MORE THAN MUSTERING OF ARMIES: AMERICAN PRODUCTION AND ACQUISTION OF ARTILLERY IN THE GREAT WAR

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MORE THAN MUSTERING OF ARMIES: AMERICAN PRODUCTION AND ACQUISTION OF ARTILLERY IN THE GREAT WAR

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ABSTRACT

ANDREW THOMAS BREER. More than Mustering of Armies: American production, and acquisition of artillery in the Great War (under the direction of DR. DAVID SNYDER

The purpose of the study was to analyze how the American Expeditionary Forces (AEF) were outfitted with artillery. This analysis focuses mainly on the Ordnance Department, and other government officials' efforts to provide artillery either via manufacture or through acquisition from other Entente members. The study focuses on artillery from 75-mm to 14-inch. Tactics and artillery strategy within the branch will be left to further study.

The American war machine woke on 6 April 1917 completely unprepared to deal with the global crisis of the Great War. America had to arm an expeditionary army to deploy across an ocean to fight modern, industrialized warfare and do so from an unprepared position. This story is virtually overlooked and assumed by current historians, but the American struggle to arm is critical in understanding the multifaceted role and performance of the forces under General John Pershing in France during the Great War. The weapon with the greatest demand in modern warfare is the artillery piece. The U.S. Army lacked sufficient numbers of modern field pieces for the conflict and their heavy artillery was nonexistent. This study attempts to explain how the United States Army armed the AEF in France with both light and heavy artillery.

The Ordnance Department assumed a massive task during Great War. Never before had the department armed so many men in so short of a time. The subject of outfitting the Army therefore requires parameters for the study. First, the lack of experienced ordnance officers and an unskilled general workforce created the largest

delay in deploying artillery. Second, complicated new designs clashed with prewar manufacturing practices. Third, the plan for a five million man army was too difficult to equip with the available resources. Finally, the war ended before the American infrastructure could be fully matured. The limiters forced the development of the AEF structure, including the very large divisions, seems to be directly related to the lack of artillery.

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HISTORIOGRAPHIC ESSAY

The subject of American armament in the Great War of 1917-1918 has not received much attention from scholars. This is especially the case when compared to America's efforts to become the "Arsenal of Democracy" during the Second World War. Almost all research conducted on the subject for the period are memoires, written within five to ten years of the cessation of hostilities. These works were the handicraft of those who ran the programs of arms production. They most often are written in the form of a memoire instead of a serious analysis within the greater framework of the American effort.

These early works have three great hurdles to overcome. First, the works were written by professionals who were civilians before and after the war, only being employed by the government to manage the war effort with "Corporate America" efficiency. These men almost always lacked the military insight that came with career military officers. Second, these authors were professional businessmen in American industry and wrote some of the most fact oriented, dry texts imaginable. Third, they are written before the American experience of the Second World War. These interwar authors did not realize that the actions taken in the Great War had an effect on the history of America's style of warfare for the next half century and beyond. Because no modern historiography existed, the current thesis was conducted.

The first and most prolific writer of the subject was Benedict Crowell. His works were part of the series How America Went to War and his best study regarding acquisition was The Armies of Industry published in 1921. Crowell was the Assistant Secretary of War and Director of Munitions from 1917 to 1920 and helped write the official history of the Ordnance Corps' actions after the war and used much of the official report as the basis for his books. Crowell extensively used the official sources

of information, but unfortunately left no record of where exactly the official information came from. His works are detail oriented, but there is an obvious bias with many of his works. Crowell took the standpoint that the army and especially the Ordnance Department were backwards in comparison to the corporate world. In many regards he was correct, but he took it a step further by inflating his personal achievements, many of which must be given to American officers in uniform. His works are massive, but they also contain flaws, which subsequent authors repeated.

The second major work is Ordnance and the World War, written in 1920 by Major General William Crozier. Crozier was a professional soldier whose career had been capped by over fifteen years service as the Chief of Ordnance. Under his watch the department prepared for war and was responsible for its lack of foresight. Crozier defends himself on several projects, including machine guns and light artillery, both of which were woefully inadequate for the new American Expeditionary Forces (AEF). Through Congressional hearings and official letters he built the case that the department was under strict constraints from above, mainly Congress. His arguments do much to counter Crowell's fiery rhetoric and outrageous claims of unpreparedness with equal claims that it was not the Ordnance Department's fault.

