JULY 1–3, 1863

BATTLE of GETTYSBURG

THE IMPACT of ALTERNATIVE TECHNOLOGIES ON CIVIL WAR HISTORY

RAND ARROYO BATTLEFIELD FUTURES PROGRAM

A STAFF RIDE/WARGAME EXPERIENCE

GIAN GENTILE, DAVID E. JOHNSON, YVONNE K. CRANE, D. SEAN BARNETT, JOHN GORDON IV, MARK HVIZDA, AND ADAM GIVENS
ABOUT this REPORT
THE RAND ARROYO BATTLEFIED FUTURES PROGRAM

The RAND Arroyo Battlefield Futures Program is designed to inform thinking about the future by understanding how available technologies that were not employed during battle might have affected the outcome of key past battles and campaigns at the strategic, operational, and tactical levels, and to spur thinking about the evolutionary and revolutionary technologies that such uses could have engendered. History shows that both types of technologies and their evolutionary and revolutionary processes are at play in many past battlefields and military campaigns.

There are two major components to the Arroyo Battlefield Futures Program: The first is a study of the battle or campaign by using either a virtual or actual staff ride for a given battle or campaign; the second major component is a custom-built counterfactual wargame that allows players to inject technologies that were available at the time but not used.

Although this Futures Program report is about the 1863 Battle of Gettysburg, there are many other past campaigns and battles to which the Arroyo Battlefield Futures Program can be applied.

Although this report was developed specifically in the context of the staff ride, we believe it should be of interest to any student of the Battle of Gettysburg, and also of interest to those curious about the concept of alternative military futures. Although it is not possible to entirely reconstruct that staff ride experience, this report still should prove an insightful addition to any reading of the history of the battle or even as an auxiliary companion on a visit to the battlefield park itself, where one can begin to develop an understanding of one of the most decisive battles of the U.S. Civil War that ultimately led to the freeing of American slaves, the primary war aim of the Union.
This report documents research and analysis conducted as part of a project entitled *Arroyo Battlefield Futures Program*, sponsored by Headquarters, Department of the Army G3/5/7 Strategic Operations Directorate. The purpose of this project is to inform thinking about the future by understanding how available technologies that were not employed might have affected the outcome of key past battles and campaigns at the strategic, operational, and tactical levels, and to spur thinking about the evolutionary and revolutionary technologies that such uses could have engendered.

This research was conducted within RAND Arroyo Center’s Strategy, Doctrine, and Resources Program. RAND Arroyo Center, part of the RAND Corporation, is a federally funded research and development center (FFRDC) sponsored by the United States Army.

RAND operates under a “Federal-Wide Assurance” (FWA00003425) and complies with the *Code of Federal Regulations for the Protection of Human Subjects Under United States Law* (45 CFR 46), also known as “the Common Rule,” as well as with the implementation guidance set forth in DoD Instruction 3216.02. As applicable, this compliance includes reviews and approvals by RAND’s Institutional Review Board (the Human Subjects Protection Committee) and by the U.S. Army. The views of sources utilized in this study are solely their own and do not represent the official policy or position of DoD or the U.S. Government.

**ACKNOWLEDGMENTS**

We would like to thank our two reviewers for this report, Michelle Grisé and Ty Seidule, for their most helpful suggestions for improvement. Without the vision and commitment of RAND Arroyo Center’s Sally Sleeper and Jennifer Kavanagh, this Gettysburg Futures Report never would have been completed. Finally, we dedicate this Futures Program report to our good friend and RAND Corporation colleague who passed away in 2022, David E. Johnson (Col, U.S. Army, retired), for his insights and understanding on history, theory, and the potential of the Arroyo Battlefield Futures Program.
PREFACE

For over a century, the U.S. Army has used staff rides to educate leaders on the lessons of the past to prepare them for future wars. In the words of Brigadier General Harold W. Nelson, staff rides provide an opportunity to see how leaders’ decisions influence tactical outcomes, how terrain shapes engagements, and how technology, tactics, and organization interact in a battlefield setting. Those observations, when combined with curiosity and diligence, lay the groundwork for a lifetime of professional reading and will produce officers who are mentally prepared for a warfighting role.

Gettysburg has been one of the Army’s favorite staff ride locations for decades. It was the site of perhaps the pivotal battle of the U.S. Civil War, and General George Pickett’s famous but disastrous charge marked the beginning of the end for the Confederacy. It is also a very accessible site with a richly documented history. The decisions of the leaders at this battle—and the effects of chance, friction, and the fog of war that create unexpected developments on the field—all come to life again for staff ride participants. As former Army Chief of Staff General Gordon R. Sullivan emphasized: “When we stand on a soldier’s battlefield and read his description of his fight, we gain insights that cannot be replicated in any other learning environment.”

Thus, these lessons from the past help leaders think about the future. And there are few places better than Gettysburg to immerse oneself in a battle.

While building on this appreciation for what happened in this crucial battle and why, this staff ride goes a step further. It attempts to create an alternative history by examining what could have happened if a few key technologies that were available for military use in the 1860s—observation balloons, telegraphs, Gatling guns, and repeating rifles—had been used at Gettysburg. In other words, would the outcome have been different if the Union and Confederate armies had innovated and deployed known and available technologies in the years preceding the Battle of Gettysburg?

The greatest challenges facing both sides in this battle were (1) inaccurate intelligence about the enemy’s location and disposition, given the terrain and the inadequacies of Confederate cavalry reconnaissance (Major General J. E. B. Stuart’s absence); (2) the inability to rapidly communicate information; and (3) the muzzle-loading weapons’ limited abilities to create high volumes of continuous fire. Observation balloons, telegraphs, Gatling guns, and repeating rifles could have mitigated these problems and given commanders different options in the battle.

Thus, one goal of this staff ride is to provide a deep understanding of the actual battle and then to imagine how the insertion of available technologies could have changed the outcome. The ultimate purpose of the endeavor, however, is to help Army leaders see this and future battles as problems that must be solved and to understand how available technologies, if exploited, might favorably change outcomes.
# Table of Contents

## About This Report

i

## Preface

iii

### Section One

**RAND ARROYO BATTLEFIELD FUTURES PROGRAM**

- Program Overview
  - 1
- Program Explanation
  - 4

### Section Two

**BATTLE OF GETTYSBURG—STRATEGIC OVERVIEW**

- Post–Civil War Technological Change
  - 7
- Gettysburg Campaign Overview
  - 10
- Description of Infantry, Artillery, and Cavalry
  - 13
- Biographies
  - 15
- Order of Battle
  - 22
- Weapon Specifications
  - 26

### Section Three

**BATTLE OF GETTYSBURG OVERVIEW—STAFF RIDE**

- Day Zero, June 30, 1863
  - 28
- Day One, July 1, 1863
  - 30
- Day Two, July 2, 1863
  - 33
- Day Three, July 3, 1863
  - 35

### Section Four

**ALTERNATIVE POSSIBILITIES IN THE PAST AND THE FUTURE**

- Problem 1: Situational Awareness
  - 38
- Problem 2: Command and Control
  - 46
- Problem 3: Technology and Civil War Tactics
  - 50

### Section Five

**RAND GETTYSBURG ALTERNATIVE TECHNOLOGIES WARGAME**

- Concept for Wargames
  - 57
- Potential Learning from RAND Arroyo Battlefield Futures Programs
  - 58

## Abbreviations

61

## Bibliography

63

## Endnotes

67
BATTLE of GETTYSBURG

THE IMPACT of ALTERNATIVE TECHNOLOGIES ON CIVIL WAR HISTORY

The meeting of War Plans Division, War Department General Staff, in 1942. (U.S. War Department Army)

RAND ARROYO BATTLEFIELD FUTURES PROGRAM

STAFF RIDE AND WARGAME BOOKLET
“Staff rides represent a unique and persuasive method of conveying the lessons of the past to the present-day Army leadership for current application. Properly conducted, these exercises bring to life, on the very terrain where historic encounters took place, examples . . . of leadership, tactics and strategy, communications, use of terrain, and, above all, the psychology of men in battle.

This historical study, particularly with personal reconnaissance, offers valuable opportunities to develop professional leadership and the capacity for effective use of combined arms on the air-land battlefield.”

— General John A. Wickham, Jr.

U.S. Army Chief of Staff, 1983–1987

PROGRAM OVERVIEW

The RAND Arroyo Battlefield Futures Program for the Battle of Gettysburg is designed to combine a traditional battlefield staff ride—either virtually or at the battlefield—with a RAND Corporation–developed custom-made wargame to see how unemployed technologies available at the time of the battle might have changed the outcome of a given battle or military campaign. The 1863 Battle of Gettysburg serves as the historical basis for this Arroyo Battlefield Futures Program report.

• UTILITY FOR ARMY SENIOR LEADERS

Secretary of Defense Mark Esper has noted that there are two types of futures technologies that the Army must pursue: evolutionary technology and revolutionary technology. Revolutionary technology is leap-ahead technology that might transform warfare but is not available in the near or perhaps midterm. By contrast, evolutionary-revolutionary technologies are either available now “off the shelf” or potentially acquired in the near term, and these technologies could lead from an interim solution to a revolutionary capability.

Both types hold promise for the Army, but it is difficult to know which specific technologies the Army should pursue. Doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) is therefore an important component of incorporating new technologies. History shows that both types of technologies and their evolutionary and revolutionary processes are at play.

The RAND Arroyo Battlefield Futures Program is designed to inform thinking about the future by understanding how available technologies that the Army did not exploit might have affected the outcome of key past battles.

Photo (p. vi): Department of History instructor Lt. Col. David Siry explains the history at Little Round Top during a Gettysburg Staff Ride in 2014. (U.S. Army)
THE ARMY HAS DONE THIS BEFORE: STUDY OF THE 1973 YOM KIPPUR WAR

In the wake of the 1973 Yom Kippur War between Israel and several Arab states, the U.S. Army comprehensively studied the conflict to learn how to fight when outnumbered and win against Soviet forces and equipment to defend the North Atlantic Treaty Organization. The questions were particularly salient in the post-Vietnam War environment. The intense review, which included staff rides and technical studies and analyses, led to evolutionary and revolutionary changes in doctrine (seen in Army Field Manual 100-5, revised in 1976, 1982, and 1986); organization (including the Division 86 organizational and operational concept); training (most notably in “How to Fight” and the combat training centers); materiel (above all, the “Big 5” acquisition programs and the Tactical Fire Direction System automation and computers); leader development (giving rise to the Noncommissioned Officer Education System, centralized command boards, and command lengths); personnel (the change from a draftee to an all-volunteer Army); facilities (such as ranges and simulators to accommodate new weapons); and policy (from preparing for monolithic communism to the Soviet Union as the named threat).3

It was with consistent leadership support from General William DePuy (far left), the first commander of U.S. Army Training and Doctrine Command, from 1973–1977, and his successor, General Donn Starry (left), from 1977–1981, that these advances were made.4
The Confederate and Union armies mirrored one another in a variety of ways. Both used the same doctrine and technology: Doctrine was drill-based, and the principal technologies were rifled muskets and cannons. Moreover, the vast majority of soldiers in both armies were amateurs when the war began. By 1863, however, they had improved significantly at the tactical level. The problem was command coordination at higher levels. The results of these armies’ inability to gain an advantage over one another in a decisive battle were symmetry and slaughter. Even at the Battle of Fredericksburg, which the South won, both sides incurred significant casualties. The same carnage occurred at Gettysburg, although the result in that event was a Union victory.5

Until the waning years of the Civil War, there was an inability on both sides (1) to combine arms to the levels of the Napoleonic Wars to produce asymmetric effects or (2) to consider the war as a campaign, which General Ulysses S. Grant did when he became the commanding general of the U.S. Army.6
PROGRAM EXPLANATION

The staff ride is broken up into two days: what happened and what might have happened.

On day one, participants will learn what happened in the battle through a traditional staff ride. The focus on historical events and actions that occurred in the three-day battle is crucial knowledge for the counterfactual study on the second day. Specific events and phases from the battle will be selected, and technologies that existed but were not used will be applied. The objective is to understand how these technologies might have significantly affected the outcome at Gettysburg. The technologies include observation balloons (for intelligence, surveillance, and reconnaissance [ISR]), point-to-point telegraphs down to division levels (for command and control [C2]), and such rapid-fire weapons as repeating rifles and the Gatling gun (fires). Counterfactually speaking, on the basis of their utility, each of these selected technologies could have driven revolutionary change: The observation balloon transitioned to aircraft, the telegraph to radio, and the Gatling gun to machine gun.

Participants will then test the effectiveness of selected technologies by applying them in a revised battle plan using a RAND-developed wargame.

