

When Technology Backfired:

The Dehumanizing Role of Machine Guns and Trench Warfare in World War I



Figure 1: British machine gun deployed in the Battle of the Somme, 1916

Dexter Theisen

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Global Studies, Ms. Kudera Pd. 4

It is difficult to fathom a 64% casualty rate caused by technological advances, yet frontline troops faced these sobering odds if they served for the duration of World War I (WWI).¹ Fought from 1914 to 1918, this massive global conflict catalyzed a pivotal and deadly shift away from the battle tactics traditionally utilized by European powers such as Britain, France, and Germany. Significantly, WWI combat relied heavily on several technological advances that followed the Victorian era and Napoleonic Wars. The introduction of machine guns – alongside complementary innovations of trenches, barbed wire, and telecommunications – drastically intensified the carnage during this four-year engagement. These advancements reshaped both the Allied and Central Powers' war strategies from a posture of offensive maneuvering to the bloody combat of defensive attrition. Because of these inventions, European armies incurred heavy death tolls when many battles became prolonged stalemates. As national economies realigned to fund the machinery of “total war,” these new devices deployed in WWI emerged as primary drivers of the conflict's devastating severity and duration. Taken in this context, it is clear that these technological developments represented a step backwards from a humanitarian perspective.

Preceding 1914, European powers often won battles through strategic positioning in lieu of excessive bloodshed, leading certain countries to mistakenly assume that WWI would follow suit. Allies such as Britain and France, as well as Central Powers such as Germany, had become accustomed to wars of maneuver, relying primarily on infantry and offense to out-strategize their opponents and force surrenders based on hypothetical outcomes.² For example, the Austro-Prussian War of 1866 took only seven weeks, and the Franco-Prussian War of 1870 lasted a mere six months.³ Astoundingly, the 2 million lives lost collectively in the Napoleonic Wars of 1803 to 1815 equated to just one-tenth of the death toll in WWI.⁴ Given this backdrop, German foreign policy adviser Kurt Rielzer incorrectly predicted in 1907 that “future wars would no longer be fought but calculated” and

¹ Roy E. Bailey, Timothy J. Hatton, and Kris Inwood, “Surviving the Deluge: British servicemen in World War I,” *Science Direct* (December 21, 2022): 10, <https://doi.org/10.1016/j.ehb.2022.101216>.

² Richard F. Hamilton and Holger H. Herwig, *The Origins of World War I* (Cambridge University Press, 2008), 46.

³ Stephen Bull, *A History of Trench Warfare on the Western Front* (Orsey Publishing, 2014), 15.

⁴ Digby Smith, *Napoleon's Regiments: Battle Histories of the Regiments of the French Army, 1792-1815* (Greenhill Books, 2000), 13.

that guns would not necessarily fire but rather “have a voice in the negotiations.”⁵ On June 28, 1914, the assassination of Austrian Archduke Franz Ferdinand haphazardly triggered a domino chain of events and multiple declarations of war across Europe.⁶ Early military directives were sparse, and civilian leaders made decisions predominantly influenced by alliances and old tactics. One such statesman was British foreign secretary Sir Edward Grey, who pushed his hesitant cabinet – with the support of Great Britain’s then-naval chief Winston Churchill – to take a firm stance in support of France by entering the war.⁷ According to George F. Kennan, former Counselor of the U.S. Department of State during WWI: “no war plan had been formally adopted or coordinated ... by any government in 1914.”⁸ European powers were particularly ill-equipped to predict the catastrophic consequences ahead because new technologies would drastically exacerbate their missteps.

At an unprecedented cost to human life, the machine gun was inadvertently poised to fill the void of cohesive military strategy at the inception of WWI. This exceptionally lethal, late 19th century invention was designed to automatically fire ammunition from a fabric belt and came to play a critical role in the conflict. While the precise timing of the machine gun’s development is poorly documented, the first mass-produced version is credited to Harim Maxim.⁹ The American-born British serial inventor filed for a wide-ranging patent in 1883, on the heels of the Victorian era of invention that also produced the telegraph and telephone.¹⁰ The “Perfected” version was distributed in 1887 after several improvements and became known simply as the Maxim.¹¹ While several other models of machine guns were developed during the same period – including the Hotchkiss, Vickers, and Madsen (with some perhaps infringing on Maxim’s patent) – the Maxim remained the most prevalent variation used in Europe before and during WWI.¹² In 1908, the German Imperial Army

⁵ Kurt Riezler, *Grundzüge der Weltpolitik der Gegenwart* (Deutsche Verlagsanstalt, 1914), 219.

⁶ Hamilton and Herwig, *The Origins of World War I*, 52.

⁷ *Ibid.*, 294.

⁸ Holger H. Herwig, *The Marne, 1914* (Barnes & Nobles, 2014), 30.

⁹ Library of Congress, “The Machine Gun: Its History,” LOC (March 9, 2024): <https://guides.loc.gov/machine-gun-its-history-development-and-use>.

¹⁰ Paul Cornish, *Machine Guns and the Great War* (Barnes & Nobles, 2009), 9.

¹¹ *Ibid.*, 11.

