational planning requirements. All excess cluster munitions would be demilitarized as soon as practicable. After 2018, United States military departments and combatant commands could only employ cluster munitions that would result in no more than one percent unexploded ordnance after arming. Previously, employing cluster munitions that exceeded the one-percent threshold had to be approved by the combatant commander.[51]

The Army recognized the need for the Guided Multiple Launch Rocket System Dual-Purpose Improved Conventional Munition and noted that the Unitary munition that was a single high-explosive warhead did not provide the same capability and effect. With this in mind, the Deputy Chief of Staff of the Army, G-3/5/7, Lieutenant General James D. Thurman, announced in June 2008 that the Army had decided to transition to an alternative warhead capability as soon as technologically and programmatically feasible. Subsequently, the Army announced its intention to procure the Guided Multiple Launch Rocket System Unitary rocket in lieu of the Dual-Purpose Improved Conventional Munition warhead and develop a Guided Multiple Launch Rocket System Alternative Warhead.[52]

After several years of development and successful testing demonstrated the munition's reliability and accuracy, the Army announced in 2014 that the 200-pound Guided Multiple Launch Rocket System Alternative Warhead contained approximately 160,000 preformed tungsten fragments, eliminated the possibility of any unexploded ordnance, and met the 2008 Department of Defense policy on Cluster Munitions and Unintended Harm to Civilians memorandum. Equally important, the Army initiated full production in 2015.[53]

As the Army worked to acquire the Guided Multiple Launch Rocket System Alternative Warhead, it upgraded its arsenal of Army Tactical Missile Systems (a long-range field artillery missile), focusing on limiting collateral damage in keeping with the Department of Defense policy on cluster munitions. In response to an urgent need statement from Headquarters, US Forces Korea, the Army fielded

the Quick Reaction Unitary Army Tactical Missile System in 2001 to complement the Army Tactical Missile System I and Ia. The I and Ia had anti-personnel and anti-material cluster submunitions that did not comply with the Department of Defense cluster munition policy and, therefore, could not be employed after 2018. The Quick Reaction Unitary, often called the Army Tactical Missile System Ia Unitary, had a deep strike capability for responsive precision employment in areas of dense foliage, deep snow cover, and built-up urban environments. With a range of 270 kilometers and a single 500-pound high-explosive warhead, it engaged point targets with minimal collateral damage at ranges comparable to the Army Tactical Missile System Ia, provided the corps and joint task force commander with the capability to attack time-sensitive targets, and augmented the Army Tactical Missile System I and Ia strikes that helped pave the way for the 2003 ground campaign in Operation Iraqi Freedom.[54]

Despite operational successes with the Army Tactical Missile System I and Ia and the Quick Reaction Unitary Army Tactical Missile System, insufficient funding prompted the Assistant Secretary of the Army, Claude M. Bolton Jr., to sign a memorandum to terminate the Army Tactical Missile System. His action cancelled contracts, and production facilities were closed out after final deliveries had been made in 2008.[55]

As of 2010, the Army had an inventory of approximately 2,000 Army Tactical Missile Systems. This included the I and Ia, the Unitary (M48 and M57), and the Army Tactical Missile System II that was never fully operational. Nearly 65 percent of the missiles failed Department of Defense cluster munition policy compliancy requirements and could not be employed after 2018. To ensure that the stockpile of Army Tactical Missile Systems I and Ia with 2016 expiration dates and the Unitary with a 2021 expiration date were available for employment, the Army designed a service life extension program in 2009 to extend the life of the I and Ia missiles by 10 years. By refurbishing or replacing propulsion and navigation systems and replacing the non-compliant I and Ia warheads with the Unitary warhead, the service life extension program would provide time to complete an analysis and develop a successor to the Army Tactical Missile System.[56]

Understanding that the service life extension program did not satisfy long-term precision fires requirements, the 27 September 2013 US Army Training and Doctrine Command Capability Needs Analysis noted the imperative to develop a long-range precision fires strategy. Without the Army Tactical Missile System, the Army lacked the capability to engage targets out to 499 kilometers and destroy strategic targets. Although viable options existed to eliminate the capability gap—ranging from joint assets to restarting the Army Tactical Missile System production—the Fires Center of Excellence at Fort Sill advocated developing a new missile because it would be the most cost-effective alternative for fielding a missile with long-range capability; they designed a block strategy to develop the new weapon in a timely and affordable manner.[57]

As of 2015, the first block or increment would hit targets from 70 to 300 kilometers and would have two missiles per missile pod. This would not require any modifications to the current Army Tactical Missile System launcher or pod. Additionally, it would permit fielding the missile in 2022 and after the end of the Army Tactical Missile System's shelf life. Initial capabilities would include 24/7 all-weather precision area and time-sensitive capability to destroy tactical or strategic targets.[58] The second increment or block would take advantage of emerging technologies to engage targets beyond 300 kilometers. This range would most likely come from improved motor, lightweight airframe, and propulsion technologies.[59]

Removing the Army's arsenal of cluster munitions extended to the 155-millimeter Dual-Purpose Improved Conventional Munition. To save money and prevent wasting the M483 Dual-Purpose Improved Conventional Munition carrier shell, the Army formulated a plan in 2011 to recycle the carrier shell as a replacement for aging or less capable munitions. The first munition using this recycle concept was the M1122 training round for the 155-millimeter howitzer. The M1122 replaced the M804 Low-cost Indirect Fire Training Round and then the M107 training round in 2012. Other munitions using the recycled M483 included the M1123 Infrared Illuminating Projectile and M1124 Visible Light Illuminating Projectile. A third round was the M110A3 White Phosphorous Smoke Projectile.[60]

As the Army and the Field Artillery initiated steps to eliminate cluster munitions, they continued work on the Precision Guidance Kit, a fuse with a Global Positioning System package that would turn a non-guided munition into a smart one as well as the Excalibur precision munition to minimize collateral damage and reduce the number of rounds to destroy a target. Following successful testing, the urgent material release Precision Guidance Kit began fielding in March 2013. The Army sent the fuse to M777 towed-155-millimeter howitzer and M109 self-propelled 155-millimeter howitzer units in Afghanistan. The fuse achieved near-precision target effects when it was screwed onto the nose of a conventional 155-millimeter projectile.[61]