* WARGAMES TO EVALUATE ALTERNATIVE TECHNOLOGIES

To help staff ride participants understand how the alternative technologies considered might have affected the outcome of the Battle of Gettysburg, RAND will use a live wargame during which the Union and Confederate armies will be equipped with supplementary technologies. The players will be free to conduct operations with them as they see fit. The wargame will build on the discussions that took place during the staff ride the day before. Players will explore the benefits and limitations of the technologies in a game that will quantify those technologies’ effects along with the effects of the other military capabilities possessed by the two armies.

One might use a tool, such as an engineering model or simulation, to evaluate the benefits of a new military technology. Alternatively, however, the advantage of using a wargame is that it allows the free play of human analysts in the full context of the battle. The analysts can adapt their operations and tactics to take best advantage of the capabilities that the technologies provide. The analysts also will consider how their opponents might adapt to mitigate the effects of the technologies, and the ways in which those technologies can be used against them. RAND frequently uses wargames to assess the potential benefits of alternative military weapon systems, force structures, and operational concepts. This game will allow the players to do the same for these technologies in the context of the Gettysburg battle.
The RAND Arroyo Center Futures Program is an immersive experience that will educate Army senior leaders and civilian partners in a variety of ways. By using history and counterfactuals, leaders will be able to think through a problem posed in a past battle whose results are known. Participants will understand the effects of the introduction of available technologies that were not employed in the battle, such as ISR, C2, and rapid-firing weapons. The result is appreciating the DOTMLPF—Policy (DOTMLPF-P) implications of the introduction of these technologies and imagining how these technologies could have evolved or served to speed a revolution, such as that from observation balloons to breechloading and repeating rifles to telegraph lines and Gatling guns.

Ultimately, the RAND Arroyo Center Futures Program will provide a vicarious experience that is transferable to existing Army modernization efforts.
Union soldiers defend against Pickett’s charge at the Bloody Angle.

POST–CIVIL WAR TECHNOLOGICAL CHANGE

The Civil War was a lesson in how technologies can affect the outcome of battles and wars. The mass-produced rifle meant that countries could arm a force based on the French levée en masse, or mass national conscription. As they did in civilian life, railroads and steamships shrunk space and time, allowing commanders to shuttle troops across vast distances and then supply them. The telegraph’s ability to transfer information rapidly gave an army a strategic advantage, although any kind of tactical advantages would not come about until the advent of the radio in the early 20th century. Still, at higher echelons between senior ground commanders and their political chiefs, the telegraph allowed civilian leaders to communicate with officers, regardless of whether the military welcomed the additional degree of management.8

Despite technological advances, the Union and Confederate armies continued using the linear tactics of the previous century: Infantry was the fundamental combat arm, and the line of battle was its primary formation. Historians have debated how to periodize the Civil War, either as the last show of the Napoleonic era or the dress rehearsal for the first modern war.9 Why did the Union and Confederate armies continue to use massed infantry at near point-blank range in a bid to wage decisive combat?

Technology dictated tactics as it had at the beginning of the 19th century. The rifled musket was an improvement over the smoothbore that it replaced, but it still lacked the range and accuracy to supplant the use of linear tactics with a new approach. In lengthy engagements, black powder obscured the field, making it important to close with the enemy and bring firepower to bear. Moreover, for units to communicate while operating, it was necessary to keep fighting formations close to one another to overcome the smoke and noise. Linear tactics, therefore, were not obsolete for the era. At least at first, relative to Napoleonic armies of the early 19th century who also used linear tactics, the Union and Confederate armies were amateurish. With experience, however, both became more professional in the latter years of the Civil War.10

The profound changes in technology after the Civil War built on and improved the advances made mid-century. The Second Industrial Revolution had the most profound effect on the evolution of technology during the 50 years leading up to World War I. The volume, range, and accuracy of fires was increased, as were the abilities to maneuver and communicate. As in the decades leading up to the Civil War, however, military conservatism, insufficient funds, and an aversion to a large standing force stunted the Army’s technical development in the latter half of the 19th century.
For some U.S. and European military leaders, there was a lack of appreciation for how new technologies were changing the character of war, owing mostly to the lack of a major conflict during the era in which the advances could have been demonstrated.11

In artillery, European technical expertise outpaced that of the United States. Breechloading artillery pieces that used smokeless powder outshined the Napoleonic-era cannon used during the Civil War. Europeans also devised explosive shells, recoil-absorbing devices, and complex sighting mechanisms. Not completely left behind, the U.S. Army did adopt its first rifled breechloading field gun made of steel, but it still used black powder.12

Small arms development fared somewhat better. In the immediate years after the war, the Ordnance Department converted Springfield muzzleloaders to breechloaders as a short-term and cheap solution to the demands of an evolving way of warfare. In 1872, the Army convened a board that analyzed more than 100 weapons as a replacement for the muzzleloader. This led to the adoption of the Model 1873 Springfield, a trapdoor single-shot breechloader that fired a .45–70-caliber, 405-grain cartridge, a weapon that remained in service for the next 20 years. When smokeless powder was made available in the United States, improving velocity and range, the Army adopted the .30-caliber Krag-Jörgensen rifle in 1892. It was a leap forward with its bolt-action and box magazine, but it proved to be an inferior weapon against the German Mauser Model 1893, which the U.S. Army faced in the Spanish-American War. Given that the Mauser was faster-firing, more accurate, and more powerful than the Krag, it spurred the Army to adopt the Model 1903 Springfield, the service rifle that the United States would use in World War I and beyond. The U.S. Army was similarly slow in adopting machine gun technology. The Gatling gun was available during the Civil War, but military thinkers never considered it to be an infantry weapon. By the latter half of the 19th century, designers had found ways to make weapons gas-operated, which led to crew-served, belt-fed weapons, such as the Colt-Browning Model 1895, which the Army possessed but never formally adopted. The concepts that the Model 1895 proved led to more advances on the eve of World War I. The pace of advances in automatic weapon technology quickened, from the water-cooled Vickers and Browning Model 1917 to the Lewis Machine Gun and Browning Automatic Rifle. The U.S. Army, however, would not formally adopt a machine gun until the country’s entry into World War I in 1917.13

There was considerable progress in communication and transportation, owing mostly to civilian technology. The advances in signals made during the Civil War continued afterward. The Signal Corps developed a flying telegraph train that used batteries and insulated wire. It also built lines across the East Coast in 1873 before constructing a telegraph system that extended more than 5,000 miles.
across the Southwest and Northwest. Building on Alexander Graham Bell’s invention of the telephone, the Army developed a field-telephone kit, which used the Bell telephone, a Morse key, and a battery. In transportation, the extension of the trans-Mississippi railroads made it somewhat easier for the post–Civil War U.S. Army to operate across the great expanses of the frontier. Developments in flight were likewise of great significance in the coming century. The Signal Corps had experimented with balloons during the Civil War and reintroduced the technology in the 1890s. This served as the foundations for the Army’s 20th-century aviation program. The first military aircraft was the 1909 Wright Military Flyer, an improved version of the first airplane to prove the possibility of heavier-than-air powered flight. During World War I, aircraft design would make quantum leaps, transforming the battlefield into a three-dimensional space.14
GETTYSBURG CAMPAIGN OVERVIEW

By the early summer of 1863, the Civil War had raged for two years. Soldiers of the ANV were in good spirits as Lee led them north to launch a second invasion of the Union, made confident by a stunning victory at Chancellorsville in early May. Lee pushed into enemy territory for two reasons. First, he needed to leave exhausted and devastated Virginia behind for bountiful Pennsylvania farmland that would easily support an army because his was running critically low on food and supplies. Second, once in the North, Lee could maneuver easily, sowing chaos and disorder and threatening major cities, such as Philadelphia, Baltimore, and Washington. He gauged that political pressure was increasing on U.S. President Abraham Lincoln, and an offensive into the North’s heartland could compel peace talks. Lee believed that, by luring the Union Army into battle at a time and on ground of his own choosing, he could secure the decisive victory that would end the war favorably for the Confederate States of America and thus protect and maintain the institution of slavery. He could not afford to wait, either. The Union’s naval blockade and fighting in the Western Theater were exhausting the South. It was also clear that, despite its losses on the battlefield, the AoP remained formidable and was likely to launch a new offensive soon.15

The United States faced an imposing enemy. Lee commanded a self-assured army with veteran regiments recently strengthened by conscripts and bolstered by untrained regiments. In the two months between Chancellorsville and Gettysburg, Lee reorganized his army into three infantry corps commanded by LTG James Longstreet, LTG Richard Ewell, and LTG Ambrose Powell “A. P.” Hill. Each corps had three divisions, and each division between three to five brigades. Along with MG J. E. B. Stuart’s oversized cavalry division, Lee also had infantry divisions with a battalion of artillery each. The reorganization produced a flexible ANV, but it also shuffled senior leaders to new commands. New habits and personalities were introduced, and freshly promoted officers would need to prove themselves. The AoP, by contrast, was a more stable army than it had been in the war’s first two years. Still, its leadership was divided by backbiting and a series of defeats. Moreover, its commanding officer, MG Joe Hooker, had been recently embarrassed at Chancellorsville by an audacious Lee.16

Lee devised only a very rough plan—rather than a detailed scheme—for his coming offensive. Lee’s ANV would strike out from Fredericksburg over the Blue Ridge Mountains and travel north through the Shenandoah Valley, using the mountains as a shield from the prying eyes of Union observers. Crossing the Potomac, Lee planned to aim for Hagerstown, Maryland, and advance through the Cumberland Valley, likely meeting only token resistance all the way to Harrisburg, Pennsylvania. The long trek north began in early June as divisions slipped away from Fredericksburg. Once Union forces understood the enemy was on the move in the Shenandoah Valley, they too headed north, still unclear of Lee’s intentions. Hooker was to locate and defeat Lee’s army, but principally, the AoP was to ensure that he stood between the enemy and Washington and Baltimore. Union cavalry searching for the Confederates ran headlong into a stunned Stuart at Brandy Station, Virginia, on June 10, and triggered the largest cavalry fight in U.S. history. By June 28, Lee’s forces were entering Pennsylvania while
Stuart raided to the east. Tangling with Union cavalry, Stuart could provide Lee with little information on the AoP. By contrast, Hooker’s scouts north of the Potomac and Bureau of Military Information informants provided the Union army with invaluable reports on Lee’s force and direction of movement. At that point, the AoP underwent another change of command. By late June 1863, detractors inside Hooker’s command were severely eroding his authority. Relations with Washington leadership became further strained when he demanded more reinforcements—despite already outnumbering Lee’s army—and threatened his resignation if he did not receive them. Three days before the battle at Gettysburg began, Lincoln obliged Hooker, appointing Major General George Meade as commanding general of the AoP.17

While Lee’s infantry marched across Pennsylvania, J. E. B. Stuart was still south of the Potomac attempting to save face after Brandy Station by launching a self-directed offensive toward the east. Stuart’s cavalry harassed Union forces moving north and inflicted minor damage on railroads instead of executing its principal mission of relaying crucial intelligence back to the main Confederate force in Pennsylvania. By the end of June, Lee ordered his army to converge on Cashtown, near Gettysburg. Union cavalry under Buford, ordered by Hooker as one of his last command acts to reconnoiter Gettysburg, first encountered Confederate forces on June 30. Brigadier General James Pettigrew’s North Carolina brigade was en route from Cashtown to Gettysburg, looking for supplies and conducting reconnaissance of the area in the absence of Stuart’s cavalry. Pettigrew’s division commander, Heth, and the corps commander, A. P. Hill, did not trust that the inexperienced Pettigrew understood what he had encountered. They, like Lee, believed that the AoP was farther south than it actually was. Armed with excellent information, Meade and his generals knew that most of the Confederate Army was marching in the direction of Gettysburg. The new commanding officer ordered his forces to do the same.18
Soldiers from the Union’s 93rd Pennsylvania Infantry a few months before the Gettysburg Campaign.
DESCRIPTION OF INFANTRY, ARTILLERY, AND CAVALRY

INFANTRY

Generally speaking, the infantry of both armies assumed the leading role in much of the fighting during the Civil War. The principal weapons for Civil War foot soldiers were single-shot muzzleloading rifles. The Union Army most commonly used the Springfield Model 1861, while the Confederacy fielded the Pattern 1853 Enfield. Although these weapons fired the innovative Minié ball out to 500–600 yards, the average infantry engagement range during Civil War battles was approximately 130 yards. Even this was a wide gulf for most smoothbore infantry weapons of the Napoleonic era, which could fire accurately only to 50–75 yards. Infantry formations employed modified linear tactics that had been developed by the professional armies of Europe over the previous 150 years. Men were grouped together into formations to mass and control both fire and movement, receiving orders over the cacophony of battle from officers primarily through drums and bugles.