The last major contemporary work was commissioned by the Carnegie Endowment for International Peace. Government War Contracts, written in 1920 by J. Franklin Crowell, adds a new dimension to the puzzle. Crowell (not related to the above) builds the case that the War Department dropped the ball. He blamed the law department of the War Department for successfully hindering the needed growth of the Ordnance Department to facilitate new programs. He does state that an inefficient pre-war arsenal setup with unchecked government facilities and department chiefs created an antiquated business style, but it worked in peacetime. Although he agrees

in that regard with Benedict Crowell, J. Franklin actually praises General Crozier for producing artillery that was of very high quality considering the resources and limitations at his disposal. Crowell is the only author who tries to place the ordnance struggle within the greater context of the war effort by taking a broad focus.

H.A. DeWeerd's work, American Adoption of French Artillery 1917-1918, a 13 page article published in the summer 1939 issue of *Journal of American Military Institute,* became the primary work on the subject for the next fifty years. DeWeerd concludes that no American made field artillery made it to combat service in France during the war, and therefore artillery manufacture in the States was a futile and costly exercise. Most commanders did not foresee the quick collapse of Germany in late 1918. DeWeerd also concludes that only American designs should have been used because subsequent French designs were complicated and inferior. Although this was true, American pieces (in this case the M1916) were also complicated to manufacture and proved almost impossible for industry to build.

James Huston wrote the history of army logistics in The Sinews of War in the 1960s. His massive work stretches from the American Revolution to the Korean War. He devotes about twenty pages to the industrial mobilization of the United States. The work is a good study of the American experience in World War I, but he does under represent the stresses confronting the Ordnance Department in the initial months of the war. The need for skilled officers with a background in ordnance design and development was completely lacking, due mainly to Congressional restrictions, and Huston fails to address this critical piece of the delay. The work presents a good grasp on the political situation and overall view of industrial conflict, especially in regard to the changing needs of modern war. He makes the point again and again that it takes

longer to mobilize industry than it does to mobilize a conscript army. This idea was first promoted by Elihu Root and still holds true today.

All works that were written before World War II were unable to utilize a huge portion of primary source material as many Ordnance Department documents were not declassified until 1948. Almost all archival sources that I have relied upon, including the cablegrams between France and Washington and weekly briefs of American production were not available to earlier authors. This "new" information helps to fill in gaps and correct information that has been previously written.

UNITED STATES ARTILLERY ORDNANCE TO 1917

The United States Army went to war with Spain in 1898 equipped with black powder artillery and antiquated equipment designed to fight Native Americans on the Great Plains. This equipment was slowly replaced and upgraded so that by 1917 when the United States entered the Great War it was equipped with relatively modern equipment. This does not mean that the needed equipment was available. This transition was slow and painful for several reasons. Historians have discussed some of the reasons for decisions about outfitting the U.S. Army from 1900-1917 and beyond, but after almost 100 years the period remains a void of serious scholarship. To understand the outfitting of the American Expeditionary Forces (AEF) with artillery in France, one must return to the start of the twentieth century.

By 1900, America stood as the only real power in the Western Hemisphere. Spain had been defeated two years before, thus removing the last piece of Spanish colonialism that had lasted for 400 years. Little chance existed that anyone would attack the U.S. from abroad, especially a first-class European power. Antiquated American weapons, however, had distinct disadvantages against an enemy equipped with modern European produced arms. Therefore a reequipping would be necessary just to keep up with the major players of the Eurocentric world within the next decade.

All weapons increased in killing efficiency since the Civil War, but artillery had become the true king of battle. Field artillery would need to be completely overhauled to utilize new technologies. Field artillery is just that, artillery that can be transported into the field for the support of the infantry or cavalry. It must be light enough to have mobility but heavy enough to be effective. American officers historically viewed artillery as a support weapon, and this mindset dominated the

design and use of the piece even after this vision was changing in other armies worldwide. A horse can pull roughly 650 pounds and each light artillery piece traditionally utilized up to six horses making 3,900 pounds the ideal maximum field weight for artillery of the period.[1]

Field artillery could not do every job. Sieges and assaults on heavy fixed fortifications required heavier artillery, made up of a siege train. Siege trains were a cumbersome and delaying component of armies and did not travel with units on normal field operations. Unlike the frontiers of Europe that were dotted with Vaubanian type defensive systems of forts and fortresses, North America lacked large bands of defensive structures. Moreover, most that did exist were near the ocean and their destruction could be relegated to heavy naval guns. The most useful task of the Ordnance Department artillery designers was to produce a modern light field gun that could be pulled by the six horse team.