¹² LOC, “The Machine Gun.”

also commissioned a lighter version of the Maxim, known as the MG08.¹³ By 1914, Allied and Central Powers alike had begun to utilize the Maxim and other models in skirmishes and colonization attempts.¹⁴

Consequently, when WWI escalated across Europe, the machine gun had already evolved into a technologically advanced weapon, glorified for its formidable capabilities with minimal regard for the unprecedented harm it could inflict. At the onset of the war, the Maxim boasted a firing speed of 400 to 600 rounds per minute and a range of 4,500 meters, dwarfing a rifle's capability multi-fold.^{15,16} The machine gun was dubbed "the Nerveless Weapon" by Major General John Eugene McMahon, who commanded the 5th Division of the U.S Army in WWI.¹⁷ According to British wartime training pamphlets distributed to military officers, the weapon "was not influenced by fear or confusion and did not fatigue like those firing military rifles, who had to contend with ear-splitting sound, gun recoil, flinching, and maintaining aim"; since machine gun firepower was faster and more reliable than humans, it was estimated to be as effective as 80 to 120 riflemen.^{18,19} As European leaders became enamored with its impressive features, the Maxim was added to military arsenals on both sides of the war and became a popular social artifact. By 1916, several fine china souvenirs portraying machine guns were sold in England, including the Arcadian figurine "Tommy" depicting a soldier hunched over his weapon.²⁰ Machine guns became a noteworthy technological and cultural phenomenon of the era, while European powers callously overlooked their horrifying potential from a humanitarian perspective.

However, these observations do not suggest that machine guns were immediately deployed with high efficacy at the start of WWI. As hostilities quickly escalated into the first total war,

¹³ Hamilton and Herwig, *The Origins of World War I*, 155.

¹⁴ Cornish, *Machine Guns and the Great War*, 16-18.

¹⁵ Michael Duffy, "Machine Guns," *First World War* (August 22, 2009): <https://www.firstworldwar.com/weaponry/machineguns.htm>.

¹⁶ Canadian War Museum, "Machine-Guns," *Global Affairs Canada* (May 30, 2023): <https://www.warmuseum.ca/firstworldwar/history/battles-and-fighting/weapons-on-land/machine-guns>.

¹⁷ Cornish, *Machine Guns and the Great War*, 32.

¹⁸ British General Staff, *SS192: The Employment of Machine Guns - Part I - Tactical* (Foreign & Commonwealth Office, January 1918): 15, ark:/13960/t74v5nh21.

¹⁹ Duffy, "Machine Guns."

²⁰ Cornish, *Machine Guns and the Great War*, 72-3.

countries reallocated all dispensable societal resources – including labor, manufacturing, and military personnel – to the sole purpose of supporting a prolonged battle. Because this type of conflict was the first of its kind, the Allied and Central Powers required time to devise a comprehensive strategy to implement this promising new machinery. Notably, the major European powers entered WWI with different dispositions on how to utilize machine guns. German and French commanders demonstrated preliminary interest in incorporating the weapons, whereas the British armies of 1914 were slow to embrace their potency, despite inventing and owning 2,000 Maxims.²¹ Paul Cornish, a prominent British war historian for the Imperial War Museums, places the blame on a culture of anti-intellectualism and reluctance to learn about technology that plagued the British Expeditionary Forces (BEF).²² Cornish contends that in early engagements, the BEF clumsily used machine guns adjunct to their infantry, and inefficiently deployed them to the front lines without proper training. Nonetheless, as the British realized the brutal efficiency of these weapons, they founded the Machine Gun Corps in 1915 and began investing heavily – evidenced by an annual production of 800 machine guns in 1914 versus a staggering 121,000 in 1918.^{23,24} Machine guns drove an astounding growth in the total British defense budget. Military spending as a percentage of GDP ballooned from 3.1% in 1913 to 40.8% in 1918, representing a twelve-fold increase in the national budget to £2.37bn.^{25,26} With the largest Allied army, Great Britain's strategic pivot to embrace new machinery proved crucial to the final outcome of WWI. The military and political leaders of Great Britain enlisted their nation into grave sacrifice by entering the war and funding machine gun production.

In contrast to the British, French forces demonstrated early enthusiasm to use machine guns, but lacked the necessary resources. The French army integrated machine guns into their strategy from the outset of WWI. However, they allocated only two weapons per battalion in the early months of combat, and gunmen used only one at a time due to faulty firing mechanisms on the early air-cooled

²¹ Ibid., 28.

²² Ibid., 29.

²³ Ibid., 48.

²⁴ Paul Kennedy, *The Rise and Fall of the Great Powers* (Goodreads, 1989), 267.

²⁵ Martin Ellison, *Funding the Great War and the Beginning of the End for British Hegemony, In Debt and Entanglements Between the Wars* (IMF, 2019): 60, <https://doi.org/10.5089/9781513511795.071.ch002>.

²⁶ Morgan, *E.V. Studies in British Financial Policy 1914-25* (Macmillan & Co, 1952), 104 (Table 9).

St. Etienne model.²⁷ But by 1915, the French had studied the various models' capabilities and ramped up the production of the more reliable Hotchkiss version to deploy more guns per battalion.²⁸

Consequently, 1920's banker and financial writer Harvey Edward Fisk recorded French Treasury Defense expenses between 1914 and 1919 swelled to 200 billion francs, about twice the 1913 French GDP.²⁹ While France entered the war with substantially fewer machine guns than the British, they compensated with early funding, and their investment further propelled a climate of mass destruction.