At the start of the Civil War, neither the Union nor Confederate infantry units could be considered professional armies. By 1861, the U.S. Army in its entirety numbered roughly 15,000 enlisted men and officers. In the North, militiamen rushed into federal service, and by summer 1861, the Union Army was made up of nearly a half million volunteers in state-formed regiments while the Confederacy attempted to amass an army of roughly the same number through voluntarism and conscription. As the war dragged on, battlefield casualties and the loss of men after their enlistments expired continually drained the armies of experienced men. Training therefore became paramount as both sides attempted to mold raw recruits into infantry units capable of receiving and executing commands under fire. Although sizes varied between armies, the organizations were similar. The infantry regiment was the basic maneuver unit, led by a colonel and composed of an authorized strength of about 1,000 soldiers. However, most regiments started off with fewer men, usually around 600, and after a few engagements or battles were reduced to about half that amount. Indeed, the average-sized infantry regiment from both sides at Gettysburg was around 300 men. Three to five regiments generally made up a brigade, two or more brigades typically formed a division, and two or more divisions formed a corps.

ARTILLERY

During the Civil War, artillery was crucial to both the Union and Confederate ways of battle. Although the U.S. Army had built a reputation during the Mexican-American War (1846–1848) for its use of artillery, that capability had eroded in the intervening period. Combat experience for the Union and Confederate armies, however, quickly shaped their artillery units into proficient and intimidating forces. This was aided by additional guns and organizational expansions over time that turned the units into nearly independent commands. By the Battle of Gettysburg, each of the Union’s seven corps had an artillery brigade attached, and each of Lee’s divisions had an artillery battalion. Both armies typically used two types of artillery: the traditional smoothbore cannon and the rifled guns that spun projectiles to increase range and accuracy. The principal task of artillery in the Civil War was to break the enemy’s line or to prevent the opponent from forming in the first place. With their rifled guns, artillerists employed four different types of ammunition and methods to achieve these ends. First, they used solid shot. Smoothbore cannons fired solid cannonballs,
which were often aimed at the ground in front of approaching lines of infantry so that they would ricochet into the formations. Rifled cannon could fire solid bolts, cylindrical projectiles that were used to destroy buildings or fortifications. Artillery units also used shells that could be timed to explode over the heads of infantry formations to knock holes in the lines and force dispersion. At close range, gun crews resorted to using canister, a tin can filled with lead slugs that created a devastating 32-foot wide swath of destruction at 100 yards. The final ammunition type was a spherical case-shell, which essentially served as long-range canister shot. The physical and emotional damage done by Civil War artillery could be nightmarish. Those targeted had no alternative but to endure the fire and press on. The nerve-wracking mental toll caused by these guns was enhanced by the fact that projectiles often traveled slowly enough to be seen by those within 1,000 yards of the artillery pieces.22

**CAVALRY**

Cavalry in the Civil War looked and operated somewhat differently from Europe’s offensively minded mounted shock troops, who charged at enemy formations to break them. Heavy cavalry had not been a large part of the American military tradition, given the costs, the country’s heavily forested terrain, and the country’s aversion to standing professional armies. Civil War cavalry generally was a flexible force that supported the infantry and artillery. Both Union and Confederate cavalry typically were armed with six-shot revolvers, carbines, and sabers. The Union and Confederacy both used their light cavalry for reconnaissance and counter-reconnaissance, as a screening force to protect larger bodies of troops, for foraging operations, and as a pursuit and raiding force to harass enemy rear areas and destroy lines of communication. By the middle of the Civil War, Union and Confederate cavalry were also employed as Dragoons—mounted infantry who used the mobility of their horses to reach the battle area, then fought on foot.

Given the time and cost involved and unclear roles, both the Union and Confederacy at first struggled to mold recruits for a capable mounted arm, and the early cavalry were not always used to best effect by commanders. For much of the early part of the war, Confederate cavalry units, such as those led by J. E. B. Stuart, were often more capable than their Union counterparts. By 1863, however, the Union had evolved its mounted arm into an aggressive force in its own right, a formidable threat to the Confederacy. The principal innovation was the creation of mounted infantry, a hybrid force of cavalrynaman who could dismount to fight enemy infantry defensively with repeating arms, like Buford’s 1st Cavalry Division at Gettysburg.23
**BIographies**

**Army of the Potomac**

The military leaders of the AoP fought to maintain the constitutional integrity of the United States of America and ultimately to end slavery.

**Major General George G. Meade (1815–1872)**—Union general in command of the AoP during the Battle of Gettysburg. The son of a wealthy Philadelphia merchant, he graduated 19th of 56 in his class at West Point. Meade commissioned in the artillery and served in the Second Seminole War and then later in the Mexican-American War. On the battlefield, his quick temper and sprightliness, combined with his penchant to lead from the front, contributed to two severe wounds. Fellow officers respected him for his sharp mind and modesty, but when he took command of the AoP only days before the Battle of Gettysburg began, he was an unremarkable figure in person and a virtual unknown by reputation to the rank and file. Meade was critiqued at the time for his seeming cautiousness while commanding the AoP. He succumbed to pneumonia at 56 years old while still in uniform.24

![George G. Meade](Library of Congress)

**Brigadier General John Buford (1826–1863)**—Commanding general of the Union 1st Cavalry Division. Descended from a long line of soldiers, Buford graduated 16th in a West Point class of 38 and served for a decade in the cavalry on the frontier before the Civil War. Considered one of the best intelligence-gatherers in the AoP, Buford was respected by his peers and men alike for his leadership, bravery, and ability to analyze and understand situations quickly. With an innovative mind, Buford saw the role of the cavalry as an intelligence-gathering force as well as mounted infantry. It was Buford’s intuition that set the battlefield at Gettysburg. Knowing he was facing a numerically superior force and understanding the tactical importance of holding the high ground south of town, his initial defense along Chambersburg Pike bought the AoP precious time while he held back the lead elements of the ANV. He died in Washington only five months after the Battle of Gettysburg.25

![John Buford](National Photographic Art Gallery, Library of Congress)

**Major General Winfield Scott Hancock (1824–1886)**—A Union corps commander from Pennsylvania, Hancock graduated 18th in a West Point class of 24 and served in the infantry during the Mexican-American War. When the Civil War broke out, he earned a promotion to brigadier general and command of an infantry brigade. Courageous under fire, his initiative during the Peninsula Campaign in 1862 earned him the moniker “Superb” Hancock. His actions at Antietam, Fredericksburg, and Chancellorsville won him a corps command at Gettysburg after Major General John F. Reynolds was killed early on the first day of battle. At the center of the Union line on Cemetery Ridge, his quick thinking and fearlessness helped rally defenses that plugged critical gaps and stabilized the line on Day Two. Still at the center on Day Three, he led the Union forces that faced the main thrust of Pickett’s Charge. Rallying his men from horseback, Hancock was gravely wounded but refused evacuation, the effects of which he endured the rest of his life. An unsuccessful bid for the American presidency as a Democrat saw him lose narrowly to Republican James A. Garfield in 1880.26

![Winfield Scott Hancock](U.S. National Archives and Records Administration)
MAJOR GENERAL JOHN F. REYNOLDS (1820–1863)—Born and raised only 60 miles from Gettysburg in Lancaster, Pennsylvania, Reynolds ranked 26th in his class of 52 students at West Point. Following his service in the Mexican-American War, assignments in the South and West preceded his post as Commandant of Cadets at West Point in 1859. At the start of the Civil War, he led the Fourteenth Infantry and went on to become the military governor of Fredericksburg. By early 1863, he succeeded Hooker as commander of First Corps of the AoP. In the weeks leading up to Gettysburg, he commanded the left wing of the AoP, including the First, Third, and Eleventh Corps, with Buford’s cavalry division as a screening force. Rushing to the sound of gunfire at Gettysburg and arriving around 10 am, he found Buford’s dismounted cavalry delaying the enemy. Determined to fight the enemy “inch by inch” for the town, Reynolds threw First Corps into the fight and called for the Eleventh to rush forward. While sitting in his saddle organizing his men, a Confederate round struck Reynolds in the back of the head. Falling to the ground, he died in the arms of his staff within seconds. A reserved man with a taciturn style, his men and peers respected him. By 1863, Reynolds was the longest-serving Corps commander in the AoP. That experience was reinforced by a surplus of confidence and aggression. He would be the highest-ranking officer to fall on either side during the battle.27

MAJOR GENERAL DANIEL E. SICKLES (1819–1914)—Union Third Corps commander. A New York lawyer and politician, Sickles used his rank in the New York militia and his political connections to raise volunteer units and earn a promotion to brigadier general at the war’s start. A controversial character who generated tabloid-worthy political and personal scandals, his close relationship with newly fired AoP commander MG Joseph Hooker and his status as a political rather than professional general made Sickles a divisive figure. On Day Two, Meade ordered Sickles to defend the southernmost position of the Union line between Cemetery Ridge and the rising slopes of Little Round Top. Believing this low area made his Third Corps vulnerable, Sickles disobeyed the order and moved 1,500 yards west to moderately higher ground, causing a dangerous bulge in the Union lines. In the ensuing Confederate attack, Sickles lost most of his corps as well as a leg after being wounded by a cannonball, an appendage he donated to the Army Medical Museum and visited annually on the anniversary of his wounding.28
COLONEL JOSHUA L. CHAMBERLAIN (1828–1914)—Union commander of the 20th Maine Volunteer Infantry Regiment. A professor of modern languages (he was fluent in nine) at Bowdoin College in Maine before the war, at 34 years old, Chamberlain volunteered to join the newly raised 20th Maine. At Gettysburg, Colonel Chamberlain rushed to Little Round Top on the extreme left of the AoP with orders to hold the ground at all costs, just as a large force, led by the ANV’s MG Hood, crashed into Union lines. After surviving multiple attacks and with ammunition nearly exhausted, Chamberlain led the 20th in a downhill bayonet charge that saved the vulnerable flank, an action for which he received the Medal of Honor. For the rest of the war, Chamberlain commanded a brigade of the Fifth Corps with distinction, suffered wounds six separate times, and as an MG accepted the Confederate surrender of arms at Appomattox. Following a short career in politics, he returned to Bowdoin as president and then pursued various jobs in law and business. He died at 85 years old from complications of a war wound.39

BRIGADIER GENERAL HENRY J. HUNT (1819–1889)—The AoP’s Chief of Artillery. From a family with a lineage of service in the U.S. Army, Hunt graduated 19th in a class of 31 at West Point in 1839, fought in the Mexican-American War, and then later fought on the frontier. Just before the Civil War, he helped to revise artillery tactics and develop a guide that both armies would use. By the time of the Gettysburg campaign, the outspoken Hunt was an expert at surveying ground, deploying artillery in the best positions possible, and preparing guns for battle. Hunt’s decisions were key to helping the AoP beat back Pickett’s Charge on Day Three as he recognized Confederate preparations for the ensuing attack. Following Gettysburg, he was breveted major general in the volunteers and later in the regular Army, and he was placed in charge of siege operations during the Petersburg Campaign. Surviving the war, he remained in the Army until 1883, when he retired.30

BRIGADIER GENERAL GOVERNEUR K. WARREN (1830–1882)—Chief engineer of the AoP. Graduating second in a West Point class of 44, the New Yorker commissioned as an engineer and spent the decade before the Civil War surveying and mapping the West. An instructor at West Point when the war began, he helped to raise the 5th New York Infantry Regiment, rising to the rank of brigadier general and becoming the AoP’s chief engineer by the start of the Gettysburg campaign. On Day Two, recognizing that the left flank of the Union army was critically vulnerable after Sickles had advanced his corps far ahead of the Union line, Warren single-handedly organized a hasty defense of Little Round Top. On his own authority, he diverted two brigades and rushed them to the hill in a successful bid to secure the extreme left of the Union line, suffering a wound in the process. For his actions, he was given command of Second Corps. His valor and initiative on Little Round Top were overshadowed the rest of his life because he was hounded by charges from more-aggressive officers that he was too cautious on the battlefield in later campaigns. In protest, Warren resigned his commission as major general of volunteers and spent the rest of his life defending his command decisions.31
SECTION TWO: BATTLE OF GETTYSBURG—STRATEGIC OVERVIEW

ARMY OF NORTHERN VIRGINIA

The military leaders of the ANV fought to protect and maintain the institution of slavery. The notion that these men fought primarily for states’ rights is a myth that was constructed during the immediate years after the South lost the war and enslaved Americans were set free.