Artillery has several key parts. Until the end of the nineteenth century, artillery had two pieces: the barrel and the carriage. The barrel was made of metal, usually brass or iron, and eventually steel. The barrel included the mechanics of the breech and everything required to fire. The barrel sat on a carriage, the second piece. The carriage was the stable platform from which the barrel could be fired and had wheels to allow for movement and recoil when the piece was fired. At the turn of the century one more element was included in this mix: the recouperator, which allowed artillery to be rapidly and accurately fired with much greater effect. The recouperator was mounted between the carriage and the barrel and affixed to both. Recouperators utilize either springs, hydraulic brakes, or a combination of the two to absorb the kinetic energy produced through the release of the shell without physically moving

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[1] Benedict Crowell. *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918.*(New Haven: Yale University Press, 1921), 61.

the carriage. Minimizing physical recoil revolutionized field artillery because it increased the rate of fire up to fivefold over the older designs because the gun did not have to be moved and resighted after every round. One modern gun now had the same effect as an entire battery of four guns before.

Field artillery took one giant leap forward in 1897. The French introduced their newest creation: the Model 1897-75mm gun. The piece was the culmination of years of designs and experiences from the best gun engineers in Europe. The 75mm fired a 2.95 inch, 15 pound projectile to 5,500 meters. Its main asset was its rapid fire, expending 20 rounds per minute accurately with a faster rate possible with a well-trained crew.[2] The rapid-fire came from three key pieces. First, all munitions were fired fixed, with the projectile and powder in one unit, similar to a rifle cartridge. Powder came in the form of the new smokeless design. The second piece was the recoil mechanism. The 75mm used a complex hydro-pneumatic system to return the barrel to battery after firing and had a "long" recoil of four feet. This complex recoil system was so advanced that it was still a national secret in 1917 and would lead to a delay in American production. The last piece was a simple shovel-like device at the end of the trail to be planted in the ground that would keep the gun in place when it was fired.

The French adoption of the *Le canon 75 mm modèle 1897* made every other field artillery in the world obsolete overnight. American ordnance officers realized the need to replace the aging M1890 3.2-inch guns with a new piece incorporating modern characteristics.[3] The first proposal came from Captain Charles Wheeler of the Ordnance Department to simply mount the old gun tube onto a new carriage. This design was sub-par in performance and represented a need for a completely new

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[2] Ian Hogg., *Allied Artillery of World War I.* (Marlborough, Wiltshire : Crowood Press, 1998)37-42.
[3] Boyd Dastrup, *King of Battle.* (Fort Monroe, Va.: Office of the Command Historian, U.S. Army Training and Doctrine Command, 1992), 144.

design. The Board of Ordnance and Fortifications convened to discuss a replacement for the 3.2-inch gun. The board discussed three models: Wheeler's modified gun, the Bethlehem No. 2 and the Ehrhardt, which was of German origin. The board decided on creating a split design between the German and Wheeler pieces.[4] The gun, christened M1902, would be made in 3-inch bore and the first 50 would be produced at the Ehrhardt plant in Düsseldorf, Germany.[5] Subsequent pieces would be built at Rock Island Arsenal in Illinois.[6] By the end of the decade the regular army, the National Guard, and the United States Marine Corps had all been issued the M1902.

The M1902 was a significant improvement over the older designs. It had a range of 6,000 yards, hydro-spring recoil system, optical sights, fired both high explosive and shrapnel rounds which increased lethality, and was still well within the weight limits for operations in the field.[7] With the field gun taken care of, the Ordnance Department could focus on creating an in-house design for larger pieces. Designers created plans for a 3.8-inch howitzer M1905 and the M1906 4.7-inch gun. Unfortunately these guns were not produced in major numbers. The M1905 3.8-inch gun was "a failure" due to a faulty design and the 4.7-inch gun was never put into full production and existed only in very limited numbers.[8]

Nothing heavier than the 4.7-inch gun was developed past the drawing board by the U.S. Army previously because the U.S. had relatively stable neighbors. Canada was under the protection of Great Britain and the United States did not anticipate a war coming from the preeminent naval power. After *rapprochement* at the turn of the century, U.S. and British relations warmed enough for both countries to end defensive

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[4] Ibid, 146.