Similar to the French, German military leaders seemed eager to embrace machine guns early on. Dennis Showalter, an American historian who specializes in German military history, contends that the German Imperial Army at the start of WWI had the advantage of organizational prowess and the specialized skill of its gun operators.³⁰ Unfortunately, the Germans' knowledge benefit was unmatched by their equipment stock – the military's initial overreliance on machine gun turrets caused it to frequently run short on ammunition.³¹ According to David Janicki, a professor of War Studies at Queens College, Germany lacked a sufficient reserve of raw materials to produce cordite, the vital propellant in bullets and explosives.³² As German forces learned to marshal their resources and continued to ramp up production of weapons, they ultimately became so dependent on MG08s that by 1917, machine guns consumed 90 percent of their ammunition.³³ The aforementioned records of all three countries imply that an arms race emerged across both the Allied and Central Powers. The machine gun had different yet steep trajectories of incorporation into WWI combat by European countries. Yet conspicuously absent from historical accounts is meaningful evidence that decision-makers debated the humanitarian losses that their automatic weapons could inflict.

It is also clear that machine guns could not have achieved such deadliness alone. To both capitalize on and defend against the capacity of machine guns, a military strategy known as trench

²⁷ Cornish, *Machine Guns and the Great War*, 36.

²⁸ *Ibid.*, 50.

²⁹ French Fisk, *Public Finance in the Great War and Today* (Bankers Trust Company Publications, 1922), 444.

³⁰ Dennis Showalter, *Tannenberg: Clash of Empires, 1914* (Potomac Books, 1991), 239.

³¹ Cornish, *Machine Guns and the Great War*, 35.

³² David A. Janicki, *The British Blockade During World War I: The Weapon of Deprivation* (Inquiries Journal, 2014), 3.

³³ Dieter Storz, *Rifle and Carbine 98* (Mowbray Publishing, 2006), 329-30.

warfare emerged in scale by late 1914, joining together some of the most problematic innovations of the era. Protected by razor-sharp barbed wire and connected by telegraph lines, armies on both sides of the war dug deep rows of trenches, often in a three-level configuration.³⁴ Every two weeks, soldiers would cycle from the primary trench (front line) to the support trench (second line) to the

S. M. E. FORTIFICATION CIRCULAR No. 11.

RECENT PRACTICE IN TRENCH DESIGN.

The attached 20 Plates illustrate recent practice in trench design, principally in the construction of prepared positions.

Plate 1.—A type of general organization of advanced line is shown in Fig. 1, and of the main line and its support line in Fig. 2.

The main line should as far as possible be concealed from observation, and although a continuous line of trenches is desirable, it is not necessary to carry trenches across sections which are badly exposed, and fire from which would serve no useful purpose. It is preferable to leave gaps, turning back a flank on each side. The "supervision trench" can sometimes be carried on across the gap, Fig. 3, or a lateral communication trench can be made further back, Fig. 4. The defence may be provided by a few lengths of trench, or by the support trench, or by special measures, *e. g.*, a strong point.

In the advanced and support lines, continuous trenches should not, in the first instance, be made. It is sufficient to put them where they are necessary.

Entanglements.—Gaps are left for counter attack, which should be concealed by overlapping lengths of entanglement. In addition, about every 100 yards, S-shaped narrow pathways are made for patrols. The rear of the pickets at these pathways are painted white so as to be easily seen from the trenches.

J. J. H. NATION,
Major, R. E.,
Brigade Major, S. M. E.

S. M. E., Chatham,
7th December, 1915.

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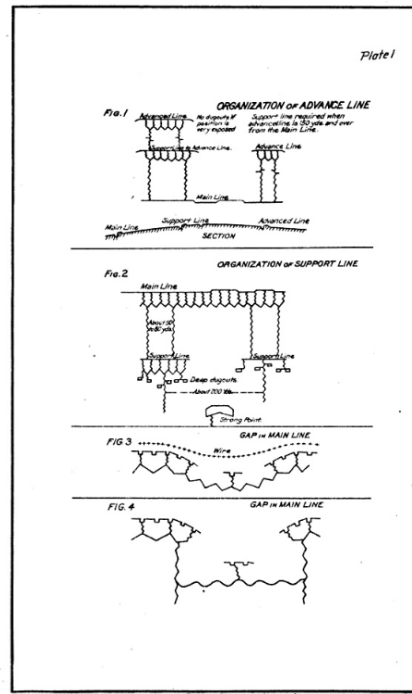


Figure 2: Specifications for three-level trench design, from S.M.E Fortification Circular of U.S. Army.

reserve trench (third line).³⁵ Brave men camped out in these crowded subterranean dugouts, waiting to launch offensive attacks while also ready to defensively operate machine gun turrets at a moment's notice. Due to the rapid-fire nature of machine guns, every shell discharged caused the barrel of the gun to move and slightly altered the trajectory of the next shot. This repeated variation created a unique "cone of fire" for each machine gun brand, which became integral to trench warfare strategy.³⁶ Militaries extensively researched cones of fire to calculate an impact zone from varying distances utilizing the spread radius.³⁷ Bullets sprayed the ground between trenches – coined as

³⁴ H. V. Bail, *Number 55 Occasional Papers: Notes on New Defensive Organizations; Notes on Wire Entanglements* (U.S. Army Engineer School, 1917), 73.