GENERAL ROBERT E. LEE (1807–1870)—Commander of the Confederate States Army. A son of Virginia as well as of Revolutionary War hero Henry “Light Horse Harry” Lee III, Robert graduated from West Point without any demerits (although six other members of his class of 46 also graduated with zero demerits) and second in the class of 1829. Compiling an impressive career as an engineer in the 1830s, he came to notoriety during the Mexican-American War as a member of Winfield Scott’s staff and later captured John Brown during the 1859 Harpers Ferry Raid. Faced with the dilemma of choosing to fight for the North or South—a choice most other Southern officers who joined the Confederacy from the U.S. military faced as well—Lee chose to fight for the South to protect and maintain the institution of slavery. Taking control of the ANV in June 1862, Lee’s bold tactics and command decisions contributed to an impressive string of Confederate campaign victories against the Union army. Lee’s decisions at Gettysburg cost the Confederacy early in manpower and ultimately caused great strategic harm. A Southern icon, his bravery, humility, and devotion to his soldiers helped to keep morale high in the ANV despite defeats later in the war. Following his surrender at Appomattox in April 1865, the war effort essentially ended. After the war, Lee became president of Washington College in October 1865, and remained there until his death five years later.33

MAJOR GENERAL JAMES EWELL BROWN “J.E.B” STUART (1833–1864)—Commander of all cavalry in the ANV. From a Virginia family with a military heritage, Stuart graduated 13th in his West Point class of 47 cadets. A skilled horseman, his first assignment was in Texas with the U.S. Regiment of Mounted Riflemen, and he spent much of his first five years in the U.S. Army as a second lieutenant in the Kansas Territory. He resigned his commission and joined the Confederate States Army after Virginia seceded from the Union, seeing service to his state—regardless of its pro-slavery stance—as an act of honor. The choice created mutual disdain between Stuart and his father-in-law, fellow Virginian General Philip St. George Cooke, who remained with the Union Army. Stuart came to be Lee’s most trusted cavalry commander and intelligence-gatherer, and his audacious exploits as a skirmisher and raider gained him notoriety throughout the country. It was his initial absence from the Battle of Gettysburg that makes up his lasting legacy, however, because Stuart’s lengthy detour to link up with advancing Confederate forces before the battle impaired Lee; the absence of cavalry left the Confederate Army blind and without a screening force. Stuart did not survive the war, succumbing to a gunshot suffered at the Battle of Yellow Tavern in May 1864.34
LIEUTENANT GENERAL JAMES “PETE” LONGSTREET (1821–1904)—
Confederate I Corps commander. Raised in South Carolina and Georgia, he graduated near the bottom of his West Point class of 1842. Following service in the Mexican-American War, Longstreet fought in the Texas-Indian Wars in Texas. Resigning his commission in June 1861, he joined the Confederate Army and quickly rose to division command. Known for his composure under fire and sensible command decisions, Longstreet was a leader who soon established himself as Lee’s most trusted subordinate. Longstreet’s men bore the brunt of the fighting on Days Two and Three at Gettysburg, and his actions and disagreements with Lee during the battle have long invited controversy. Delayed in attacking the Union left flank early on Day Two as planned because Longstreet elected to wait for McLaws’ brigade, and again on the morning of Day Three, Lee was frustrated by Longstreet’s apparent lack of preparation and cooperation. Lee instead decided to order a massive assault on the Union center, Pickett’s Charge. Longstreet openly disagreed with the order and prepared for the attack lethargically. Although he served with distinction for the rest of the war and suffered a serious wound from friendly fire at the Battle of the Wilderness, Longstreet was dogged by postwar criticism for his actions at Gettysburg. He earned even more invectives from his former Confederate comrades after he worked for the U.S. government during Reconstruction, joined the Republican Party, and publicly criticized Lee’s command decisions.35

LIEUTENANT GENERAL AMBROSE POWELL “A.P.” HILL (1825–1865)—
Commander of the III Corps of the ANV. Born to a prominent Virginia family, Hill was a talented officer but given to bouts of unpredictability. He graduated 15th out of 38 students in his West Point class after being forced to repeat his third year because of complications from gonorrhea. He served in the Mexican-American War and the Seminole Wars before resigning as a first lieutenant and commissioning as a colonel in the Confederate army, choosing, in effect, to defend the institution of slavery even though he did not outwardly support it. Beloved by his men, who called him “Little Powell,” Hill was known to wear a bright red shirt into battle. At Gettysburg, he initiated the battle as III Corps commander but was then largely a non-factor owing to lingering effects of his gonorrhea. His troops were used throughout the battle, however, suffering the most casualties of all three infantry corps in the ANV. For the rest of the war, he was intermittently on sick leave. A Union straggler shot and killed Hill on April 2, 1865, when he was on his way to rejoin his corps at Petersburg.36
LIEUTENANT GENERAL RICHARD “DICK” S. EWELL (1817–1872)—
Commander of the Confederate II Corps. Grandson of the first U.S. secretary of the Navy, Ewell was born in 1817 and raised on an estate near Manassas, Virginia. After graduating 13th of 42 in his class at West Point, he served with distinction on the frontier and during the Mexican-American War. Ewell was known for his foul language as much as his fighting, and his bravery under fire, modesty, and sense of humor made him popular. Despite his talents, he was high-strung and had a penchant for losing his temper under fire. Compelled by his Virginia roots and pro-slavery stance, he entered the Confederate army as a colonel and quickly earned a promotion to brigadier general. At the Second Battle of Bull Run, he lost his right leg, an injury that necessitated him being strapped to his saddle thereafter. His performance at Gettysburg as II Corps commander has garnered criticism. On the first day of the battle, he pushed the Union Eleventh and First Corps back through town and to Cemetery Hill, where he then stopped, deciding against an assault after Lee’s order to take the position “if practicable.”37 His caution subsequently resulted in heavy losses for his corps when he attacked the reinforced Union positions on Days Two and Three. In poor health, his performances at the battles at Wilderness and Spotsylvania led to Lee reassigning him to Richmond’s defense. He resided in Tennessee as a farmer until his death in 1872.38

LIEUTENANT COLONEL WALLER TAZEWELL PATTON (1835–1863)—
Commander of the Confederate 7th Virginia Infantry Regiment. Born to a prominent Virginia family (the great uncle of George S. Patton), he graduated from Virginia Military Institute in 1855, second in a class of 16. He became assistant professor of language and an instructor of tactics at the school where he had already taught as a student and served as an acting assistant professor of Latin for two years before the Civil War. Afterward, he became an attorney in Virginia and the commander of a volunteer militia unit. He was commissioned as a captain in the Confederate Army on April 17, 1861, rising to the rank of lieutenant colonel by the time of the Second Battle of Bull Run, where he was wounded in the hand. While recuperating at his home, Patton was elected to the Virginia State Senate, but he chose to remain in the Confederate Army. At Gettysburg, he commanded the 7th Virginia, part of Kemper’s brigade of Pickett’s division. He was mortally wounded during Pickett’s Charge and died in a Union hospital in Gettysburg on July 21, 1863.39
(Edwin Forbes, "Officers' Winter Quarters," Thirty Years After: An Artist's Story of the Great War, New York Public Library Digital Collections, 1868.)
### Section Two: Battle of Gettysburg — Strategic Overview

**Order of Battle — Army of the Potomac**

#### Organization Overview

<table>
<thead>
<tr>
<th>Unit</th>
<th>Number of Units</th>
<th>Subordinate Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Army</td>
<td>1</td>
<td>8 corps per army</td>
</tr>
<tr>
<td>Corps</td>
<td>7 infantry, 1 cavalry</td>
<td>2-3 divisions per corps</td>
</tr>
<tr>
<td>Division</td>
<td>19 infantry, 3 cavalry</td>
<td>2-4 brigades per division</td>
</tr>
<tr>
<td>Brigade</td>
<td>49 infantry, 9 cavalry</td>
<td>4-5 regiments per brigade</td>
</tr>
<tr>
<td>Regiment</td>
<td>247 infantry, 33 cavalry</td>
<td>—</td>
</tr>
</tbody>
</table>

#### Gettysburg — July 1863

<table>
<thead>
<tr>
<th>Corps</th>
<th>Units</th>
<th>Officers</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Corps</td>
<td>x5 ARTY Btry</td>
<td>Reynolds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wadsworth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.701</td>
</tr>
<tr>
<td>II Corps</td>
<td>x5 ARTY Btry</td>
<td>Hancock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.320</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.588</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.643</td>
</tr>
<tr>
<td>III Corps</td>
<td>x5 ARTY Btry</td>
<td>Sickles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.094</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.924</td>
</tr>
<tr>
<td>V Corps</td>
<td>x5 ARTY Btry</td>
<td>Sykes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.418</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.020</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.862</td>
</tr>
</tbody>
</table>

Note: ARTY = artillery; BDE = brigade; Btry = battery; Div = division.
## FORMATION

<table>
<thead>
<tr>
<th>Formation</th>
<th>Guns</th>
<th>Personnel</th>
<th>Losses(%)</th>
<th>Symboleg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Army Headquarters</td>
<td>—</td>
<td>1,529 (4 staff)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Corps Reynolds</td>
<td>28</td>
<td>12,220</td>
<td>49.6</td>
<td></td>
</tr>
<tr>
<td>II Corps Hancock</td>
<td>28</td>
<td>11,226</td>
<td>38.9</td>
<td></td>
</tr>
<tr>
<td>III Corps Sickles</td>
<td>30</td>
<td>10,674</td>
<td>39.5</td>
<td></td>
</tr>
<tr>
<td>V Corps Sykes</td>
<td>26</td>
<td>10,926</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>VI Corps Sedgwick</td>
<td>48</td>
<td>14,074</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>XI Corps Howard</td>
<td>26</td>
<td>9,242</td>
<td>41.2</td>
<td></td>
</tr>
<tr>
<td>XII Corps Slocum</td>
<td>20</td>
<td>9,788</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Cavalry Corps Pleasonton</td>
<td>46</td>
<td>11,331</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Tyler (Art Reserve)</td>
<td>106</td>
<td>2,376</td>
<td>10.2</td>
<td></td>
</tr>
</tbody>
</table>

## Symboleg

- **XX**: Unit symbol
- **Division**: Unit type
- **3,800**: Manpower
- **Infantry**: Cavalry
- **Cavalry**: Infantry

---

## Army Strengths

<table>
<thead>
<tr>
<th>Corps</th>
<th>Guns</th>
<th>Personnel</th>
<th>Losses(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI Corps Sedgwick</td>
<td>14,074</td>
<td>1,529</td>
<td>49.6</td>
</tr>
<tr>
<td>XI Corps Howard</td>
<td>9,242</td>
<td>11,220</td>
<td>38.9</td>
</tr>
<tr>
<td>XII Corps Slocum</td>
<td>9,788</td>
<td>10,674</td>
<td>39.5</td>
</tr>
<tr>
<td>Cavalry Corps Pleasonton</td>
<td>11,331</td>
<td>10,926</td>
<td>20.0</td>
</tr>
</tbody>
</table>

---

## Unit Symbols

- **X**: 1st BDE
- **XX**: 2nd BDE
- **XXX**: 3rd BDE

- **1st Div**: Infantry
- **2nd Div**: Cavalry
- **3rd Div**: Artillery Reserve

---

## Manpower

- **Army Headquarters**: 3,800
- **I Corps Reynolds**: 2,376
- **II Corps Hancock**: 1,598
- **III Corps Sickles**: 1,821
- **V Corps Sykes**: 1,418
- **VI Corps Sedgwick**: 1,348
- **XI Corps Howard**: 1,220
- **XII Corps Slocum**: 1,236
- **Cavalry Corps Pleasonton**: 1,217

---

## Losses

- **Army Headquarters**: 7.5%
- **I Corps Reynolds**: 10.2%
- **II Corps Hancock**: 11.1%
- **III Corps Sickles**: 11.1%
- **V Corps Sykes**: 7.5%
- **VI Corps Sedgwick**: 1.7%
- **XI Corps Howard**: 41.2%
- **XII Corps Slocum**: 11.1%
## ORDER OF BATTLE — ARMY OF NORTHERN VIRGINIA

### ORGANIZATION OVERVIEW

<table>
<thead>
<tr>
<th>UNIT</th>
<th>NUMBER OF UNITS</th>
<th>SUBORDINATE UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARMY</td>
<td>1</td>
<td>3 corps per army</td>
</tr>
<tr>
<td>CORPS</td>
<td>3 infantry</td>
<td>3 divisions per corps</td>
</tr>
<tr>
<td>DIVISION</td>
<td>9 infantry, 1 cavalry</td>
<td>3–5 brigades per division</td>
</tr>
<tr>
<td>BRIGADE</td>
<td>37 infantry, 5 cavalry</td>
<td>4–5 regiments per brigade</td>
</tr>
<tr>
<td>REGIMENT</td>
<td>172 infantry, 26 cavalry</td>
<td>—</td>
</tr>
</tbody>
</table>

### GETTYSBURG — JULY 1863

<table>
<thead>
<tr>
<th>Battalion</th>
<th>Army</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
<tr>
<td>II Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
<tr>
<td>III Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Battalion</th>
<th>Army</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
<tr>
<td>II Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
<tr>
<td>III Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Battalion</th>
<th>Army</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
<tr>
<td>II Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
<tr>
<td>III Corps</td>
<td>71,699</td>
<td>LEE</td>
</tr>
</tbody>
</table>