[5] Ehrhardt, named after its founder Heinrich Ehrhardt, would evolve into Rheinmetall, one of the largest defense companies in Europe and the designer and initial maker of the main barrel for the M1 Abrams Main Battle Tank today.

[6] Hogg, 48.

[7] Dastrup, 146.

[8] Hogg, 48.

postures against each other.[9] The only other neighbor was Mexico and until 1910 it was relatively peaceful.

Because neither Mexico nor Canada had a large standing army the United States felt safe enough to keep a relatively small regular professional army. The only plausible invasion would have to come from the sea, placing the front line of protection in the hands of the United States Navy (USN). The navy had been growing in power since the writings of Alfred Thayer Mahan in the late 1800s and had gained considerable funding in Congress. By 1914 the U.S. was the third largest naval force in the world, defending a massive continental coastline and newly acquired Philippines and other Pacific islands. The battleship was seen as the first line of defense to the United States. The second line of defense was the coast artillery.

By the turn of the twentieth century, the U.S. had acquired an extensive coast line. The war with Spain had produced several colonial entities, and it too had to be defended to protect American interests. The coast artillery was given a high priority within the budget of the war department. America had 26 fortified locations on the continent alone, distributed between the three coasts. Seventeen defensive locations were located on the Atlantic coast from Maine to Key West, Florida, five were built in the Gulf Coast region, and four defended the Pacific coastline.[10] This massive buildup of material represented the preferred posture of fighting a defensive war if possible at the beginning of the 1910s.

From its inception until 1906, coast and field artillery had been one joint bureau. The commanding officer was a brigadier general who had much of the same power of any other bureau chief. To produce well rounded artillery men, officers were trained in both field and coast tactics. Unfortunately artillery, like nearly everything

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[9] Paul Kennedy, *The Rise and Fall of the Great Powers.* (New York: Random House 1987), 248.
[10] Frederic Huidekoper, *The military unpreparedness of the United States; a history of American land forces from colonial times until June 1, 1915.* (New York: Macmillan Co., 1915), 326.

else in the military, was a highly technical branch and well rounded officers were usually not as effective as those who were experts in one subject. On 25 January 1907, the two disciplines were officially split, and the reform spoke deeply as to what Congress thought of field artillery. The reorganization allowed coast artillery to become a bureau service. It would have its own brigadier and full complementing staff. Field artillery was relegated back into the line. Artillery would fall under the command of the infantry, which delegated it a support role only. On 31 May 1907, General Orders 118 formed six regiments of artillery.[11] This allowed for the field artillery to re-specialize in a branch that had been neglected at a time when it was becoming much more important in armies around the world.

America was relatively safe from any major threat abroad. The vast distances of oceans allowed Congress to spend more on butter than on bullets. From the 1880s until 1917 the United States became the major industrial power, eclipsing every country in Europe. Steel production is usually given as a way to measure military power in modern warfare. In 1914 the U.S. produced more steel than Germany, Great Britain, Russia, and France combined![12] This production was used almost exclusively for civil purposes. The U.S economy was much more geared to making non-military goods than any of its European counterparts. "Splendid isolationism" allowed the U.S. economy to surpass the Old World one country after another. A European war did little to hurt the U.S. industry, in fact, the mass destruction would see the United States gain a larger share of the world market in steel and other necessary wartime materials.

Conflicts outside the Western Hemisphere illustrated the changing face of war. The Russo-Japanese War was in many regards an oracle war. It demonstrated for the

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[11] Dastrup, 158-159.
[12] Kennedy, 244.

first time the use of heavy artillery, indirect fire, high explosive (HE) rounds and barbed wire to great effect. The lessons of the war established that artillery would have a growing place on the battlefield and that wherever artillery was used, high casualties would follow. Many European armies realized that rapid fire artillery had risen in effectiveness and increased the amount of artillery to bayonets ratio; the main method of calculating the distribution within armies. The United States army, though, did not increase in either size or percentage until well into the second decade of the century. It would not be until after World War I started that Congress would increase funding to the War Department.