Meanwhile, the Army continued developing a program-of-record Precision Guidance Kit fuse. In May 2015, it successfully completed an initial operational test and evaluation that demonstrated the fuse's operational effectiveness, accuracy, operational suitability, and survivability. This permitted moving the fuse into full-rate production and adding anti-jamming capabilities to the fuse.[62]

The Field Artillery School concurrently continued participating in developing precision Excalibur Ia-2 and Ib that would be improvements over the Excalibur Ia-1 that had been fielded in Iraq and Afghanistan as an urgent material requirement. The Excalibur Ia-1 had a range of 24 kilometers, while the Excalibur Ia-2 had a range of 37 kilometers and better accuracy. The Army concluded fielding Excalibur Ia-2 in 2012. Although funding constraints reduced the number to be produced, the Army Acquisition Executive approved full-rate production of Excalibur Ib on 25 June 2014.[63]

Introducing new weapon systems complemented developing new munitions. After several years of work in the 1990s, the contractor delivered prototypes of the XM777 towed 155-millimeter howitzer, also called the Lightweight 155. Unveiled at Picatinny Arsenal, New Jersey, in June 2000, the first prototypes held great promise. The howitzers' reduced size and weight permitted towing by the same prime mover used to tow the M198 towed 155-millimeter howitzer and allowed two howitzers to fit into a C-130 aircraft for strategic deployability. Additionally, the XM777 (designated as the M777) could be emplaced in three minutes or less, be

displaced in two minutes or less, and fire faster than the M198—with a range of 30 kilometers.[64]

Fielding the M777 with a conventional optical fire control system began as planned. On 19 January 2005, the Marine Corps received its first howitzers and conducted its first live fire at Fort Sill. Other howitzers were fielded to the 3d Battalion, 11th Marines at Twenty Nine Palms, California, and the 2d Battalion, 11th Marines at Camp Pendleton, California. On 19 December 2005, Colonel John M. Sullivan Jr., the 11th Marine Regiment Commander, certified that the Marine Corps had achieved its initial operational capability with the M777.[65]

Work on the software for the Towed Artillery Digitization package subsequently produced a sophisticated towed howitzer. Early in the fall of 2006, the Army tested an M777 digital fire control system at the Yuma Proving Ground, Arizona. After successful software and material testing, Major General William M. Lenaers, US Army Tank Command Life Cycle Management Command Commanding General, proceeded with full material release of the XM777E1 as the M777A1 in January 2007.[66]

Figure 12: M119A2 towed 105-millimeter howitzer.
Source: US Army photo by First Lieutenant Jonathan J. Springer.

Shortly afterward, the Army upgraded the M777A1 with software improvements to fire the Excalibur precision munition and redesignated it as the M777A2. Fielding of the howitzer began in July 2007 and continued into 2010. At the same time, the Army retrofitted the M777 and the M777A1 as the M777A2. Then on 13 January 2008, C Battery, 3d Battalion, 321st Field Artillery Regiment fired the first Excalibur in Operation Enduring Freedom in Afghanistan from the M777A2; and later the 2d Battalion, 11th Field Artillery Regiment fired the first Excalibur from the howitzer in Operation Iraqi Freedom on 26 April 2008.[67]

After creating the Infantry Brigade Combat Team with its organic fires battalion in 2002, the Army required more towed 105-millimeter howitzers than in its inventory. This led to a June 2004 decision by a general officer steering committee to rebuild and refit old M102 towed 105-millimeter howitzers and press them into service. Pressured by the US Army Training and Doctrine Command and the US Army Field Artillery Center at Fort Sill, the general officer steering committee reevaluated the decision in August 2004 and ordered production of new M119A2 towed 105-millimeter howitzers to fill the shortages.[68] Based on successful testing, the Army subsequently granted new production full materiel release for the M119A2 on 10 June 2008 and began fielding.[69]

With the fielding of the digitized M777A1 towed 155-millimeter howitzer and the phasing out of the M102 towed 105-millimeter howitzer, the M109A5 self-propelled 155-millimeter howitzer, and the M198 towed 155-millimeter howitzer, the M119A2 would be the only howitzer in the Army's inventory without digital capabilities. This would exacerbate the capability gap between the Infantry Brigade Combat Team that was equipped with the M119A2 and the Stryker Brigade Combat Team that was equipped with the M777A1. The lack of digital capabilities with the M119A2 would also prevent the howitzer from using the Precision Guidance Kit fuse. The lack of precision, in turn, would lead to less accuracy; make dispersed operations more difficult to perform; and decrease the survivability of the Infantry Brigade Combat Team. Influenced by these reasons, the Field Artillery School, the US Army Training and Doctrine Command, and the Army G-8 (Programming and Materiel Integration)

developed the requirement in 2007 to digitize the M119A2 along the lines of the M777A1. Later on 24 January 2008, the Program Executive Officer, Ground Combat Systems, and Major General Peter M. Vangjel, the commanding general of the US Army Fires Center of Excellence and Fort Sill from 2007 to 2009, approved digitizing the M119A2 to give it the same self-locating, self-orienting, and digital communications capabilities as the M777A1 and M109A6 (Paladin) self-propelled 155-millimeter howitzer. The Army designated the digitized M119A2 as the M119A3.[70]

Fielding the M119A3 began in 2013 when the 3d Battalion, 319th Field Artillery Regiment, Fort Bragg, North Carolina; the 1st Battalion, 320th Field Artillery Regiment, Fort Campbell, Kentucky; and the 1st Battalion, 78th Field Artillery Regiment, 428th Field Artillery Brigade, Fort Sill, received their howitzers as part of a six-year fielding plan. With this action, all the Army's towed artillery had digital capabilities for the first time.[71]