---

*SECTION TWO: BATTLE OF GETTYSBURG—STRATEGIC OVERVIEW*
<table>
<thead>
<tr>
<th>FORMATION</th>
<th>GUNS</th>
<th>PERSONNEL</th>
<th>LOSSES (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARMY HEADQUARTERS</td>
<td>—</td>
<td>108</td>
<td>4.6</td>
</tr>
<tr>
<td>I CORPS LONGSTREET</td>
<td>87</td>
<td>20,941</td>
<td>36.6</td>
</tr>
<tr>
<td>II CORPS Ewell</td>
<td>79</td>
<td>20,597</td>
<td>32.5</td>
</tr>
<tr>
<td>III CORPS HILL</td>
<td>84</td>
<td>21,948</td>
<td>38.7</td>
</tr>
<tr>
<td>CAVALRY—STUART</td>
<td>23</td>
<td>8,105</td>
<td>4.7</td>
</tr>
</tbody>
</table>

**SYMBOLOGY**

- **XX** — Unit symbol
- **Division** — Unit type
- **Manpower**
- **Infantry**
- **Cavalry**

---

**III Corps**

- x9 ARTY Btry

**HILL**

- **XX**
  - x4 ARTY
  - Pettigrew: 2,850
  - Heth: 7,458

- **XX**
  - x4 ARTY
  - Pender: 1,882
  - Pender: 6,603

- **XX**
  - x3 ARTY
  - Anderson: 742
  - Anderson: 7,136

- **XX**
  - x6 ARTY
  - Stuart: 1,173
  - Stuart: 8,105

**CAVALRY**

- **xx**
  - x4 ARTY
  - Davis: 2,305
  - Davis: 1,413

- **xx**
  - x3 ARTY
  - Scales: 1,351
  - Scales: 1,543

- **xx**
  - x6 ARTY
  - Posey: 1,322
  - Posey: 1,543

- **xx**
  - x3 ARTY
  - Mahone: 1,542
  - Mahone: 1,322

- **xx**
  - x2 ARTY
  - Thomas: 1,248
  - Thomas: 1,542

- **xx**
  - x2 ARTY
  - Archer: 1,197
  - Archer: 1,912

- **xx**
  - x2 ARTY
  - Crawford: 1,197
  - Crawford: 1,912
## WEAPON SPECIFICATIONS

### SMALL ARMS

<table>
<thead>
<tr>
<th><strong>SPRINGFIELD MODEL 1861 RIFLE-MUSKET</strong></th>
<th><strong>ENFIELD PATTERN 1853 RIFLE-MUSKET</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARMY</strong></td>
<td>AoP</td>
</tr>
<tr>
<td><strong>ACTION</strong></td>
<td>Caplock</td>
</tr>
<tr>
<td><strong>CALIBER</strong></td>
<td>.58</td>
</tr>
<tr>
<td><strong>RATE OF FIRE</strong></td>
<td>2–3 rounds per minute</td>
</tr>
<tr>
<td><strong>MAXIMUM EFFECTIVE RANGE</strong></td>
<td>500 yards</td>
</tr>
<tr>
<td><strong>AVERAGE FIRING RANGE</strong></td>
<td>125 yards</td>
</tr>
<tr>
<td><strong>COUNTRY OF ORIGIN</strong></td>
<td>United States</td>
</tr>
</tbody>
</table>

### ARTILLERY

<table>
<thead>
<tr>
<th><strong>MODEL 1857 12-POUNDER (“NAPOLEON”) HOWITZER</strong></th>
<th><strong>MODEL 1863 10-POUNDER PARROTT RIFLED CANNON</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARMY</strong></td>
<td>AoP, ANV</td>
</tr>
<tr>
<td><strong>BORE</strong></td>
<td>4.62 inches (smooth)</td>
</tr>
<tr>
<td><strong>NUMBER AT GETTYSBURG</strong></td>
<td>AoP—142; ANV—99</td>
</tr>
<tr>
<td><strong>AMMUNITION</strong></td>
<td>Solid, spherical-case (shrapnel shell), canister</td>
</tr>
<tr>
<td><strong>EFFECTIVE RANGE</strong></td>
<td>400–1200 yards (solid); 350 yards (canister)</td>
</tr>
<tr>
<td><strong>MAXIMUM RANGE</strong></td>
<td>1,680 yards (solid) at 5 degrees</td>
</tr>
<tr>
<td><strong>BARREL WEIGHT</strong></td>
<td>1,220 pounds</td>
</tr>
<tr>
<td><strong>COUNTRY OF ORIGIN</strong></td>
<td>France</td>
</tr>
</tbody>
</table>

### 3-INCH ORDNANCE RIFLE (“GRIFFIN GUN”)

| **ARMY** | AoP, ANV |
| **BORE** | 3 inches (rifled) |
| **NUMBER AT GETTYSBURG** | AoP—144; ANV—77 |
| **AMMUNITION** | Spherical-case (shrapnel shell), canister |
| **EFFECTIVE RANGE** | 2,400 yards |
| **MAXIMUM RANGE** | 4,000 yards at 16 degrees |
| **BARREL WEIGHT** | 820 pounds |
| **COUNTRY OF ORIGIN** | United States |
Artillery battery of 10-pounder rifled cannons “in battery” and ready to fire. (Matthew Brady, “Ringgold Battery on Drill,” Photographs of Civil War–Era Personalities and Scenes, Records of the Office of the Chief Signal Officer, 1860–1985, National Archives and Records Administration, undated.)
DAY ZERO, JUNE 30, 1863

On June 30, 1863, the Union and Confederate armies were on the ten roads that converged at Gettysburg, mostly uncertain of each other’s movements. While Lee’s ANV approached the town from the north and west, MG George Meade’s AoP advanced from the south in parallel columns from around Frederick, Maryland, along a nearly 30-mile front. His seven corps were split into two groups. The first was made up of three corps under the operational control of John Reynolds, commander of First Corps, making up the army’s left wing. Along with the First Corps, the Third Corps under MG Daniel Sickles and Eleventh Corps led by MG Oliver Howard were marching directly toward Gettysburg via Emmitsburg, Maryland. The other four corps were farther to the east and south. MG Winfield Hancock’s Second Corps was on the road to Taneytown; MG Henry Slocum’s Twelfth Corps was making progress toward Littlestown, Pennsylvania; MG George Sykes’ Fifth Corps had left Westminster, Maryland, and was heading north for Hanover, Pennsylvania; and MG John Sedgwick’s Sixth Corps tracked east from Manchester and planned to continue north to Gettysburg from Westminster. Two brigades of MG John Buford’s cavalry division screened the left of the Union advance, relaying key information to Meade and Reynolds.40

Lee planned to focus his three corps on the Chambersburg-Cashtown area. However, his advance was cautious because his cavalry was 30 miles distant, about to lose another day skirmishing with Union cavalry to the east. The ANV had no mounted screening force, precious little information in unfamiliar country, and only best guesses as to the AoP’s locations. LTG James Longstreet’s I Corps was west of Gettysburg near Chambersburg, LTG Richard Ewell’s II Corps was north and east of Gettysburg in the general vicinity of Harrisburg, and lead elements of LTG A.P. Hill’s III Corps were about ten miles from Gettysburg at Cashtown. On June 30 at around 10 am, acting on orders to search Gettysburg for supplies, three regiments from MG Henry Heth’s division under BG J. Johnston Pettigrew arrived in the western outskirts. Stopping at the Lutheran Theological Seminary, the Confederates sighted Buford’s cavalry reconnoitering the hills south and east of the town. Pettigrew withdrew toward Cashtown to report his findings to Hill and Heth, both of whom received the news with incredulity and supposed Pettigrew saw local militia rather than well-trained horsemen of the AoP.41

After leaving Emmitsburg that morning, Buford’s two brigades and an artillery battery of six guns arrived in Gettysburg by 11 am. He ordered his men to take up defensive positions in an arc north and west of town on either side of Chambersburg Pike, covering the most likely avenues of Confederate approach. Scouting parties ranged out and made clear what Buford already knew: that the enemy was in the area and outnumbered his own relatively small force. Regardless, analyzing the area, he understood that the high ground south and east of town was tactically advantageous to whichever army controlled it. Additionally, Gettysburg was the nexus of an excellent road network, aiding the speedy arrival of reinforcements to the area within the next day.42

By evening on June 30, Lee was headquartered in woods east of Chambersburg. Only three of his nine divisions were on the eastern side of South Mountain and within a day’s march of Gettysburg and its surrounding
area, two coming in from the north and one from the west. The other six all would need to use the same route to Gettysburg, Chambersburg Pike, promising time-consuming bottlenecks. After an exhausting march, by the evening of June 30, the divisions of MG John Bell Hood and MG Lafayette Mc Laws from Longstreet’s I Corps were at the foot of South Mountain, 15 miles west of Gettysburg. The third division of I Corps, commanded by MG George Pickett, remained at Chambersburg to cover the rear of Lee’s army. Ewell’s II Corps was equally spread out. MG Edward Johnson’s division camped the night of June 30, 20 miles northwest of Gettysburg at Scotland. MG Robert Rodes stopped his soldiers ten miles northeast of town at Heidlersburg. After starting the day miles apart, hard marching by MG Jubal Early’s division closed the gap between him and Rodes, and the two units camped only three miles apart. Two divisions of General Hill’s III Corps, MG Richard Anderson’s and Heth’s, were in the general area of Cashtown by the end of the day on June 30. The third division, under MG Dorsey Pender, remained in camp at Fayetteville.43

Meanwhile, the balance of a Union Cavalry division held Gettysburg and two corps of Union infantry could easily reach town by morning—Reynolds and his First Corps camped merely five miles south of Gettysburg at Marsh Creek, while Howard’s Eleventh Corps was only another five farther south at Emmitsburg. The Second, Third, and Twelfth were not far away and all on roads converging on the Gettysburg area. If the Confederates were in the area, this was where Buford was prepared to force them to fight.44
DAY ONE, JULY 1, 1863

At 5 am on July 1, Confederate MG Henry Heth’s division left Cashtown, Pennsylvania, less than ten miles west of Gettysburg. Three hours later, his skirmishers encountered BG John Buford’s pickets. The clash was set up from the previous day’s events. On June 30, Buford, with his two brigades of cavalry, had ridden through Gettysburg toward Cashtown and ran into BG James J. Pettigrew’s brigade, which was heading toward Gettysburg in search of supplies. Because Pettigrew was unsure of the size of the Union force in front of him, he fell back and reported the events to his division commander, MG Heth. Both Heth and III Corps commander LTG A. P. Hill were sure that the Union infantry was still south of Gettysburg, but they also knew the Union cavalry was in the area. Still, they made plans to move down the Chambersburg Pike and push aside what they believed to have been militia from the previous day. Deeply frustrated by the absence of MG Stuart’s cavalry, General Lee ordered caution to his subordinate units and directed that they not bring on a general engagement or battle until he was sure what was to his front. Union cavalry commander Buford had judged the terrain and network of roads around Gettysburg to be of vital importance, and he planned to halt what he suspected would be a Confederate advance in the morning. This would buy time for the AoP and its newly appointed commander, MG George Meade, to arrive. Buford deployed his two brigades as dismounted troops on either side of the Carlisle Road. With good positions, defense in depth, a high rate of fire from Sharps carbines, and a battery of artillery, Buford slowed Heth’s advance long enough for reinforcements to arrive.45

The second phase of the battle began at 10:30 am, when MG John F. Reynolds’ First Corps arrived to assist Buford’s Union forces, who had withdrawn to Seminary Ridge. Behind Heth, two more Confederate divisions marched toward Gettysburg; farther north, LTG Richard S. Ewell’s II Corps drew closer. To check Ewell, Union Eleventh Corps commander MG Oliver O. Howard hurried toward the battle. At noon, one of Ewell’s divisions engaged the Union First Corps’ right, north of town. To shore up the flank, Howard ordered two of his divisions to block Ewell’s path, forming a semicircle around Gettysburg. He deployed his third division south of town, on high ground at Cemetery Hill. General Lee arrived at Gettysburg at 1:30 pm and lifted his order to avoid a general engagement.46

The final phase of the first day began in mid-afternoon. By 4:30 pm, unrelenting pressure on both First and Eleventh Corps forced the Union line to retreat through Gettysburg and link up on either side of Howard’s third division on Cemetery Hill, positioning themselves in a fishhook from the north to the south, from Cemetery Ridge to Culp’s Hill. The Union’s Twelfth Corps began arriving at 5 pm and Third Corps an hour later. By evening, despite the Confederate success during the day, the Union had the high ground around Gettysburg. Crucially, Ewell had hesitated after receiving a discretionary order from Lee to take Cemetery Hill “if practicable.” His decision not to launch an attack before nightfall gave the Union time to build defenses and await the Confederate attack sure to come in the morning.47
Gettysburg Campaign—Day Two