The United States Ordnance Department kept up with new designs during 1900-1917. Congress charged the Ordnance Department with providing the army weapons. A list of equipment revolving around the weapons of the U.S. land forces was huge. Infantry had to be equipped with rifles, ammunition, and cartridge belts. Cavalry needed sabres and pistols. Artillery required guns, munitions, and optical sights. All of these needs had to be provided by Ordnance. Although the needs of the infantry and cavalry were large, manufacturing a sabre or rifle was infinitely easier than producing an artillery piece. A common factor lay within all ordnance products: no civilian use or alternative product existed and everything had to be built by government arsenals or under specific contract. The Quartermaster Department found the task of outfitting troops difficult, but manageable, because many of the goods it had to procure were also used by civilians with little modification such as canvas and boots. The civil industries made goods without having to rotate factories onto a wartime footing. Ordnance was not afforded this luxury, and this was a main reason for the government arsenals and armories scattered across the United States.

Six arsenals existed before the war for the production of all the products necessary for the Ordnance Corps. Watervliet Arsenal in upstate New York made cannon along with some naval guns. Watertown, Massachusetts made carriages of all types and armor piercing projectiles. Springfield Armory in Massachusetts produced all rifles, pistols, and machine guns. Frankford Arsenal, in Philadelphia, Pennsylvania produced ammunition and fire control equipment. Picatinny Arsenal in New Jersey produced powder and high explosives. Finally, Rock Island, Illinois produced field carriages, caissons and other vehicles, artillery harness, targets and rifles.[13] In addition to these locations, the Ordnance Department ran a proving ground at Sandy Hook, New York to test and inspect all artillery before issuance. It also ran smaller arsenals in Benicia Arsenal in San Francisco, California to repair all equipment on the Pacific Coast, and Manila Ordnance Depot in the Philippines to keep the units on that island properly equipped, as well as several smaller arsenals around the country.[14]

Despite the massive job of developing all ordnance equipment, managing all depots, producing weapons and equipment, and managerial staff positions, the department was woefully understaffed throughout the period before the U.S. entrance into World War I. Very little has been written in recent historiography about the role of staff officers. Line officers receive attention in secondary literature, but Washington staffs other than the General Staff are woefully understudied. It is this story that helps explain fully the breakdown of the War Department in 1917 to effectively raise and deploy the AEF.

The 1906 Defense Appropriation Act authorized the Ordnance Department one brigadier general as a chief of the bureau, six full colonels, nine lieutenant

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[13] William Crozier, *Ordnance and the World War; a contribution to the history of American preparedness.* (New York, C. Scribner's Sons, 1920), 21.

[14] Officers assignments before the war, Record Group 156, Records of the Chief of Ordnance, entry 178. National Archives II, College Park, Maryland. (hereafter cited as NARA).

colonels, 19 majors, 25 captains, and 25 first lieutenants.[15] This staff of 85 officers had to complete all the assignments of the department. This was nearly an impossible task even for the small needs of the peacetime army. The department had too many directions in which it was pulled for the manpower. The design aspect was one of the most neglected responsibilities. Only experienced officers, usually those above major, possessed the requisite experience to design new systems. Unfortunately these experienced officers were almost always in staff jobs running the day to day business of arsenals, proving grounds, or the Washington offices. In April 1917 only ten officers possessed any training in designing artillery.[16] One of those was the Chief of Ordnance, Brigadier General William Crozier. Nearly every other officer was smothered behind excessive paperwork. This limited their work designing the next generation of artillery which would meet the needs better of the artillery branch and the nation's defense.

Congress had the authority to increase the staff of the army departments although no change was implemented from 1906 until the eve of war in 1916 for the Ordnance Department. Within that time period great powers undertook a massive evolution in gun design. Many first generation modern weapons were either replaced or modified to gain increases in range or lethality. Unfortunately, this did not happen in the United States. Ordnance did advance during this period in regard to coast artillery. The vast majority of the funds allotted to the department went to this cause. The years 1906 to 1916 saw a huge expansion in defenses everywhere from the strategic Chesapeake Bay, to the foundations of building Fort Drum, a massive complex defending Manila Bay, and defense of the Panama Canal Zone, which was being built in this period.

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[15] Huidekoper, 319.

[16] Benedict Crowell,, *Americas Munitions 1917-1918.* (Washington: Government Printing Office, 1919) 25.