Weapons platform modernization also included the M109A6 (Paladin) self-propelled 155-millimeter howitzer. In the fall of 2007, the US Army and BAE Systems signed a memorandum of understanding establishing a public-private partnership to develop and sustain the Army's M109 Family of Vehicles—the M109A6, the M992A2 Field Artillery Ammunition Resupply Vehicle, and the Paladin Operations Center Vehicle—through the Paladin Integrated Management. Then in May 2008, they signed a contract to design and develop the Paladin Integrated Management M109 system of vehicles.[72]

The Army intended for Paladin Integrated Management to improve readiness, avoid component obsolescence, and increase sustainability of the M109 platforms to mitigate size, weight, and power gaps required to support Heavy Brigade Combat Teams through 2037. Operationally, upgrades would make the howitzer faster, more maneuverable, more sustainable, and more lethal as well as reduce the logistics footprint and operational and support costs. To achieve these objectives, Paladin Integrated Management would leverage commonality with Future Combat System's Non-Line of Sight Cannon and the Heavy Brigade Combat Team's Bradley fighting vehicle. For example, Paladin Integrated Management would use the Bradley's engine, transmission, and track/suspension sys-

tem and incorporate select technologies from the Non-Line-of-Sight Cannon—including but not limited to the automated projectile rammer and modern electric-gun drive system to replace the current hydraulic elevation and azimuth drives that were designed in the early 1960s. Once delivered to the field, the Paladin Integrated Management M109 family of vehicles would give the Heavy Brigade Combat Team upgraded capabilities, including more maneuverability, a higher rate of speed, increased crew survivability, and improved delivery of accurate and timely fires. Then when Secretary of Defense Robert M. Gates cancelled the Non-Line-of-Sight Cannon in April 2009, the Paladin Integrated Management became the Army's number one modernization effort.[73]

Meanwhile, the US Army Training and Doctrine Command stripped the Paladin Operations Center Vehicle from Paladin Integrated Management and tied it to a command and control vehicle to replace the M113, the M577, and the M1068 vehicles. In August 2009, the Army awarded a contract to BAE to produce seven Paladin Integrated Management vehicles – five self-propelled howitzers and two carrier ammunition tracked vehicles. Five months later on 20 January 2010, the company unveiled its first M109 Paladin Integrated Management prototype howitzer.[74]

Figure 13: M109 Paladin Integrated Management howitzer.
Source: US Army photo by Sergeant Sean Harriman.

Over the next several years, the Army ran the Paladin Integrated Management howitzer through various tests to determine its suitability, reliability, lethality, survivability, and sustainability, among other things. After successful 2010 and 2011 tests, the Program Executive Office Ground Combat Systems announced that the howitzer had passed a major hurdle when the Defense Acquisition Executive approved production on 18 October 2013. The howitzer moved into low-rate initial production in 2014, with full-rate production scheduled for 2017 and the first unit equipped in 2017. While its cannon remained the same as the M109A6, the Paladin Integrated Management howitzer—designated the M109A7 in 2015—had a new chassis, engine, transmission, suspension system, and steering system.[75]

Modernizing the M270 and M142 launchers paralleled cannon developments. After fielding the M270A1 in 2002, the Army upgraded it. During 2005, the Army introduced the Improved Weapon Interface Unit, which was required for firing the Guided Multiple Launch Rocket System munition—both the Dual-Purpose Improved Conventional Munition and Unitary.[76] In 2005, the Army also completed other significant modification projects, including the Environmental Control Unit and Auxiliary Power Unit. The launcher cab's existing ventilation system did not meet Manpower Personnel Integration requirements for a crew during firing and silent watch operations in all weather. Additionally, multiple radios and electronic equipment in the cab generated heat. To address these issues, the Army installed the Environment Control Unit to control adverse climate conditions and permit the maximum use of radios and computer systems as well as the Auxiliary Power Unit to reduce maintenance time and costs, provide electricity, and permit the launcher to remain powered while in the hide area with the main engine shut off.[77]

Meanwhile, operations in Iraq and Afghanistan demonstrated that the threat had changed, requiring greater protection for the M270 crew. As explained in the January–February 2016 *Fires Bulletin*, the Improved Armored Cab would support current and future operations and provide greater protection against mines, improvised explosive devices, enemy artillery fragmentation and direct attack from small arms. Based on 2015 testing, the Army concluded that

the Improved Armored Cab would furnish crew protection on par with the High Mobility Army Rocket System cab.[78]

With the increasing need for better communications over long distances, the Army also initiated development of a long-range communication system for the Multiple Launch Rocket System and the High Mobility Artillery Rocket System. As of 2006, digital messages to the launchers were transmitted from the Advanced Field Artillery Tactical Data System via a Single Channel Ground and Airborne Radio System. This message flow was sequential from command and control node to command and control node. Line-of-sight radio communications limited the distance between each command and control node. Although there were advantages to this communications flow, it increased fire mission times, reduced effectiveness of time-sensitive targets by taking a long time to process, and increased the quantity of equipment required to complete a fire mission. The long-distance communication system as employed by 2015 integrated high-frequency radios and satellites to permit units to receive and send secure voice and digital fire missions over extended distances, reduced the physical and electronic footprint by expanding reach, and provided tactical flexibility when positioning launchers.[79]

Referred to as the "Big Three Modifications," the Modular Launcher Communications System, Driver's Vision Enhancement, and Blue Force Tracker gave soldiers three hardware upgrades that enhanced battlefield operation of the M270 mission. The Driver's Vision Enhancement allowed drivers to conduct day and night operations and maneuver in smoke, fog, dust, or other battlefield obscurants, while the Blue Force Tracker delivered greater situational awareness through a small screen that showed the locations of friendly units as well as other battlefield intelligence.[80]