³⁵ *Ibid.*, 74.

³⁶ Cornish, *Machine Guns and the Great War*, 41.

³⁷ *Ibid.*

“No-Man’s Land” due to its difficulty to cross alive – and the resulting “beaten-down zone” marked the most hazardous area. From their technical studies, armies devised detailed plans to overlap their machine guns’ beaten-down zones to make No-Man’s Land impossible to penetrate.³⁸ If a soldier miraculously managed to traverse the first beaten-down zone, he would next be slowed down by strategically placed barbed wire, affording the defending battalion an opportunity to shoot him at close range. These cruel tactics demonstrated a growing disregard for human casualties. Additionally, the new technology of fixed telecommunications lines played a significant role in the static warfronts. Because No-Man’s Land typically

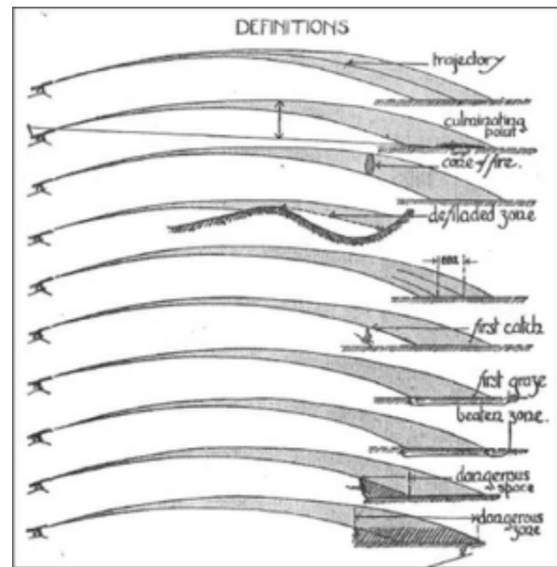


Figure 3: Machine gun zones of fire, from British military training notes.

spanned 100 to 200 yards, soldiers in the trenches quickly relayed intelligence about enemy attacks via telegraph to commanders behind the front lines, who promptly authorized defensive machine gun fire.³⁹ According to Dr. Stephen Bull, an accomplished curator of military history and archeology, the fully developed German trench systems of 1915 incorporated a “telephone” position attached to each covered rear trench.⁴⁰ These new technologies deployed during WWI worked in tandem to amplify the savage of machine guns, at a devastating cost to human life. With the advent of trench warfare, the risk of serious harm to servicemen precipitously increased above the machine gun alone.

In order to contextualize the growing dependency on machine guns and trench warfare in WWI, it is instructive to analyze the evolution of their use, such as in the 1914 First Battle of the Marne compared to the 1916 Battle of the Somme. Renowned German war historian Holger Herwig argues that in many ways, Marne was the last of the Napoleonic-style battles which relied on strategy over extreme bloodshed.⁴¹ Though machine guns were part of both Allied and Central Armies’

³⁸ Ibid., 42.

³⁹ Nedim Maric, *The Battle of Somme* (Captivating History, 2019), 7.

⁴⁰ Bull, *A History of Trench Warfare*, 38.

⁴¹ Herwig, *The Marne*, 3.

battalions, their brutality was not fully realized during this war. The four-day confrontation at Marne in September 1914 occurred during German Commander Helmuth von Moltke's botched execution of the Schlieffen Plan to surprise and expeditiously defeat France on the Western Front (before turning to address Russia on the Eastern Front).⁴² When the French and British became aware of the German's route of attack, they immediately sent troops North to meet the Germans at the river of Marne. Initially, the offensive German army possessed 24 machine guns per battalion, whereas the French possessed only two per battalion.⁴³ However, only one in eight German units were capable of deploying all 24 guns, instead utilizing an average of fifteen; similarly, the French could only deploy one of every two machine guns due to their dependency on the faulty St. Etienne.⁴⁴ It is noteworthy that despite the advantage of more machine guns and 400,000 additional troops, Germany's plan fell apart within hours, and its soldiers retreated within days due to a collapse in supply lines and the failed element of surprise.⁴⁵ The French and British armies drove back the German military, predominantly through traditional war strategies of shorter attacks and coordinated rifle-firing – tactics which became obsolete as the war progressed.⁴⁶ While Germany held several advantages, it failed to clinch the Battle of the Marne and was forced to retreat to the Aisne. It is plausible that some military commanders presumed that the remainder of WWI would play out with similar strategic maneuvers.⁴⁷

Historical documents suggest that the German army resolved after the Marne to conduct training and improve the integration of machine guns into battle tactics. According to French military papers, collected and declassified by American Lieutenant H.V. Bail after the war, intelligence suggested that the Germans studied French and British trench strategies from 1914 to 1917. The Germans leveraged espionage to obtain Allied documents detailing how “trenches should be used for immediate counter-attack, ... offense, and defense. Machine guns connected by telephone ... should

⁴² Ibid., 7.