The focus on coast artillery produced several interesting effects. Building a large gun was both a science and an art. The extreme firing forces involved grew exponentially with the projectile size. Guns as large as 16 inches were being experimented with for coastal defense.[17] By far the most common guns were of the 5 and 6-inch models. The defense of the Panama Canal Zone is of particular interest for the sheer amount of resources that were given to its defense. Two 14-inch guns were placed at each side of the canal, custom made for that location. The 1913 Sundry and Civil Deficiencies Acts set aside $2,506,000 for these guns.[18] By December 1914, 1,299 guns had been placed at coastal sites all over U.S. possessions. Manning these guns required 30,309 enlisted men and 1,312 officers, including spotlight, mine, and staff officers for the United States and all territories.[19] Unlike the regular army, the coastal defense had to be at full strength to act as the tripwire for an imminent invasion. The total authorization by 1915 was only 80,000 men and 3,441 officers.[20] Well over one quarter of the entire strength of the United States Army was allocated for coast defense.

The Ordnance Department realized that static forts were liabilities because it allowed only one location to be used in defense, especially in areas such as the Chesapeake Bay. After the turn of the century designers started working to solve this. If a system could be created to move the same gun in several locations it would be much harder for invading ships to overrun the initial defenses. This brilliant idea did have major drawbacks. Manufacturing a carriage capable of moving a gun ranging from 70 tons for an 8-inch gun to 256 tons for a 14-inch gun challenged designers.[21]

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[17] Hogg, 189.
[18] Huidekoper, 417. It appears thought that the 16-inch gun that was scheduled for the defensive system was never placed which is included in the appropriation.
[19] Ibid, 485, 481.
[20] Ibid, 466.
[21] Hogg, 219.

Horse and vehicle were out of the question, which left the idea of mounting coastal artillery onto railway mounts. By 1917 experimental models had been placed in the defense of the Chesapeake Bay with satisfactory results, but it had not been put into full production mode when war was declared. These experiments proved that heavy guns could be moved and fired from railway carriages on standard gauge line and moved with locomotive power. This discovery would pay dividends not in the Chesapeake, but in France.

The United States was not the only country to experiment with railway guns. France had also experimented with this idea in the 1880s, but had cancelled the program without producing an acceptable design. France picked the idea back up after static lines became the rule instead of the exception in late 1914 and early 1915. The Ordnance Department might have seen the writing on the wall for the necessary need to use existing resources in an overseas conflict. The project would steal precious energies from the Ordnance Department, a commodity that was less rare in other parts of the world.

The United States was the only major country in the western world that made all of its ordnance in-house. Europe had a major defense industry by the turn of the twentieth century but Europe's constant arguing over borders and ethnicities had created a charged atmosphere that private arms manufacturers were able to provide weapons for these conflicts. These private manufacturers developed and built complete weapons systems under government contracts. Krupp, Rheinmetall, Vickers, Armstrong, Skoda, Schneider et Cie, St Chamond, and Coventry were just some of the main makers of weapons that would revolutionize modern warfare. Their designs armed every major power in the Great War, including the United States.

Private firms did have some advantages over government arsenals. Building any type of ordnance is an art, especially at the turn of the twentieth century. It took years and sometimes decades to train a craftsman in the arms industry. The seemingly trivial fine polishing of a slide might make the difference between a weapon working or failing. The artisanal nature of design and production was natural to the cottage industry that grew to giant proportions during the second industrial revolution. These workers spent years as apprentices before gaining the knowledge necessary for the job. Workers had some flexibility in the design process. An experienced worker often had the ability to tweak the design to produce a higher quality product. Blueprints might say one thing, but the finished product might be altogether different in small details of construction. Specific dimensions were considered state secrets and were only available in the mind of the specific craftsman who had built the piece for years. Artillery design could be fine tuned by experienced workers without the necessity of a professional gun designer looking over their shoulder. The massive size of some of these operations such as Krupp and Schneider also allowed profits to be reinvested in the most modern equipment, making a more efficient and streamlined process. Private firms were also more willing to not put all of their eggs in one basket. New designs were tried and experimented with, and, if successful, the contract would usually more than pay for their entrepreneurial cost. With so many trained people, more ideas could be floated because designers were not burdened with the administrative work of the government employees and staff. The system of arms manufacturers was the only way that a modernized, mechanized war on the terrific scale of the Western Front could have happened.