Concurrently, the Army pushed a fire control system upgrade. In addition to upgrading the obsolete fire control system, the upgrade provided fire control system software and hardware commonality between the High Mobility Artillery Rocket System M142 launcher and M270A1 launcher by taking advantage of the latest technology and better processors to enhance mission processing and make the fire control system more user-friendly. These modernization pro-

grams made the M270A1 more modern, survivable, and sustainable for the 21st Century battlefield.[81]

As it updated the M270A1, the Army fielded the High Mobility Artillery Rocket System M142 launcher beginning in 2005.[82] Just as fielding began, the Army approved a 20 October 2005 urgent need statement by the 3d Battalion, 27th Field Artillery Regiment at Fort Bragg, North Carolina, and XVIII Airborne Corps identifying the need for increased crew protection to counter the threat of small arms fire, field artillery fragments, and land mines in the Global War on Terrorism. Even with armor, the cab still had to meet C-130 transportability requirements while achieving Standardization Agreement (STANAG) level II armor requirements. Developed in 2005–2006 to meet the urgent need statement, the near-term armor solution used the Low Signature Armored Cab developed for use with the family of medium tactical vehicles. The Army designated the modified M142 as the Low-Signature Armored Cab-High Mobility Artillery Rocket System. The system's appliqué armor consisted of 43 pieces of armor that could be installed on the cab in less than two hours and removed in less than one hour.[83] Then late in 2006, the Army initiated work on the Increased Crew Protection to provide even greater crew protection. After test results indicated that the cab met the critical operational criteria, the Army awarded BAE Systems the contract for 64 Increased Crew Protection cab up-armor kits in 2009. Retrofitting all M142 launchers with cab was completed in 2012.[84]

As the Army developed the crew protection cab up-armor kit, it introduced hot panel capability for the M142. This allowed the launcher software to receive positional updates while in flight aboard a C-130 or C-17 aircraft—giving the M142 a true roll off and fire capability and allowing for greater flexibility to project force on the battlefield.[85]

For the past 20 years, the Advanced Field Artillery Tactical Data System Increment I tied together the Field Artillery's system of systems—weapons, sensors, and support systems—and served as the Field Artillery's primary mission command system. It processed, analyzed, and exchanged combat information and furnished fully automated support for planning, coordinating, controlling, and

executing fires and effects. Increment I supported mortars; field artillery cannons, rockets, and missiles; close air support; attack aviation; and naval surface fire support systems and was integrated with 80 different battlefield systems from the US Army, Marine Corps, Navy, and Air Force as well as German, French, Turkish, and Italian fire support command and control systems.[86]

In June 2011, the Joint Requirements Oversight Council approved the Advanced Field Artillery Tactical Data System Increment II to replace Increment I. Increment II was designated as a software modification effort Version 7.0 and was slated for initial fielding in 2019. Then the fires command and control migration strategy would move all field artillery command and control systems under the Advanced Field Artillery Tactical Data System around 2019–2025. These systems included the Pocket-sized Forward En-

Figure 14: M270A1 Multiple Launch Rocket System.
Source: US Army photo by John Hamilton.

try Device that forward observers and fire support teams used to compose, edit, transmit, receive, store, and display messages; process data; and monitor status as well as conduct, plan, and execute fire support missions. Other systems were the Lightweight Tactical Fire Direction System (Centaur), a backup system to the Advanced Field Artillery Tactical Data System; the Forward Observer System; and the Joint Automated Deep Operations Coordination System that was also a command and control system tool.[87]

The Advanced Field Artillery Tactical Data System, the Pocket-sized Forward Entry Device, Centaur, other digitized command and control systems, and digital-capable firing platforms were significant developments for the Field Artillery. They pushed the branch further into the age of precision munitions and digitization to complement conventional unguided munitions.

Force Structure and Doctrine

At the beginning of the 21st Century, the Army significantly overhauled its force structure. As previously discussed, it introduced the modular brigade combat team as its basic fighting organization to replace the division; placed a fires battalion within the Brigade Combat Team; furnished fires brigades to support brigade combat teams, divisions, corps, or joint task forces; and created functional brigades. The Army also wrote new doctrine.

The formation of the Brigade Combat Team with its organic field artillery battalion and the elimination of division artillery abolished senior field artillery command headquarters at the division and corps. This action left the force with an inadequate number of force field artillery headquarters to support divisions and corps and to integrate fires and training and readiness oversight. Specifically, seven active component fires brigades supported 14 divisions and corps headquarters as well as the Eighth US Army in Korea. Under the modular concept, the Brigade Combat Team would provide training, readiness, and administrative oversight to its organic fires battalion, while the fires brigades would function as a force field artillery headquarters for divisions, corps, or joint task forces. However, the Field Artillery School and field artillery officers and Soldiers knew that the Brigade Combat Team would not provide

such oversight and thus challenged the Brigade Combat Team concept. When the school opposed the concept, the Chief of Staff of the Army acknowledged at a Pentagon meeting that some things would be broken, but he basically dismissed the concerns—adding that it was important to move forward. Operational experience reinforced the school's and field artillery officers' and Soldiers' fears about the Brigade Combat Team's ability to furnish training, readiness, and administrative oversight.[88]

As the Army projected returning to combined arms operations and executing regionally aligned force missions, the modular design created several capability gaps. The echelon above brigade mission command field artillery force structure and organizational design did not sufficiently meet the combatant commander requirements as part of the joint force. It lacked the ability to integrate and synchronize fires effectively at the division and the corps in support of unified land operations. The organization also failed to provide fires battalion training and readiness oversight in the Brigade Combat Teams and could not provide consistent fire support certifications and leader development. This led to skill atrophy and neglected or misused fire support Soldiers. Major General James M. McDonald, who was the Commanding General of the Fires Center of Excellence from 2012 to 2014, submitted a force design update to the Army in December 2012 to re-establish field artillery command headquarters in echelons above brigade at division and corps levels.[89]