⁴³ Cornish, *Machine Guns and the Great War*, 35.

⁴⁴ Ibid., 37.

⁴⁵ Herwig, *The Marne*, 313.

⁴⁶ Ibid., 318.

⁴⁷ Sidney Rogerson, *The Last of the Ebb: The Battle of the Aisne, 1918* (Pen & Sword Books Limited, 1937), 19.

support [attacks] by flanking fire ... and prevent the enemy from coming.”⁴⁸ They also reviewed critical British military papers from 1915 specifying how to efficiently construct “wire

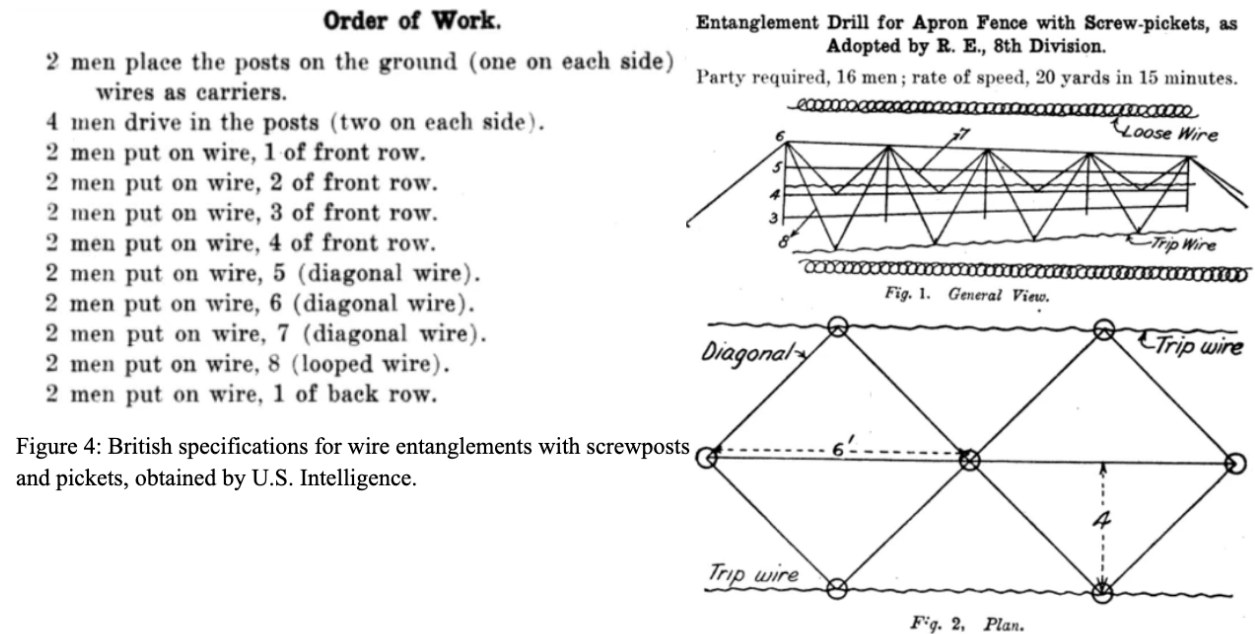


Figure 4: British specifications for wire entanglements with screwposts and pickets, obtained by U.S. Intelligence.

entanglements” with five-foot screw-posts and fifteen-inch pickets.⁴⁹ Combining this knowledge with their own version of stolen American barbed wire, the Germans formulated optimized trench criteria, including: sufficient depth away from fire, good organization with exits, observation posts to detect potential incoming attacks, wide radius for counter-fire, machine gun nests built from concrete, and barbed wire to fortify the front lines.⁵⁰ By the Battle of the Somme in northern France from July to November 1916, the Germans had learned how to “trench” properly, and mounted a solid defense to the first Allied offensive attack of WWI. As the Germans dug into their trenches, the Allies suffered higher casualties – 40,000 Allied soldiers versus 20,000 German soldiers on the first day of combat.⁵¹ Unfazed by this tremendous death toll, the Allied commanders continued to sacrifice their own soldiers on offensive lines during this horrendous war of attrition. During this treacherous battle, the German army pioneered many advances in defensive machine gun strategy, such as the concept of

⁴⁸ Bail, *Number 55 Occasional Papers*, 24.

⁴⁹ *Ibid.*, 34.

⁵⁰ *Ibid.*, 22.

⁵¹ Maric, *The Battle of Somme*, 23.

“traversing fire.” This term refers to the repeated 20 degree vertical movement of a machine gun along a clamp to maximize the “spread radius” and thus improve chances of hitting the enemy.⁵² Several other types of fire were utilized, with devastating consequences: over three million soldiers fought, and over one million casualties fell at the first battle of the Somme.⁵³ The bloody struggle continued in stalemate for four months, and diplomatically ended with a truce in November.⁵⁴

Like the Battle of Marne, the provoking army at Somme believed the battle would end quickly, but underestimated the defensive strategies of their opponents – rooted this time in trench warfare. At Somme, the Allies failed to penetrate German trenches and barbed wire with their bombardment, and the Germans mowed down advancing troops with their well-situated and concrete-fortified machine gun nests.⁵⁵ After 141 days, the Allies managed to advance only seven miles, at the grave toll of 420,000 Allied and 450,000 German casualties.⁵⁶ The Somme exemplified an escalating win-at-all-costs, dehumanizing mindset of Allied and German commanders. Arguably more unnerving than the machine gun’s deadly capabilities were the offensive generals’ progressive desensitization to the extreme loss of human life.