DAY TWO, JULY 2, 1863

Both armies arrived in force around Gettysburg in the early hours of July 2. Meade finally arrived at midnight and decided to stay and fight. Lee’s plan to capitalize on the previous day’s gains was to roll up the Union left flank that roughly paralleled the Emmitsburg Road with LTG James Longstreet’s I Corps and then move north. MG Richard H. Anderson’s III Corps division would attack the Union center at Cemetery Ridge. When the orders reached Longstreet around 11 am, he was dissatisfied, which created more delays. He had argued for threatening the Union lines of communication and forcing Meade to attack, but Lee disagreed. To him, retaining the initiative was vital. Lee did compromise, however, and ordered Ewell to launch a diversionary attack at Culp’s Hill on the Union right as a preamble to Longstreet’s move on the union left. But earlier in the morning, Lee had received a faulty reconnaissance report from one of his staff officers that the Union left was in the air. Lee therefore ordered Longstreet’s two divisions (his third, Pickett’s, was guarding the army’s trains at Chambersburg) to roll up the Union left from south to north. Although he disagreed fundamentally with his commander’s plan, Longstreet’s artillery opened at 3:30 pm, before Ewell had begun his demonstration. A half hour later, Longstreet moved his divisions forward and made immediate contact with the Union Third Corps, which was not positioned where he expected it to be. Earlier, Union MG Daniel E. Sickles, who commanded Third Corps, had moved down from the end of the Union line on Round Top and Little Round Top to a peach orchard three-quarters of a mile to his front. He reasoned that the peach orchard was higher than his original position, and wanted to deny it to Confederate artillery. In so doing, however, he created a salient and was now covering more ground than his corps could defend. Meade, after hearing Longstreet’s artillery, arrived at his left flank to find the heights unoccupied and his Third Corps commander forward of the Union line. Meade scrounged what units he could to occupy Sickles’ original position. Meanwhile, at 4 pm, Ewell had begun his demonstration with an ineffectual artillery bombardment from Benner’s Hill, opposite of Culp’s Hill. For his troubles, he received accurate and withering counterbattery fire in return.48

Longstreet’s attack became uncoordinated, but his divisions and brigades fought well. MG John Bell Hood’s division flanked Sickles’ left, overrunning the Devil’s Den, the low ground between the Peach Orchard and Little Round Top. This allowed Hood’s Division to make a bid for taking Little Round Top, which had only a small signal detail atop it, and pour fire down on the Union line. As Hood’s Division attacked, it found that one Union brigade and an artillery battery had come to occupy the position only moments before. Fighting on the hill became desperate; there was hand-to-hand combat and a downhill charge from COL Joshua Lawrence Chamberlain’s 20th Maine Regiment that ultimately kept Little Round Top in Union hands. Confederate MG Lafayette McLaws concentrated on Sickles’ corps, striking at the peach orchard and a wheatfield behind it, where 11 brigades fought for two hours. At 6 pm, MG Richard H. Anderson from Hill’s III Corps un成功fully assaulted the Union center on Cemetery Ridge, despite Meade earlier taking units from the area to strengthen his left flank. At 7 pm, believing the Union right flank was thin, Ewell mounted a full-scale assault of Culp’s Hill and East Cemetery Hill, achieving marginal gains after three hours of combat.49

Fighting on the second day lasted until after 10 pm. Later that night, Meade called a council of war, asking his corps commanders and staff officers whether the AoP should fight defensively or offensively the next day. They agreed that they would wait for Lee to attack.50
This map depicts the outline of the Union defensive position, the **fishhook**, on the morning of July 3rd. Under Longstreet’s command, the main infantry assault—Pickett’s, Pettigrew’s, and Trimble’s Divisions—occurred on the Union center near the Copse of Trees at 1:00 pm.
DAY THREE, JULY 3, 1863

On July 3, Lee ordered his men to reprise the plan from the day before, confident that he had mauled the AoP badly enough that he would soon dislodge them from the heights. With the peach orchard in his possession, Longstreet was to hit the Union left again; Ewell was to use the gains he had made on Culp’s Hill and renew his attack. Union MG Henry Warner Slocum threw the plan into disarray, however, when his Twelfth Corps opened with a dawn artillery barrage on the Confederate troops who occupied a breastworks taken in the fighting the evening before on Culp’s Hill. Ewell responded, but Longstreet was unprepared to launch his attack. By 11 am, the fighting on Culp’s Hill was over, and Lee was forced to change his plans. Now, instead of attacking the Union left, Lee would have his army attack the Union center along Cemetery Ridge. He reasoned that the Union center must have been weakened from the fighting on Day Two, because it had to send reinforcements to both the Union right and left flanks.51

Longstreet again made the same case he had the day before: Cut Meade’s communications and force him to attack. Lee demurred. Sensing that time was not on his side, Lee sought the decisive battle. He planned to attack the center of the Union line on Cemetery Ridge and take the Emmitsburg Road, an important interior line of communication for Meade. Meanwhile, MG Stuart’s cavalry, which had finally arrived on the field late the previous day, was to swing from Lee’s left flank around the Union right and exploit the confusion from the infantry attack. Longstreet was to take command of the plan, one that he believed had little chance of success. He would use MG Pickett’s division from his own I Corps, which had yet to be committed, and six brigades from Hill’s corps. At 1 pm, 159 Confederate guns opened on Cemetery Ridge. Union artillerymen did not answer immediately because they wished to save ammunition. Once they did open with counterbattery fire, they slowly tailed off to convince the Confederates that their barrage had been successful. Longstreet’s artillery fell silent at 2 pm. From the woods along Seminary Ridge, more than 12,000 Confederate troops stepped off in a line one mile long. Ahead of them was three-quarters of a mile of open field that was choked with smoke. The troops soon discovered that their artillery barrage had failed as Union shell and shot punched holes in the Confederate ranks. As they drew closer to Cemetery Ridge, canister and musket fire buckled the leading edge of the Rebel formations.52

Pickett’s men reached the first Union line, a stone fenceline on the slope of Cemetery Ridge, but the assault collapsed shortly thereafter. After less than an hour, 7,000 Confederate troops became casualties.53

After three days of bitter fighting, Lee was forced to leave the field. Meade did not give chase and lost the opportunity to destroy the badly mauled ANV. The battle was costly for both sides: Union losses were more than 23,000, while Confederate casualties were perhaps as high as 28,000, or one-third of Lee’s army.54
“Because decisions about the future are usually based on weighing up the potential consequences of alternative courses of action, it makes sense to compare the actual outcomes of what we did in the past with the conceivable outcomes of what we might have done.”

— Niall Ferguson

Senior Fellow of the Hoover Institution, Stanford University, and The Center for European Studies, Harvard University
The Gettysburg campaign happened and is recorded in history as the previous section explained. But what if things during the Battle of Gettysburg had been done differently: for example, if technologies that were available at the time had been used? Would the outcome of the battle have been different? If so, why?

Counterfactual historical analysis—what might have happened if things had been done differently—is an important analytical tool that historians use to understand what actually did happen by exploring the possible outcomes of alternative histories. Indeed, as Yale University’s intellectual historian Niall Ferguson notes, the way we think about the future is inherently based on consideration of the possibilities of alternative courses of action. Ferguson goes on to note that this notion of considering alternative possibilities in the past is deeply embedded in Western culture. For example, think of Hollywood’s embrace of alternative pasts in many popular movies. In It’s a Wonderful Life, George Bailey’s guardian angel intervenes when Bailey is just about to commit suicide by jumping off a bridge. The guardian angel then shows Bailey how poorly things would have turned out for his family and local community if he had not lived. Or, there is the movie Back to the Future, in which Marty McFly travels back in time to the past, where he takes different actions that end up changing his life and his family’s lives for the better in a new alternative present based on a changed, alternative past.

Military planning and the analysis that goes into it essentially is based on considering different hypothetical courses of action that will transpire at some point in the future. For example, a simple tactical plan of attack for a combat brigade is developed by the brigade’s planners by developing different courses of action for the attack. In one course of action, two infantry battalions might secure key objectives and the armor battalion exploits through the middle. Or in a different course of action, the armor battalion seizes the objectives while the infantry battalions assault. To test these courses of action to see which one is optimal and to be recommended to the brigade commander, the planners rely on a frequently used analytical tool: the wargame. In the wargame, planners test and evaluate various courses of action—hypothetical futures of what might happen in the course of the tactical plan—by applying combat outcome and attrition tables, time-space-combat power analysis, and so on. The result is a selection of the most optimal course of action by examining different hypothetical futures.

That is what we are doing in this custom-built RAND wargame that applies alternative technologies that were available at the time in the Battle of Gettysburg: considering what might have been if alternative technologies had been pursued and how the use of those technologies might have affected the outcome of the battle. This kind of historical knowledge and sensibility might then be used as a premise to help Army planners and leaders think creatively about the various possibilities they face in the present, and more importantly, in the future.
EXPLANATION OF PROBLEM

At Gettysburg, both Union and Confederate commanders faced challenges of understanding the disposition, actions, and intentions of the enemy army they confronted. Lee, the commander of the ANV, faced especially acute challenges in this regard. For one, his main cavalry, force commanded by Stuart, was not in a position to report on the movement of the AoP in the handful of days prior to the battle, leaving Lee essentially blind to what his opponent was doing to his front. And on the morning of Day One of the battle, Lee had an incomplete picture of Union dispositions or strength. Although the Union commander, MG George C. Meade, also faced challenges of understanding the enemy force to his front, they were not as severe as Lee’s. Probably the biggest challenge Lee faced on Day One of the battle—because of his lack of reconnaissance information—was knowing where and when he would begin a general engagement with the AoP, if he would at all.

ALTERNATIVE TECHNOLOGY: AERIAL INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE

In the first year of the Civil War, Union armies at times used observation balloons during battles to report on the location, disposition, and movement of Confederate armies. During the Peninsula Campaign in 1862, for example, a Union observation balloon was raised to a height where it watched the Confederate commander shift a large infantry unit in an attempt to hit the flank of the Union line. The observation balloon quickly sent a message using a telegraph wire to the Union commander, who was then able to shift forces to deal with that Confederate threat to his flank.55
If Lee had an observation balloon placed with the lead elements of Hill's corps at Cashtown, he could have easily seen that three Union corps were within hours’ marching distance of Gettysburg and its surrounding area. With that information, he could have then formulated operational and tactical options for his army to engage the Union Army to his front.
SECTION FOUR: ALTERNATIVE POSSIBILITIES IN THE PAST AND THE FUTURE

ALTERNATIVE TECHNOLOGY OVERVIEW—OBSERVATION BALLOON

The most successful Civil War observation balloons were the product of a U.S. inventor and aeronaut, Thaddeus S. C. Lowe, who was a worldwide leader in balloon design and construction. Realizing that the United States could use balloons as a military observation platform, Lowe demonstrated the capability of such technology at the White House for President Lincoln, personally rising to 500 feet above the executive mansion before sending a telegraph message to the ground. Lowe’s first wartime flight was at the First Battle of Bull Run, the success of which led to Lincoln ordering the formation of a balloon corps and placing Lowe at its head as chief aeronaut. The core group of the Union Army Balloon Corps consisted of civilian aeronautical professionals, not soldiers.56

The Balloon Corps was made possible through two technological innovations: (1) hydrogen gas–filled balloons and (2) portable hydrogen gas generators. The balloons were constructed of cotton cording covered in varnish. In total, Lowe’s team built seven balloons, six of which went into service. Three smaller balloons (25,000 cubic foot capacity) were meant for windier weather and quick ascents that carried one to three men, and three larger ones (32,000 cubic feet) were capable of carrying a telegraph set and an operator that could rise higher and carry five men.57 Lowe’s portable gas generators, however, were what made the balloons capable of operating for lengthy periods in the field; otherwise, the Balloon Corps would have had to inflate in cities at static gas hubs. Gas hubs were constructed of copper plumbing and metal tanks and transported on a buckboard wagon. When sulfuric acid and iron filings mixed inside, a chemical reaction occurred that created hydrogen. On average, a balloon required three hours and 15 minutes to be inflated with one generator. If two generators were used, however, this time could be roughly halved. The balloons and generators were generally cumbersome to move when packed away, and even more difficult to maneuver over rough terrain.58

Ascensions could be made day or night and whenever weather permitted. Crews routinely ascended just before sunrise, when enemy positions were easily identified by the smoke of morning fires. Heavy camp smoke could be seen from ten to 25 miles away, and tents would be visible within five or six miles. During battles, balloons were ordered to remain at altitude all day, capable of staying inflated for up to two weeks. Aerial dispatches could be sent to the ground through three methods: telegraph, written messages dropped to the ground, and visual signals. Tactically, observation balloons were used for enemy observation, map making, and artillery fire direction.59

Sharpshooters and artillerists kept constant pressure on the aerial posts, but no direct hits ever landed during the war. Other schemes included entire batteries firing simultaneously underneath the balloon, creating a swath through which it would have to pass as the balloon descended—also unsuccessful.60

• COUNTERFACTUAL JUSTIFICATION

The Confederacy’s balloon program was less sophisticated than the Union Army Balloon Corps, suffered from a lack of experts, and was plagued by deficient technical designs. However, this game assumes that since the ANV had captured Union portable gas generators during the Peninsula Campaign, the Confederates have the ability to employ observation balloons. Given the cumbersome nature of the balloons and necessary supporting
equipment, it is plausible that the AoP might have also been forced to abandon an entire observation station at the same time. Taken off the battlefield undamaged and transported in the ANV’s wagon trains along with Lee’s main force, the Confederates would have the equipment and capability of employing two of Lowe’s larger 32,000 cubic feet designs. With two gas generators and all attendant supporting materials, including telegraph, each army headquarters would have identical observation balloon capabilities. We also assume that the Confederates decided to make a focused effort to manufacture balloons and supporting wagon trains.