The proposal established a division artillery without organic firing units for each active component division. The division artillery would be assigned to each active component division; would be stationed with the division; and would coordinate, integrate, and synchronize fires to achieve the division commander's objectives. Meanwhile, the division artillery commander would serve as the fire support coordinator for the division. Moreover, division artillery could be tailored with a variety of fires battalions (rocket and cannon), unmanned aerial systems, and counter-rocket artillery; integrate and deliver fires; and furnish mission command to train and certify the Brigade Combat Team fires battalion and fires cell.[90]

Also, the proposal provided a field artillery brigade to be assigned to each active component corps as well as one to the US

Eighth Army in Korea. The brigade would coordinate, integrate, and synchronize fires; provide long-range precision fires to the corps; and give the corps/US Eighth Army commander a headquarters that could plan, prepare, execute, and assess fires in support of operations. Additionally, it would provide counterstrike capability throughout the corps area of operations; and the field artillery brigade commander would serve as the fire support coordinator for the corps. In addition, the corps field artillery brigade would train and certify its subordinate field artillery battalions and allocate them to the division as required to provide reinforcing fires.[91]

In October 2013, the Army approved the echelon above brigade force design update. It created 10 division artilleries that would be assigned to the 10 active component divisions and retained four active component fires brigades that would be assigned to each corps and the Eighth Army. Later, the Army authorized redesignating fires battalions in the Brigade Combat Team and echelons above Brigade Combat Teams as field artillery battalions. To standardize naming convention within field artillery units, Major General McDonald also changed the fires brigade to the field artillery brigade.[92]

The Fires Center of Excellence force design update also modified the existing field artillery brigade in the Army National Guard with the same organizational design as the active component. The Army National Guard field artillery brigades would provide flexibility to the Total Army and perform the same functions as the active component field artillery brigades. However, they would be aligned with Army National Guard divisions for training affiliation, be capable of serving as a division artillery to support Army National Guard divisions during deployment, or provide reinforcing and counterfire capability to active component corps and joint task forces. The brigade's primary function included coordination, integration, synchronization, employment of fires, and long-range precision fires to the corps. The number and mix of field artillery battalions assigned to the brigade would vary depending on mission and number as well as type of divisions assigned to the corps.[93]

In 2014, the Army started standing up division artillery; the last one stood up in 2016. Late in 2014, the Army converted the 212th Field Artillery Brigade to the 1st Armored Division Artillery and

the 42d Field Artillery Brigade to the 3d Infantry Division Artillery. It also activated the 82d Airborne Division Artillery, 101st Air Assault Division Artillery, 25th Infantry Division Artillery, 2d Infantry Division Artillery, and 3d Infantry Division Artillery. US Army Forces Command noted that the Army's decision to implement field artillery brigades and division artilleries would provide the Field Artillery with the capabilities to plan, synchronize, and coordinate strategic, operational, and tactical fires in support of the unified land commander and provide mission command for the training and readiness of attached field artillery units. This action would effectively reverse 12 years of continuing atrophy of field artillery skills as well as erosion of leader and professional development within the fires warfighting function—from basic section/platoon level skills to the ability to mass and synchronize fires in support of the maneuver commander. The division artillery commander of the 3d Infantry Division, Colonel John O'Grady, pointed out that the return of division artillery reflected the Army's commitment to strengthen core skills that had been eroded by modularity and combat operations in Iraq and Afghanistan.[94]

Many senior officers expressed apprehension that standing up division artilleries was a return to the old division artillery with its organic firing units that had existed through 2004 when modularization changed fire support organization. Brigadier General William A. Turner, who was the Commandant of the Field Artillery School and Chief of Field Artillery from 2014 to 2016, reassured maneuver Brigade Combat Team commanders about the positive aspects of the new division design. They would not lose their organic field artillery battalions to division artillery. Rather, the new division artillery would modernize the Field Artillery by adopting emerging technologies and empower the Brigade Combat Team's field artillery battalion by moving fire support personnel from the maneuver battalion to the field artillery battalion. Division artillery would also plan, prepare, execute, and assess combined arms operations to provide close support and precision strike for the division; consist of a headquarters and headquarters battery, a signal platoon, and a target acquisition platoon; provide command oversight for training management and certification of Brigade Combat Team field artil-

lery battalions and fire support cells; and provide an effective field artillery force structure for full-spectrum operations.[95]

Writing new doctrine paralleled the development of the division artillery. On 23 August 2011, the US Army Training and Doctrine Command Commanding General, General Robert W. Cone, issued Doctrine 2015 guidance. Once completed, Doctrine 2015 would give the Army well-defined enduring principles, tactics, and standard procedures. The transition to Doctrine 2015 required all doctrine publications to be reviewed and separated into new categories. General Cone noted that even though resources would be constrained, the US Army Training and Doctrine Command had to produce quality doctrine by its best and brightest. He concluded:

> In summary, we need to make the development and implementation of Doctrine 2015 a priority. We must seize the initiative we now enjoy as we reflect on this decade of war our Army has fought. We have too many hard-earned lessons, and we must capitalize on the talent we have across our force to ensure. . .our Army. . .can win upon arrival [in theater].[96]

In his guidance, General Cone established key priorities. First, he wanted Army doctrine publications and Army doctrine reference publications to be completed by August 2012. Second, he directed field manuals to be finished by December 2013. Third, he wanted technique publications to be written by December 2015. To accomplish these goals, he authorized service schools, such as the Field Artillery School, to increase their manning levels commensurate with the workload and fill writing positions with the best qualified personnel who would be competitive for battalion command and beyond and had recent operational experience, subject matter expertise, and a fundamental understanding of Army concepts.[97]

Besides increasing the number of people required to author the publications, the Field Artillery School started writing its doctrinal publications and Army doctrine reference publications, field manuals, and Army technique publications in 2011. On 6 January 2012, the School submitted the initial draft of Army Doctrine Publication 3-09 and the initial draft of Army Doctrine Reference Publication

3-09 to the Combined Arms Center at Fort Leavenworth, Kansas, and initiated work on Field Manual 3-09, *Field Artillery Operations*, which focused on fire support tactics and procedures.[98]