Soldiers’ personal accounts bear witness to the atrocities caused by new technology. German soldier Ernst Jünger, who bravely crossed No-Man’s Land at the Battle of Somme, recounts in his memoir *Storm of Steel*:

I crept on my belly through dewy grass and thistle stems, painfully anxious to avoid cracking the least twig, for fifty metres in front the English trenches rose as a black streak in the half-light. The bullets of a distant machine-gun fell almost perpendicularly round us; here and there a Verey light went up and threw its cold illumination on the desolate plots of ground.⁵⁷

Jünger’s heart-pounding assignment to crawl across No-Man’s Land camouflaged by the darkness of the night was unfortunately all too common for WWI soldiers. Tragically, those who attempted to cross this dangerous terrain faced a 29% likelihood of death.⁵⁸ Men climbed over mounds of

⁵² Cornish, *Machine Guns and the Great War*, 41.

⁵³ Maric, *The Battle of Somme*, 18-19.

⁵⁴ Alan Axelrod, *The Battle of the Somme* (Globe Pequot, 2016), 195.

⁵⁵ Maric, *The Battle of Somme*, 15.

⁵⁶ *Ibid.*, 35.

⁵⁷ Ernst Jünger, *The Storm of Steel* (Chatto & Windus, 1929), 69.

⁵⁸ Bailey, Hatton, and Inwood, “Surviving the Deluge,” 2.

wounded or fallen comrades, whose corpses were left to decompose in the muddy soil or be repurposed as machine gun props. Derby Holmes, an American Corporal who led a British Battalion at Somme, also describes the heinous landscape in his diary:

The dead here were enough to give you the horrors. I never seen so many before and never saw so many afterwards in one place. They were all over the place ... and in all states of mutilation and decomposition. There were arms and legs sticking out of the trench sides...And [the] dead lay in the trenches and outside and hanging over the edges...I first got the real meaning of that old quotation about the curse of a dead man's eye. With so many laying about, there were always eyes staring at you.⁵⁹

Corporal Holmes' entry is sadly not unique, since many brave soldiers grappled with the haunting images from the trenches. After synthesizing many macabre first-person accounts, it is striking that commanding officers often became numb to their own battalion's dead bodies. In their quest for victory, many leaders did not widely document the extreme mortality rates of their troops. Soldiers in the trenches became dehumanized commodities who were repeatedly sent into dire situations to pursue the low-conviction combat strategies of their leaders. As further documented by frontline British soldier C. E. Crutchley in his memoir *Machine-Gunner*:

Corpses became more numerous as we approached the line. The stench, increasing in direct ratio to the number, seemed to have at least the solidity of corpses by the time we reached the shambles of the old front line trenches, full to overflowing with bodies ... I got to the stage eventually where if a handy corpse provided a better foothold than the surrounding quagmire, I used it. I was not alone in that.⁶⁰

This first-hand account reveals that desensitization was not confined to the commanding officers in the rear, but also spread to the frontline soldiers out of a necessity to survive. Barbarically, the deceased simply piled up in No-Man's Land because there was no viable way to be retrieved.

Despite unprecedented spending, militaries on both sides of WWI were depleted, demoralized, and traumatized on an epic scale. Supplied with machine guns, barbed wire, and telecommunications, the Allied and Central armies embraced a bloody shift in battle strategy to a war of attrition with unprecedented human casualties. New war tactics reshaped the way territory lines were drawn compared to the Napoleonic era, with significantly diminished military movement and a

⁵⁹ R. Derby Holmes, *A Yankee in the Trenches, 1918* (Little, Brown and Company, 1918), 58-59.

⁶⁰ C. E. Crutchley, *Machine-gunner 1914-1918: Personal experiences of the Machine Gun Corps* (Pen & Sword Books Limited, 1973), 39.

substantially higher death toll. Though 2 million died over twelve years of Napoleonic wars, just four years of WWI resulted in a staggering 20 million deaths, including 9.7 million military personnel.^{61,62} Stunningly, nearly two-thirds of these WWI deaths resulted from machine guns.⁶³ Notably, the victorious Allies suffered a higher death toll than the Central Powers, losing 5.7 million men versus 4 million respectively.⁶⁴ This statistic highlights the outsized impact of defensive machine gun fire and its consequential role in WWI.

It was a travesty that the new and savage technology that slipped into WWI altered the complexion of modern warfare, leaving commanders desensitized to the unprecedented humanitarian impact on their own countrymen. Winston Churchill, acting commander of the UK military during WWI, lamented the grievous toll of machine guns and trench warfare in his journal published in 1927. He noted: “If only the generals had not been content to fight machine gun bullets with the breasts of gallant men, and think that was waging war.”⁶⁵ Though Churchill had initially supported machine guns in a bid to win the war, in hindsight, he acknowledged their pernicious effect on both soldiers’ survival rates and commanders’ decision-making. Ultimately, the Allies’ success in WWI hinged on their ruthless ability to outspend the Central Powers in human and technological capital. The expensive innovations deployed ravaged Europe with death and destruction. Machine guns and trench warfare backfired: they failed to provide decisive outcomes in WWI, and instead chaotically catapulted the continent into an unprecedented and inhumane total war.