(top photo) Thaddeus Lowe observing the battle from his balloon *Intrepid*, Fair Oaks, Va., May 31, 1862. (“Fair Oaks, Va., Prof. Thaddeus S. Lowe Observing the Battle from His Balloon *Intrepid,*” Library of Congress, 1862.)


Professor Lowe offered his services as an aeronaut for the purposes of performing aerial reconnaissance on Confederate troops on behalf of the Union Army. In July 1861, Lowe was appointed Chief Aeronaut of the Union Army Balloon Corps by President Lincoln. (“Inflating an Observation Balloon at the Battle of Fair Oaks,” U.S. Signal Corps, 1862.)

**BALLOON COUNTERFACTUAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Army</th>
<th>AoP</th>
<th>ANV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inflation Time</strong></td>
<td>3 hours, 15 minutes</td>
<td></td>
</tr>
<tr>
<td><strong>Max Altitude</strong></td>
<td>5,000 feet</td>
<td></td>
</tr>
<tr>
<td><strong>Observational Range</strong></td>
<td>10–25 miles</td>
<td></td>
</tr>
<tr>
<td><strong>Flight Time</strong></td>
<td>2–3 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Communications Equipment</strong></td>
<td>One Beardslee Telegraph, signal flags, dropped messages</td>
<td></td>
</tr>
<tr>
<td><strong>Game Allocation</strong></td>
<td>Two</td>
<td>Two</td>
</tr>
</tbody>
</table>
UNION—LINE OF SIGHT (LOS) WITH OBSERVATIONAL BALLOON AT 750 FEET, DAY ONE, 4:00 AM

- Balloon position
- LOS
- Obstructed LOS
UNION—LOS WITH OBSERVATIONAL BALLOON AT 1,500 FEET, DAY ONE, 4:00 AM

Obstructed LOS

Balloon position

LOS
CONFEDERATE—LINE OF SIGHT (LOS) WITH OBSERVATIONAL BALLOON AT 750 FEET, DAY ONE, 4:00 AM

Balloon position

LOS

Obstructed LOS
A common problem of C2 in U.S. Civil War armies was the ability of higher-level commanders—army to division—to influence a tactical battle at the close fight. At that close level, regimental and brigade commanders fought, but their division and corps commanders remained relatively far to the rear.

Indeed, at Gettysburg, it is likely that Confederate brigade and regimental commanders in areas where the most intense combat occurred perceived a potential advantage to split the Union defensive line in two. Yet, they were unable to communicate those perceptions. At even higher levels of command from army to corps, commanders faced major challenges at Gettysburg. Lee faced larger challenges of coordinating his army on Day One. For instance, despite his wish to bring together his entire army before becoming engaged, Confederate divisions assaulted Buford’s cavalry and Reynolds’ First Corps. During the resultant complex attacks, Lee operated from exterior lines and his attacks failed, at least partly because of uncoordinated actions. On the Union side, even though Meade’s army was operating from interior lines and his higher-level commanders were much closer to the combat, he still faced major problems of C2 as his army rushed to the fight and the battle developed throughout the afternoon of July 1.

Although the technology of telegraph lines between two points at significant distance was available to Civil War senior commanders, they generally chose to use them only at the highest levels and mostly on the Union side. For example, at Gettysburg, Meade used the telegraph to communicate with President Lincoln via General Halleck in Washington, D.C., and not at the tactical level of war, at least from army HQ to corps HQ. Such an alternative technology, if used, could have assisted Lee in coordinating his corps and divisions on Day One and Meade in coordinating the defensive line of the Union Army.
At 3:45 pm on July 1, the ANV had massed a relatively significant force (approx. 19,800) using exterior lines against a smaller AoP (approx. 12,400) operating on interior lines that eventually broke the entire AoP line, causing it to fall back to Cemetery Hill. However, with a telegraph line between AoP Corps commanders Doubleday on Seminary Ridge and Howard on Cemetery Hill, the ANV could have coordinated a shorter defensive line slightly north of Gettysburg and perhaps prevented the rout of the AoP that actually occurred.

The advance elements of Slocum’s Twelfth Corps of the AoP were still two hours march east and southeast of Gettysburg at 3:00 pm. Its location at 12:00 pm had been five miles away at Two Taverns, where the corps had arrived the night before. If Howard had a telegraph line run from Cemetery Hill at 11:30 am when he arrived to Slocum’s HQ in Two Taverns, by 2:00 pm, Howard could have wired Slocum and demanded that he march hard to Gettysburg. If that had happened, Slocum’s 12th Corps could have slammed into Ewell around the time the Union line was beginning to break.
ALTERNATIVE TECHNOLOGY OVERVIEW—BEARDSLEE TELEGRAPH

During the Civil War, there were two competing telegraph outfits in the North: U.S. Military Telegraph and the Army Signal Corps. Then—Secretary of War Simon Cameron and later Edwin Stanton contracted private industry to use railroads and telegraph systems, particularly Western Union and Southwestern. The use of civilians undercut Army Signal Corps, which, as early as 1861, petitioned the federal government to consolidate control of electric telegraphs under its authority but lacked the influence to do so. As a consequence of the arrangement, the Signal Corps became more responsible for operational-tactical communications, including tapping into strategic-operational lines to pass pressing information and using visual telegraphy (also known as wigwagging).62

There were also competing technologies. Initially, the Signal Corps used the electro-magnetic Beardslee Telegraph, the first electrical device designed and built for army signals. It could transmit 15 words per minute, five times faster than flag telegraphy, but it lacked range and reliability. Its competitor was a system that Henry J. Rogers developed and delivered to the Signal Corps in January 1862. Two horse-drawn terminal vans were equipped with instruments, batteries, lance poles, insulation, and ten miles of wire between the team. However, the trains cost $2,500, were complicated, and required large batteries. Military Telegraph’s monopoly on skilled operators made it difficult to find qualified individuals for service.63

The Signal Corps then blended the train concept with the Beardslee Telegraph. The Beardslee train, which used magnetos rather than batteries, was first fielded in the 1862 Peninsula Campaign. At the height of their use, 30 trains existed. By spring 1863, however, enthusiasm for the Beardslee trains waned. Wires deteriorated, range was limited, and the Confederates began deciphering visual signals, which resulted in commanders intentionally withholding information from the Signal Corps.64

By 1863, Military Telegraph assumed control of both strategic and tactical lines. During the First Battle of Bull Run, the Union established wires from Falls Church to Springfield and Fairfax; couriers ran messages from McDowell’s headquarters to Fairfax. Initial messages to the War Department described a rout on July 21. Following Military Telegraph’s success, Secretary of War Stanton, who formerly worked in the Atlantic and Ohio Telegraph Company, allowed Signal Corps’ equipment to be cannibalized beginning in November 1863. The Signal Corps thereafter was relegated to visual signals only.65

• COUNTERFACTUAL JUSTIFICATION

Similar to the balloon, the telegraph was a technological innovation that required unique inputs to produce, mostly only accessible to the Union.

TELEGRAPH: This game assumes that a Beardslee Telegraph would have been on board the Union’s balloons. Because Confederates captured Union balloon-gas generators during the Peninsula Campaign, it is likely that the ANV also could have captured an undamaged telegraph along with an intact observation station.

TELEGRAPH OPERATORS: Telegraphs required skilled operators to use them, and most telegraph operators were contracted by the federal government under the U.S. Military Telegraph organization. This game assumes that
because commercial telegraphs operated all along the eastern seaboard, some telegraph workers from southern states decided to remain loyal and work for Confederate forces. Given that the Beardslee Telegraph was relatively simple, this game assumes that the Confederate army could have developed its own cipher system and method of using it to send messages.

(A. R. Waud, "The Army Telegraph - Setting Up the Wire During an Action," January 24, 1863.)

The Beardslee Telegraph machine operated using hand-cranked magnetos that generated electricity to send a message over the telegraph wire. (U.S. Army)

<table>
<thead>
<tr>
<th>TELEGRAPH COUNTERFACTUAL SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARMY</strong></td>
</tr>
<tr>
<td><strong>NAME</strong></td>
</tr>
<tr>
<td><strong>POWER</strong></td>
</tr>
<tr>
<td><strong>TRANSMISSION RATE</strong></td>
</tr>
<tr>
<td><strong>COMMUNICATION DISTANCE</strong></td>
</tr>
<tr>
<td><strong>DEPLOYMENT</strong></td>
</tr>
<tr>
<td><strong>GAME ALLOCATION</strong></td>
</tr>
</tbody>
</table>
EXPLANATION OF PROBLEM

The fundamental premise to linear battlefield tactics—in effect, soldiers drawn up in long lines from two to eight ranks deep—was to mass the firepower of muskets, then rifled muskets, against an opposing force arrayed in similar ways. Indeed, during the Civil War generally and the Battle of Gettysburg specifically, rifled musket firepower produced about 85 percent of the casualties, artillery about 14 percent, and cold steel 1 percent. Civil War commanders controlled and massed soldiers in these linear formations to concentrate musket firepower against the enemy. Some commentators have been highly critical of Civil War commanders for not appreciating the increased range of the rifled muskets, which was outward to 500 meters. But commanders on both sides judged that trying to train soldiers to estimate range and elevating the rifle to hit targets at that distance simply was not worth it. In any case, the result of linear tactics on Civil War battlefields was incredible amounts of death and destruction, often with engagements and battles ending in stalemate.

ALTERNATIVE TECHNOLOGY: BREECHLOADING RIFLES AND GATLING GUNS

Repeating rifles, such as the Sharps breechloader, were a technology available to Civil War armies, although the North had clear advantages in supply because of its industrial prowess.

But for a number of reasons, this technology and the Gatling gun were not pursued by either the North or the South. Such alternative technologies, if extensively pursued and incorporated into innovative tactics, might have allowed the rigid linear formations at the close combat level to relax. These technologies might have allowed greater freedom of maneuver for lower echelons from regiment to divisions.
One infantry regiment, ~300 soldiers

The Wheatfield

Repeating rifles and Gatling guns, if incorporated at the Wheatfield, might have altered the Civil War tactic of rigid linear formations, allowing for greater movement and possibly fewer casualties caused by massed musket firepower.
Of the breechloading percussion weapons produced in the mid-19th century, the Sharps was the most successful. In 1859, the Sharps Rifle Manufacturing Company in Hartford, Connecticut, offered an improved version of an 1851 design that the Ordnance Board had reviewed highly. The New Model 1859 was a lever-action, falling-block percussion rifle that bridged the gap between the paper and metallic cartridge era. The single-shot breechloader fired a .52-caliber, 462-grain bullet by the breech block’s edge shearing off the end of a paper cartridge, exposing powder for a percussion cap to ignite. With a muzzle velocity of 1,000 feet per second and a range of 700 to 800 yards, the New Model 1859 was a favorite of sharpshooters. Sharps also built a carbine version, which was so respected that the Confederates produced 5,000 copies in Richmond.\(^\text{66}\)

The Sharps' value was its rate of fire. Its rate of fire of eight to ten shots per minute was more than double what soldiers with muzzle-loading rifles could manage, providing units the potential to deliver overwhelming firepower. A typical company of 100 soldiers could fire 1,000 shots per minute, and therefore 30,000 shots in a skirmish that lasted 30 minutes. Another advantage of the Sharps breechloader was that soldiers could easily fire the rifle while lying on the ground. However, ammunition capacity for an infantryman was 60 to 80 rounds (100 for cavalry), with the same number for percussion caps. Federal supply and ordnance officers resisted buying the Sharps in large numbers, judging that the rifle’s high rate of fire would potentially lead soldiers to waste ammunition, thereby stressing a supply system that already struggled to keep up with demand. Moreover, each rifle cost nearly three times as much as the $15 muzzle-loading Springfield.\(^\text{67}\)

The New Model 1859 did suffer from several issues. Chief among them was fouling. A buildup of carbon residue had the potential to prevent the sleeve from setting back against the breech face, which would allow gas to leak. In trying to clear any fouling by running a patch through the barrel, there would be delays in shooting. The Sharps also had the potential to overheat, although this was never put to the test because they were never fired at their maximum rate in combat.