Several months later in August 2012, the Army published and distributed Army Doctrine Publication 3-09 and Army Doctrine Reference Publication 3-09, both written by a team from Forces Command, the Air Defense Artillery, and the Field Artillery. An Army Doctrine Publication contained fundamental principles that guided military forces' actions and expressed them so that Army forces could seize, retain, and exploit the initiative. Army Doctrine Publication 3-09 incorporated air and missile defense as well as electronic attack in the Army fires warfighting function; included fires from other services; and provided fires doctrine that would enable the development of interoperable, networked, and integrated systems that could execute multiple missions. Army Doctrine Reference Publication 3-09, meanwhile, served as a doctrinal manual for commanders, leaders, and staffs of the fires warfighting function and furnished a comprehensive explanation of all doctrinal principles in support of offensive and defensive tasks. In 2014, the Army revised Army Doctrine Reference Publication 3-09 to include the new division artillery and field artillery brigade concepts to anchor them firmly in doctrine then continued to make revisions in 2015.[99] As of the end of 2015, Army Doctrine Publication 3-09 and Army Doctrine Reference Publication 3-09 manuals were current after revisions.[100]

Meanwhile in February 2016, the School completed a draft of Army Doctrine Reference Publication 3-09.90, *Division Artillery Operations and Fire Support for the Division*. The manual explained division artillery's three primary tasks for the division's fires warfighting function as delivering fires; integrating all forms of Army, joint, and multinational fires; and conducting targeting.[101]

Concurrently, the Field Artillery School distributed drafts of Field Manual 3-09, *Field Artillery Operations.* With an intended audience of maneuver commanders and their staffs, this revised version of the 2011 Field Manual 3-09 covered field artillery operations, fire support, fire support and the operations process, and fire support coordination as well as other control measures in four chapters. Published in April 2014, Field Manual 3-09 gave the

maneuver arms a single field manual on how the Field Artillery supported the maneuver missions during unified land operations. Later, the School updated the April 2014 Field Manual 3-09 based on a 1 May 2014 Field Artillery Brigade/Division Artillery white paper, which explained the role of the fire support coordinator and division artillery.[102]

Over a period of 25 years, modernization represented by writing new doctrine, restoring division artillery, adopting nonlethal fires and effects to complement lethal fires and effects, digitizing firing platforms, introducing precision munitions, and fielding the Advanced Field Artillery Tactical Data System transformed the Field Artillery. Early in the 1990s, the Field Artillery relied on massed fires and a minimal amount of digitization. The modernized Field Artillery of 2015 relied on sophisticated computers to provide responsive lethal and nonlethal fires and effects and precision munitions.

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Epilogue

Into the Future

Looking into the future, the Field Artillery School understood in 2015 that it had to develop, evaluate, and institute future concepts, doctrine, and capabilities for the Field Artillery to keep it abreast of foreign field artilleries. To do this, the school would have to take advantage of emerging technologies.

In 2015, the US Army Fires Center of Excellence at Fort Sill, Oklahoma, completed "Azimuth 2015: A Strategy for the Future of Fires." The strategy established a path to achieve mid- to long-range objectives through three major lines of effort. Line of effort one involved modernizing the Fires (Air Defense Artillery and Field Artillery) force by developing Fires concepts and introducing new weapon systems and equipment. Line of effort two encompassed producing highly trained Fires Soldiers and Marines for the operational forces by improving education and training; and line of effort three concentrated on upgrading Fort Sill's training ranges and facilities.[1]

Modernizing the Fires force addressed developing concepts and capabilities required for the current and future Field Artillery and embodied working closely with industry, materiel developers, research and development communities, and other Army commands to introduce new systems and equipment. For the Field Artillery, a strategy of one sensor, one shooter, and one mission command system ranked high as a priority for the long term. One sensor, one shooter, and one mission command system would shrink the Fires footprint considerably. Sometime in the future, one artillery platform would serve as an air defense artillery weapon system and as a field artillery weapon system; one radar would be used for air defense artillery and field artillery missions; and one mission control system would provide command and control for both artillery branches.[2]

Continuing to enhance precision fires also fell under Field Artillery modernization and was a key priority for Major General John G. Rossi, who was commanding general of the Fires Center of Excellence at Fort Sill from 2014 to 2016. Near-term fielding of

the Joint Effects Targeting System would improve precision field artillery fires. This system would enable the dismounted observer (forward observer, joint target attack controller, special operations forces, and others) to acquire and engage targets as well as control all available effects providers (field artillery, close air support, attack aviation, and naval gunfire). With a Joint Effects Targeting System, the forward observer could designate stationary targets out to five kilometers and moving targets out to three kilometers for a precision munition to attack and hit. Equally important, the system would reduce the length of time to mensurate (the process of locating a target precisely on a map by longitude and latitude for a guided munition to hit). With the Lightweight Laser Designated Rangefinder that was currently being used, a forward observer took 20 to 30 minutes to mensurate a target because coordinates had to be checked and rechecked by the fire support chain of command before permission was given to shoot a precision munition. The Joint Effects Targeting System—to be fielded by late 2018 or early 2019—promised to reduce the time by sending coordinates digitally through the fire support chain of command.[3]

A long-range precision fires system also played a prominent role in modernizing the Field Artillery to keep it abreast of foreign developments. In 2007, budget concerns prompted the Army to stop production on the long-range precision Army Tactical Missile System. The system had been initially fielded in the 1980s and served effectively in Operation Desert Storm of 1991 and Operation Iraqi Freedom of 2003. This left the Army without a long-range precision missile and created a serious capability gap as foreign militaries began fielding long-range precision missiles.[4]

In February 2013, the Army decided to develop a new long-range precision missile. It would have a 500 or more kilometer range with a 200 pound or larger warhead, be all-weather, leverage existing technologies, be compatible with M270A1 and M142 launchers already in the inventory, sustain and advance Army missile capability to 2050 and beyond, and be affordable. After three years of work, the Army awarded a contract to Raytheon in 2016 to start developing the missile and field it sometime in the 2020s.[5]