⁶¹ Smith, *Napoleon’s Regiments: Battle Histories*, 13.

⁶² Nadege Mougel, “World War I Casualties,” REPERES (January 2011): <https://www.census.gov/history/pdf/reperes112018.pdf>.

⁶³ National WWI Fund, “Artillery in WWI,” The National WWI Museum (June 2012): <https://www.theworldwar.org/learn/about-wwi/artillery>.

⁶⁴ Ibid.

⁶⁵ Winston S. Churchill, *The World Crisis, Vol. 3: 1916-1918* (Charles Scribner's Sons, 1927), 74.

Bibliography

Primary Sources:

Bail, H. V. *Number 55 Occasional Papers: Notes on New Defensive Organizations; Notes on Wire Entanglements*, U.S. Army Engineer School, 1917.

H.V. Bail was a 1st Lieutenant in the American military during WWI. I used his papers to explain French defensive fortifications and British barbed wire installment, and used two graphics from this document.

British General Staff. *SS192: The Employment of Machine Guns - Part I - Tactical*, January 1918.
ark:/13960/t74v5nh21.

The British General Staff oversaw training soldiers and officers during WWI. I leveraged this pamphlet to detail why the British Army came to believe machine guns were superior to riflemen.

Churchill, Winston S. *The World Crisis, Vol. 3: 1916-1918*, Charles Scribner's Sons, 1927.

During most of WWI, Churchill served as the First Lord of the Admiralty for the United Kingdom. He wrote several volumes of one work, titled *The World Crisis*. I used his book to understand his opinions on machine gun use during the war.

Fisk, French. *Public Finance in the Great War and Today*, Bankers Trust Company Publications, 1922.

Harvey Edward Fisk was an American banker and financial writer who authored many military reports during WWI. Although he is an American, he wrote about the French, British, Canadians, and Australians during the war. I used his book for statistics on French defense spending as WWI progressed.

Holmes, R. Derby. *A Yankee in the Trenches, 1918*, Little, Brown and Company, 1918.

Derby Holmes was an American Corporal who led a British Battalion during WWI. He kept a diary of his first-hand accounts, including in the trenches of the Battle of Somme. I used his words to paint a picture of the heavy carnage of the war of attrition.

Jünger, Ernst. *The Storm of Steel*, Chatto & Windus, 1929.

Ernst Jünger was a German soldier, philosopher, and author who became known for his auto-biographical memoir of World War I. I used his source to depict the barbarism of No-Man's Land.

Riezler, Kurt. *Grundzüge der Weltpolitik der Gegenwart*, Deutsche Verlagsanstalt, 1914.

Kurt Riezler was a German philosopher and diplomat, a top-level cabinet adviser during WWI. I used his book to recount his assumptions on what war would look like just before the outbreak of WWI.

Rogerson, Sidney. *The Last of the Ebb: The Battle of the Aisne, 1918*, Pen & Sword Books Limited, 1937.

Sidney Rogerson was a British university student who was conscripted to fight during WWI. He later entered public relations and advised the War Office at the request of Winston Churchill. I used his book to explain the reasoning behind some commanders' decisions during the war.

Secondary Sources:

Axelrod, Alan. *The Battle of the Somme*, Globe Pequot, 2016.

Alan Axelrod is the author of more than 100 military history books. I used this source to explain background information about the Battle of Somme.

Bailey, Roy E., Hatton Timothy J., and Inwood, Kris. "Surviving the Deluge: British servicemen in World War I," Science Direct, December 21, 2022.
<https://doi.org/10.1016/j.ehb.2022.101216>.

Roy Bailey is a professor in Economics at the University of Essex; Timothy Hatton is a professor in Economics at the Australian National University; Kris Inwood is a professor in Economics and in History at the University of Guelph. I used this source to understand the survival odds from serving in WWI generally, and from actively charging a trench in battle.

Bull, Stephen. *Trench: A History of Trench Warfare on the Western Front*, Orsey Publishing, 2014.

Dr. Stephen Bull studied at the University of Wales, worked at the National Army Museum in London, served as Curator of Military History and Archaeology for Lancashire County Museums, and was elected to the Chartered Institute for Archaeologists. I used his book for specific details about trenches.

Canadian War Museum. "Machine-Guns." Weapons on Land, May 30, 2023.

<https://www.warmuseum.ca/firstworldwar/history/battles-and-fighting/weapons-on-land/machine-guns>.

The Canadian War Museum holds the nation's military history and is world-renowned for the study of armed conflict. I used this source to quantify and present some of the statistics about a 1914 Maxim model Machine Gun.

Cornish, Paul. *Machine Guns and the Great War*, Barnes & Nobles, 2009.

Paul Cornish has worked at the Imperial War Museums since 1989, primarily as a curator of exhibits. I used his book to explain the history of machine guns, capabilities of this new technology.