New Model 1859s were present at Gettysburg. On July 2, in Pitzer’s Woods, four companies of the U.S. 1st Regiment, Berdan’s Sharpshooters—who had specifically requested the rifle—expended 95 rounds per man in a 15-minute firefight. They inflicted 56 casualties on Confederate BG Cadmus Wilcox’s Alabaman brigade.\(^\text{68}\)

**Counterfactual Justification**

This game assumes that the Confederate States Army’s adoption of the New Model 1859 Sharps Rifle could have occurred through various methods. First, the Confederacy’s indigenous production capabilities allowed for 5,000 copies to be produced in Richmond. Second, Sharps models, produced under license in Europe and successfully filtered through the federal Navy blockade, could have augmented these numbers. Likewise, ammunition for these rifles, such as lead and paper for cartridges, might have come from indigenous production, overseas sources that ran the blockade, supplies captured from Union storehouses, cavalry who captured it from Union supply lines, and battlefield scavenging.
SHARPS COUNTERFACTUAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>ARMY</th>
<th>AoP</th>
<th>ANV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NAME</strong></td>
<td>New Model 1859 Sharps Breech-loading rifle</td>
<td>Lever</td>
</tr>
<tr>
<td><strong>ACTION</strong></td>
<td>.52 (paper)</td>
<td>One</td>
</tr>
<tr>
<td><strong>CALIBER</strong></td>
<td>8-10 rounds per minute</td>
<td>700-800 yards</td>
</tr>
<tr>
<td><strong>MAGAZINE CAPACITY</strong></td>
<td>Two divisions</td>
<td>One division</td>
</tr>
<tr>
<td><strong>RATE OF FIRE</strong></td>
<td>8-10 rounds per minute</td>
<td>700-800 yards</td>
</tr>
<tr>
<td><strong>RANGE</strong></td>
<td>Two divisions</td>
<td>One division</td>
</tr>
</tbody>
</table>

(above) 2nd United States Volunteer Sharpshooter Regiment, also known as Berdan's Sharpshooters, with Sharps Model 1859 rifles.
(U.S. Army)

(right) Patent and explanation of the breechloading and self-priming technology for the Sharps rifle, carbine, shotgun, and pistol.
(U.S. Patent Office)
ALTERNATIVE TECHNOLOGY OVERVIEW—MODEL 1862, TYPE II GATLING GUN

In 1861, just a few months after the opening salvos of the war, inventor Richard Jordan Gatling developed one of the most infamous firearms in history, the Gatling gun. Ironically, Gatling had designed the weapon not for the purpose of generating destruction on the battlefield but rather to minimize the horrors of war. Distraught by images of dead Union soldiers returning from the front, Gatling vowed to create a gun that would “enable one man to do as much battle duty as a hundred,” which would “supersede the necessity of large armies, and consequently, exposure to battle and disease [would] be greatly diminished.” Although it was born of a desire for peace, the Gatling gun would ultimately revolutionize warfare, paving the way for the use of machine guns in combat.

By July 1861, just a few months after he initially sketched his design for the weapon, Gatling tested a functional prototype. This first model fired a .58-caliber Minié ball affixed to a black powder charge wrapped in paper and secured with a percussion cap at its base. These were similar to the rounds used in the Union’s standard-issue infantry rifle of the time, the Model 1861 Springfield. Gatling further improved his design by encasing the rounds in steel cartridge-chambers, which contained a percussion cap at the back end of the case. In essence, the rotation of the crank would cycle the six barrels and push forward a firing pin or striker, which would detonate the cap attached to the cartridge; the explosion of the primer at the back of the cartridge case would ignite the powder in the cartridge, thus forcing the Minié ball out the barrel and down range. The cartridges also created a better seal in the breach of the gun, preventing the loss of explosive gas needed to propel the projectile from the barrel. The introduction of the metallic case, coupled with the addition of a hopper for speedily loading the barrels and a mechanism for extracting spent cartridges, led to the patent of the Model 1862 Type II Gatling gun on November 4, 1862. Initial testing of the gun determined that it could effectively fire 200 rounds per minute, with one turn of the crank firing all six barrels.

COUNTERFACTUAL JUSTIFICATION

Resistant to change and unimpressed by the Gatling’s performance, Union Army Chief of Ordnance BG James W. Ripley refused to adopt the Gatling gun in 1862. However, Gatling’s efforts did not go unnoticed by other military leaders. In 1863, Union MG Benjamin Butler purchased 12 Gatling guns at $1,000 a piece, which he successfully used at the Battle of Petersburg one year later. Similarly, Rear Admiral John A. Dahlgren also approved of the weapon and granted naval officers permission to outfit their ships with them. Indeed, some forward-thinking Union officers saw the potential of the Gatling gun; accordingly, one might plausibly argue that the Union could have adopted Gatling guns as early as 1862 had it empowered certain military leaders over others. With clear direction from military and government leadership, it is likely that the Union could have prioritized the production and allocation of Gatling’s weapon prior to Gettysburg.

Many historical records have detailed the Confederacy’s inferiority to its enemy in terms of manufacturing and production capabilities. Consequently, it is somewhat unconvincing to argue that the rebels could have created large numbers of Gatling guns using stolen or copied designs; they simply would not have had access to the raw
materials and skilled laborers necessary to produce effective guns. However, it is quite possible that rebel forces could have captured Union Gatling guns during battle. Gatling guns were extremely heavy and essentially operated as part of artillery units. Therefore, if a group of Confederate soldiers or cavalry quickly happened on a Union Gatling battery, they could have easily captured it and brought it into service for the South. In this counterfactual, the assumption that the North widely produced and fielded Gatling guns dovetails with the theory that Confederates could have captured active Union guns on the battlefield—there were simply more guns available to capture. As a result, both sides employ Gatling guns in this analysis of the Battle of Gettysburg.

GATLING GUN COUNTERFACTUAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>ARMY</th>
<th>AoP</th>
<th>ANV</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>Model 1862, Type II Gatling gun</td>
<td></td>
</tr>
<tr>
<td>ACTION</td>
<td>Hopper-fed, hand-cranked</td>
<td></td>
</tr>
<tr>
<td>BARRELS</td>
<td>Six</td>
<td></td>
</tr>
<tr>
<td>CALIBER</td>
<td>.58 (rimfire)</td>
<td></td>
</tr>
<tr>
<td>RATE OF FIRE</td>
<td>200 rounds per minute</td>
<td></td>
</tr>
<tr>
<td>RANGE</td>
<td>500 yards</td>
<td></td>
</tr>
<tr>
<td>GAME ALLOCATION</td>
<td>Four pairs</td>
<td>Two pairs</td>
</tr>
</tbody>
</table>

First used in combat during the Civil War, the Gatling gun leveraged a complex, rotary hand-crank mechanism to fire, rotate, and reload six rifled barrels in a single revolution. The rotation of the barrels prevented them from overheating when operating at high rates of fire.

The RAND Gettysburg Alternative Technologies Wargame
CONCEPT FOR WARGAMES

To help staff ride participants understand how the alternative technologies considered might have affected the outcome of the battle or military campaign, the RAND Arroyo Battlefield Futures Program uses a RAND custom-made in-person wargame, in which opposing military forces will be equipped with these technologies and the players will be free to conduct operations with those technologies as they see fit. The wargame will build on the discussions that take place during the prior virtual or actual staff ride and allow the players to explore the benefits and limitations of the technologies in a game that will quantify their effects along with the effects of the other military capabilities possessed by the two armies. Alternatively, one might use a tool, such as an engineering model or simulation, to evaluate the benefits of a new military technology, but the advantage of using a wargame is that it allows the free play of human analysts in the fuller context of the battle. The analysts can adapt their operations and tactics to take best advantage of the capabilities the technologies provide while also considering how their opponents may adapt to mitigate the effects of the technologies or use the technologies against them. RAND frequently uses wargames to assess the potential benefits of alternative military weapon systems, force structures, and operational concepts.

This Battlefield Futures report is premised on the 1863 Battle of Gettysburg. But the Arroyo Battlefield Futures Program can be adapted to other battles and military campaigns in history. For example, it can
be adapted to the World War II Normandy campaign, in which Allied forces landed in Normandy, France, which ultimately led to Germany’s surrender. Another possible historical military campaign could be the Korean War’s Inchon landing. The Battlefield Futures Program is historical-case agnostic, meaning that it can be applied to a wide variety of historical battles and military campaigns and tailored to the learning demands of the players involved.

POTENTIAL LEARNING FROM RAND ARROYO BATTLEFIELD FUTURES PROGRAMS

These custom-made RAND wargames can enable players to explore and discuss the benefits of the alternative technologies and use them in innovative ways to accomplish their missions in a given RAND Arroyo Battlefield Futures Program. For any strategic or operational challenge, there may be multiple approaches and paths forward. These wargames can be used to gaining insights about the adoption of technologies and to make decisions about modernization and its costs/benefits.

The battle of Gettysburg began on July 1st at 4:00 am, with union and confederate positions as shown on the map. Key commanders include Lee, Stuart, Pender, Heth, Johnson, Hood, McLaws, Anderson, Meade, Reynolds, Sickles, Howard, and Sickles. The map details the positions and movements of the opposing forces during the first day of the battle.
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANV</td>
<td>Army of Northern Virginia (Confederate)</td>
</tr>
<tr>
<td>AoP</td>
<td>Army of the Potomac (Union)</td>
</tr>
<tr>
<td>C2</td>
<td>command and control</td>
</tr>
<tr>
<td>DOTMLPF</td>
<td>doctrine, organization, training, materiel, leadership and education, personnel, and facilities</td>
</tr>
<tr>
<td>DOTMLPF-P</td>
<td>doctrine, organization, training, materiel, leadership and education, personnel, and facilities—policy</td>
</tr>
<tr>
<td>ISR</td>
<td>intelligence, surveillance, and reconnaissance</td>
</tr>
<tr>
<td>LOS</td>
<td>line of sight</td>
</tr>
<tr>
<td>LRT</td>
<td>Little Round Top</td>
</tr>
</tbody>
</table>
The historical facts and detail presented in this volume were drawn from the sources listed below and from the authors’ many years of work in the area.


Gettysburg Staff Ride: *Briefing Book*, U.S. Army Center of Military History, undated.


**BIBLIOGRAPHY**


Robertson, William Glenn, “The Peach Orchard Revisited: Daniel E. Sickles and the Third Corps on July 2, 1863,” in


Scott, Joseph C., “The Infernal Balloon: Union Aeronautics During the American Civil War,” *Army History*, No. 93, Fall 2014.


ENDNOTES

5 See Scott, 1835; Moseley, 1677; Rogers, 1973; Fox, 1889.
7 Fiebeger, 1915, p. 43.
18 Hall, 2003, pp. 21–35.
26 Gettysburg Staff Ride: Briefing Book, undated, p. 53.
27 Gettysburg Staff Ride: Briefing Book, undated, pp. 55–57.
32 Seidule, 2021, p. 211.
37 As quoted in Guelzo, 2014, p. 217.
39 Hessler and Motts, 2015, p. 147.
ENDNOTES

55 Scott, 2014, pp. 6–27.
56 Block, 1966; Squires, 1937, pp. 652–669.
58 Scott, 2014, p. 10.
59 Haydon, 1941, pp. 308–375.
60 Haydon, 2000, pp. 339–344.
61 Thompson, 1954, pp. 188–201.
63 Raines, 1996, pp. 18–21.
64 Thompson, 1954, pp. 31.
66 Adkin, 2008, p. 95.
68 Berdan’s Sharpshooters, 2008.
72 Keller, 2008, p. 188.
RAND ARROYO BATTLEFIELD FUTURES PROGRAMS
A STAFF RIDE/WARGAME EXPERIENCE

Blending a staff ride and wargaming offers a way to rigorously think through the root-cause of military failure and what—if anything—could be done to alter the outcome. By first conducting a staff ride of a well-known battle (in this case, the Confederate defeat at Gettysburg) as a proof of concept, we first diagnose why the Union won and conversely, Confederates lost. Through a follow-on wargame, we can "test" whether the outcome could have been changed by organizational, capability, or capacity solutions.