A long-range precision missile would also improve the Field Artillery's cross-domain precision fires capability. This emerging warfighting concept aimed to employ air assets to attack ground attack weapons, and ground attack weapons would provide fires for air forces. This concept also included using Army cannon, rocket, and missiles fires from land-based batteries combined with nonlethal effects across the land, air, maritime, space, and cyber domains with the capacity to overmatch enemy capabilities.[6]

While developing a long-range precision missile was a long-term solution to cross-domain Fires capability, the Army required a short-term solution to strike maritime targets from land-based batteries. In 2016, after two years of pressure from Congress, the Army started investigating how to get back in the business of killing ships from land-based batteries—the first such effort since the Coast Artillery was abolished in 1950. Rather than developing a totally new missile system or buying one on the global market for such a mission, Secretary of Defense Ashton Carter announced on 28 October 2016 that the Department of Defense would upgrade the Field Artillery's Army Tactical Missile System to hit moving targets on land or sea by integrating an existing seeker on its front. This would permit hitting a moving target from the land domain up to 300 kilometers into the maritime domain. For the Field Artillery, this capability would be revolutionary because at present it could only attack a stationary target with precision.[7]

Modernizing the Fires force also comprised efforts to exploit revolutionary capabilities. In August 2010, Major General David D. Halverson, who was the commanding general of the Fires Center of Excellence from 2009 to 2012, hosted a panel of senior leaders and retired general officers at Fort Sill to discuss the Army's vulnerability to directed energy and electrodynamics kinetic energy weapon systems, often called electric fires. They noted deficiencies and recommended that the Army Space and Missile Defense Command/ Army Strategic Command provide an initial vulnerability assessment to the Vice Chief of Staff, General Peter W. Chiarelli.[8]

In June 2011, the Army Space and Missile Defense Command briefed General Chiarelli. Based on the briefing, he tasked the command to conduct a comprehensive electric fires assessment to iden-

tify current and emerging threat capabilities and recommend how to fill any gaps in electric fires capabilities. He also directed the Fires Center of Excellence to support the effort as a user representative. Subsequently, the center assigned the Fires Battle Laboratory in its Capabilities Development and Integration Directorate to take the lead for this endeavor. After several months of study, the Fires Center of Excellence and the Army Space and Missile Defense Command briefed General Chiarelli in January 2012 on their final assessment on electric fires. He directed further study and charged them to brief the incoming Vice Chief of Staff, General Lloyd J. Austin III.[9]

The Fires Center of Excellence briefed General Austin in August 2012 about the state of electric fires in the Army and about General Chiarelli's June 2011 recommendation to form an Electric Fires Office under the Fires Battle Laboratory. General Austin concurred with the recommendation. Then in November 2012, the Fires Center of Excellence chartered the Electric Fires Office to work with the Fires Battle Laboratory and the Army Space and Missile Defense Command, provide subject matter expertise, and coordinate and conduct electric fires efforts across the Army. This effort would address the Army's capabilities to counter the threat with "game-changing technologies."[10]

In line with this, the Electric Fires Office coordinated the Army's first electric fires seminar in February 2013 to examine "game-changing technologies." Participants discussed the potential impact of electric fires on doctrine, organization, training, materiel, leadership, personnel, facilities, and policy. Additionally, they gained a greater understanding of integrating electric fires into future planning, synchronization, and execution of missions. Specifically, seminar panels presented papers on energy particle beams, high-power microwaves, laser weapon systems, electro-chemical-thermal guns, and electromagnetic launches, among other topics.[11]

As part of the electric fires effort, Fort Sill constructed an electric fires range. After several years of work beginning in 2013, Fort Sill used its not-yet-completed electric fires range for the first time in 2016. The range permitted developers to observe and examine emerging electric fires technologies in a live-fire event as well as evaluate the technology through modeling and simulation.[12]

In April 2016, the Fires Battle Laboratory conducted the 2016 Maneuver and Fires Integration Experiment at the range. This experiment explored challenges with detecting, identifying, and defeating threat unmanned aerial systems. These systems represented a great danger because they had the potential to conduct reconnaissance and deliver nuclear, biological, chemical, or conventional weapons. Specifically, the experiment exhibited Army's High Energy Laser Mobile Test Truck's ability to acquire, track, engage, and destroy air and ground targets. The truck, an initiative pursued by the Army Space and Missile Defense Command, consisted of a truck-mounted laser platform designed to track and shoot down incoming enemy unmanned aerial systems, rockets, artillery, and mortars. During the experiment, the truck employed a 10-kilowatt high-energy laser and subsystems that shot down 15 unmanned aerial system targets. Future plans included developing a 50- or 100-kilowatt high-energy laser.[13]

Addressing this and other electric fires technologies, Major Michael Burke of the Capabilities Development and Integration Directorate's Requirements Determination Division explained in 2016 that electric fires experiments involved more than just investigating ways to shoot down incoming threats. They also encompassed electromagnetic launch technologies that used a magnetic field created by electricity to launch field artillery projectiles without the use of explosives or propellants. As the major explained, electric fires represented long-term solutions to resolve field artillery capability gaps.[14]

Concurrently, the Fires Battle Laboratory participated in a study that examined the possibility of employing a next-generation guided hypervelocity projectile fired from a 155-millimeter howitzer to intercept an aircraft. This would require allowing a traditional field artillery platform to connect to an air defense network then fire munitions capable of air engagements. Although BAE Systems was working on developing such a munition, the Field Artillery conceded that it was a long-term effort that was still in the science and technology phase of development.[15]

Fires Azimuth 2015, therefore, outlined a broad plan to move the Field Artillery into the future. Introducing the Joint Effects Targeting System and a new long-range precision missile as well as

modifying the Army Tactical Missile System represented significant improvements over field artillery systems of 2015. However, the one shooter, one sensor, and one mission command system concept as well as electric fires and a hypervelocity 155-millimeter munition promised to revolutionize the Field Artillery by taking it into a totally new era—making a total break with 2015 systems.