Crutchley, C. E. *Machine-Gunner 1914-1918: Personal Experiences of the Machine Gun Corps*, Pen & Sword Books Limited, 1973.

C. E. Crutchley was a British lieutenant who served in the 1/4th Northants Territorial Regiment and 135 Machine Gun Company during WWI. I used his book of personal accounts to unveil the gruesome trench conditions of WWI.

Duffy, Michael. "Machine Guns." Weapons of War, August 22, 2009.

<https://www.firstworldwar.com/weaponry/machineguns.htm>.

Michael Wolf Duffy is an American journalist and author, most famous as an op-ed writer for the Washington Post. I used his article to detail the capabilities of the Maxim at the beginning of WWI.

Ellison, Martin. *Funding the Great War and the Beginning of the End for British Hegemony, In Debt and Entanglements Between the Wars*, IMF, 2019.

<https://doi.org/10.5089/9781513511795.071>.

Martin Ellison is a professor of Economics at Oxford University and a fellow of Nuffield College. I used his book to detail the remarkable increase in British defense spending over the course of WWI.

Hamilton, Richard F. and Herwig, Holger H. *The Origins of World War I*, Cambridge University, 2008. Dr. Holger H. Herwig is a German-born Canadian, internationally-renowned military historian and professor. He is the author of more than a dozen books, many of which have won awards. Richard F. Hamilton is a Professor Emeritus of Sociology and Political Science at Ohio State University. I used this source to give detail on multiple WWI battles, as well as more generally explain the origins of the war.

Herwig, Holger H. *The Marne, 1914*, Barnes & Nobles, 2014. This is another of Dr. Herwig's award-winning scholarly works. I used this source to explore the strategies deployed early in the war at Battle of Marne.

Janicki, David A. *The British Blockade During World War I: The Weapon of Deprivation*, Vol. 6, *Inquiries Journal*, 2014.

<http://www.inquiriesjournal.com/a?id=899>.

David Adam Janicki graduated from Buffalo State College with a bachelor's degree in European History and currently teaches at Queens College as a professor of War Studies. I used his book to examine how Germany began running out of the raw materials needed to make explosives.

Kennedy, Paul. *The Rise and Fall of the Great Powers*, Goodreads, 1989.

Paul Michael Kennedy is a British historian specializing in international relations, economic power, and war strategy. I used his book to detail how the production of machine guns increased as WWI progressed.

LOC. "The Machine Gun." *The Machine Gun: Its History, Development and Use*, March 9, 2024.

<https://guides.loc.gov/machine-gun-its-history-development-and-use>.

The Library of Congress is the largest library in the world, and also the main research wing of the U.S. Congress. I used this source to help explain the history of the machine gun and how it was developed.

Maric, Nedim. *The Battle of Somme*, Captivating History, 2019.

Nedim Maric is a former history professor who has dedicated his post-academia life to writing books that are both interesting and historically accurate. I used his book about the Battle of Somme to explain how trenches and the war of attrition progressed and changed throughout WWI.

Morgan, E.V. *Studies in British Financial Policy 1914-25*, Macmillan & Co, 1952.

Edward Victor Morgan was a professor of economics at Manchester University during the early 1900's. I used his book detailing British Financial Policy to explain the massive increases in British military spending from 1914-1918.

Mougel, Nadege. "World War I Casualties," REPERES, January 2011.

<https://www.census.gov/history/pdf/reperes112018.pdf>.

Nadege Mougel is a professor of contemporary history at Campus Lettres et Sciences Humaines de l'Université de Lorraine. I used his report to explain the lethality and demographics of machine guns in WWI.

National WWI Fund. "Artillery in WWI," The National WWI Museum, June 2012.

<https://www.theworldwar.org/learn/about-wwi/artillery>.

The National WWI Fund is an international entity which serves to document the war as well as possible. I used this article to explain how machine guns (and more generally artillery) constituted a majority of deaths in WWI.

Showalter, Dennis. *Tannenberg: Clash of Empires, 1914*, Potomac Books, 1991.

Dennis Showalter was a 20th-century military historian who specialized in German studies. He gained such respect from historians that he was elected President of the American Society for Military History from 1997 to 2001. I used his book to detail some of the advantages the German Imperial Army had over the Allies at the beginning of WWI.

Smith, Digby. *Napoleon's Regiments: Battle Histories of the Regiments of the French Army, 1792-1815*, Greenhill Books, 2000.

Digby Smith was born in 1935 in the U.K. After completing generic military training (incentivized by his father who also served in the military), Smith became a military historian. I used his book about Napoleon to contrast the strategies and results of the Napoleonic Wars versus WWI.

Storz, Dieter. *Rifle and Carbine 98*, Mowbray Publishing, 2006.

Dr. Dieter Storz was born in 1958 in Germany. After brief military service, he studied history in Munich and later became a well-respected military author. I used his book to detail German ammunition expenditure during early versus late WWI.

Appendix A:

Figure 1: Courtesy of the Imperial War Museum in London.

Figure 2: *Number 55 Occasional Papers*, p. 14.

Figure 3: *Machine Guns and the Great War*, p. 89.

Figure 4: *Number 55 Occasional Papers*, p. 34.