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Glossary

AAA	Anti-aircraft Artillery
AAR	After Action Review/After Action Report
AC	Assistant Commandant
ACH	Annual Command History
ACR	Armored Cavalry Regiment
ACTD	Advanced Concept Technology Demonstration
ADA	Air Defense Artillery
ADP	Army Doctrinal Publication
ADRP	Army Doctrinal Reference Publication
AECP	Army Experimentation Campaign Plan
AHR	Annual Historical Review
AI	Air Interdiction
AFATDS	Advanced Field Artillery Tactical Data System
ARNG	Army National Guard
ATACMS	Army Tactical Missile System
ATP	Army Technical Publication
AUSA	Association of the United States Army
AWE	Army Warfighting Experiment
BAT	Brilliant Anti-armor Submunition
BCT	Brigade Combat Team
BDE	Brigade
BFIST	Bradley Fire Support Team
BL	Battle Laboratory
BOLC	Basic Officer Leader Course
CAC	Combined Arms Center
CALL	Center for Army Lessons Learned
CAS	Close Air Support
CB	Counterbattery
CDID	Capabilities Development and Integration Directorate
CG	Commanding General
CSA	Chief of Staff of the Army
CSM	Command Sergeant Major
DA	Department of the Army
DAC	Deputy Assistant Commandant

DARPA	Defense Advanced Research Projects Agency
DCD	Directorate of Combat Developments
DCX	Division Capstone Exercise
DIVARTY	Division Artillery
DOD	Department of Defense
DOTD	Directorate of Training and Doctrine
DOTE	Directorate of Test and Evaluation
DOTLM	Doctrine, Organization, Training, Leadership, and Materiel
DOTLMPF	Doctrine, Organization, Training, Leadership, Material, Personnel, and Facilities
DPICM	Dual-Purpose Improved Conventional Munition
DPTM	Directorate of Plans, Training, and Mobilization
DSWS	Division Support Weapon System Study
ECC	Effects Coordination Cell
ESPAWS	Enhanced Self-propelled Artillery Weapon Study
EW	Electronic Warfare
EXSUM	Executive Summary
GAO	Government Accountability Office
GMLRS	Guided Multiple Launch Rocket System
GPS	Global Positioning System
FA	Field Artillery
FATDS	Field Artillery Tactical Data Systems
FCoE	Fires Center of Excellence
FCS	Future Combat System
FECC	Fires Effects Coordination Cell
FDIC	Futures Development and Integration Center
F2C2	Future Fires Command and Control
FIST	Fire Support Team
FISTV	Fire Support Team Vehicle
FM	Field Manual
FORSCOM	Forces Command
FSCAOD	Fire Support and Combined Arms Operations Department
FSCOORD	Fire Support Coordinator
FY	Fiscal Year
HE	High Explosive
HELP	Howitzer Extended Life Program

HEMMT	Heavy Expanded Mobility Tactical Truck
HIMARS	High Mobility Artillery Rocket System
HIP	Howitzer Improvement Program
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HQDA	Headquarters, Department of the Army
HRDC	Historical Research and Document Collection
IAV	Interim Armored Vehicle/Initial Armored Vehicle
IBCT	Initial Brigade Combat Team/Interim Brigade Combat Team
ID	Infantry Division
IFSAS	Initial Fire Support Automation System
JACI	Joint and Combined Integration
JFO	Joint Fires Officer
JPSD	Joint Precision Strike Demonstration
JRTC	Joint Readiness Training Center
LCMR	Lightweight Countermortar Radar
LLDR	Lightweight Laser Designator Rangefinder
LS	Launch System
LW	Lightweight
MEF	Marine Expeditionary Force
MLRS	Multiple Launch Rocket System
MOS	Military Occupational Skill
MTT	Mobile Training Team
NATO	North Atlantic Treaty Organization
NCO	Noncommissioned Officer
NCOES	Noncommissioned Officer Education System
NET	New Equipment Training
NLOS	Non-line-of-Sight
NLOS-C	Non-line-of-Sight Cannon
NLOS-LS	Non-line-of-Sight Launch System
NTC	National Training Center
OCONUS	Outside Continental United States
ODS	Operation Desert Shield/Operation Desert Storm
OIC	Officer in Charge
OEF	Operation Enduring Freedom (Afghanistan)
OIF	Operation Iraqi Freedom
OPFOR	Opposing Force

PEO	Program Executive Office/Program Executive Officer
PGK	Precision Guidance Kit
PIM	Paladin Improvement Management
RC	Reserve Component
RAMS	Rockets and Missiles Systems
RDT&E	Research, Development, Test, and Evaluation
RGFC	Republican Guard Force Command
SADARM	Sense-and-Destroy Armor Munition
SBCT	Stryker Brigade Combat Team
SIGACTS	Significant Activities
SINCGARS	Single Channel Ground and Airborne Radio System
SITREP	Situation Report
SME	Subject Matter Expert
SPLLS	Self-Propelled Loader/Launcher
STANAG	Standardization Agreement
TAA	Total Army Analysis
TACFIRE	Tactical Fire Direction System
TAD	Towed Artillery Digitization
TCM	TRADOC Capabilities Manager
TCP	Transformation Campaign Plan
TF	Task Force
TOC	Tactical Operation Center
TPSO	Theater Precision Strike Operations
TRADOC	US Army Training and Doctrine Command
TSM	TRADOC System Manager
US	United States
USAF	United States Air Force
USAFACFS	United States Field Artillery Center and Fort Sill
USAFACS	United States Field Artillery Center and School
USAFAS	United States Army Field Artillery School
USAFCOEFS	United States Fires Center of Excellence and Fort Sill
USMC	United States Marine Corps
VCSA	Vice Chief of Staff of the Army
WIDD	Warfighting Integration and Development Directorate
XO	Executive Officer

Select Bibliography

This bibliography only contains the books and articles used to write the book. For messages, fact sheets, information papers, reports, emails, and other comparable documents, please see the notes at the end of each chapter.

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