The American system was quite the opposite in many regards. All weapons making was done within the arsenals and it appears that blueprints were followed

exactly, allowing interchangeability of parts, an American pastime in armament since the Hall rifle in the antebellum period. Ordnance was produced under the close supervision of an officer of the Ordnance Department at one of the six arsenals. American private industry at this time was based on mass production techniques that required little training or artisan skill. The only workers in the country that had any experience building large pieces of artillery were those at Watervliet Arsenal in upstate New York. No other manufacturer had built castings or finished pieces with such tight tolerances as required by artillery before 1914. This style of manufacturing stressed quantity to quality, which could be helpful in total war if it could be groomed for certain precise characteristics.

In addition to being the only locations on the continent producing ordnance, the government arsenals were woefully understaffed for their job. Watervliet Arsenal only had four officers stationed there and Rock Island had nine. Therefore the only two forges in the government service in 1916 had a grand total of 13 officers who had to manage everything from orders to supply, including harness building, gun proving, gun manufacture and personnel. The only experienced gun designer was not even at an arsenal. Lieutenant Colonel C.C. Williams was the most experienced modern designer of pieces in the service, but he was stationed at New York City, where he was close to Sandy Hook Proving Ground. Williams served on several boards during this period, including the Ordnance Board, Gun Forging Board, Engineer Board, Powder Board, and the Board for Testing Rifled Cannon.[22] Williams would become arguably the most important officer in the department after war was declared.

By 1915 General Crozier was loudly clamoring for more officers in the Ordnance Department. The needs of the army were growing, but the department was

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[22] Officers assignments before the war. NARA Record Group 156, entry 178.

not. Congress realized by 1916 that no matter how isolationist the United States was, the military was inadequate. The 1916 National Defense Act increased the size of the military substantially although it still did not achieve everything that was needed. The act authorized a regular army of 175,000, nearly double its size. It also authorized 57 more officers in the department. There was a catch though. The growth was scheduled over a five year period with 11 or 12 officers joining every year. The act authorized each year one colonel, one lieutenant colonel, two or three majors, three or four captains and three or four lieutenants.[23] Captains and lieutenants though usually took one to two years to train and were not available for immediate use. The department would grow, but it would rise by only 65 percent as compared to the army that was growing by nearly 100 percent. On 6 December 1916, General Crozier complained to the Secretary of War that the Ordnance Department was getting further behind.[24] The National Defense Act for all of its positives still did not iron out all of the problems. Although the National Defense Act of 1916 looked good on paper, the law actually made their work load worse. Because the army was increasing, more troops needed outfitted. This required more money from Congress, which did not cover the new troops. Overall, the new ratio of staff officers to soldiers dampened the ability of the department to take initiative in design and manufacture.

The National Defense Act had created from a need to increase the size of the military that had developed in the last six years. Events in North America and Europe were the main contributions to the need. The first threat was mainly perceived on the southern border.

In 1911 a civil war erupted in Mexico. The relatively stable and democratic dictatorship of General Jose Diaz was overthrown by revolutionaries. Several rulers

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[23] Ibid.
[24] J. Franklin Crowell, *Government War Contracts.* (New York: Oxford University Press. 1920), 67.

ran the country between 1911 and 1917, including Francisco Madero and Venustiano Carranza.[25] Interestingly, the conflict increased American security as any effect the Mexican army had before the revolution became minimal at best after Diaz was overthrown.

On 9 April 1914 a whaleboat from the USS Dolphin anchored at Tampico Harbor on Mexico's Caribbean coast was captured its crew. Although the crew was quickly released and an apology was sent back to the fleet, the wheels were set in motion for an intervention. Admiral Henry Mayo demanded that a formal apology be sent to the fleet, an American flag be raised in the town, and a 21-gun salute would follow.[26] This event caused the U.S. Army and Marine Corps to be deployed to Veracruz Harbor. The Veracruz campaign demonstrated perfectly how the U.S. experience in utilizing artillery was constabulary in nature as compared to the Europeans who were about to use them in full force in the initial stages of the Great War.

In addition to Veracruz, the 1916 "Pancho" Villa raid on Columbus, New Mexico also occurred. In retaliation, President Wilson ordered Brigadier General John Pershing to pursue the bandit. Pershing's force included all three arms of the military, but the artillery contingent only consisted of the 6th regiment, which was arguably the best in the army at the time. The pursuit was fast paced and broke United States Army records for endurance. Pershing never caught up to Villa's men, even after penetrating hundreds of miles into Mexican territory. The Punitive Expedition's last elements were removed on 5 February 1917 and represented the end of an era for the US Army. The experience was the culmination of the Army's past. It represented an offensive pursuit against a guerilla force. Artillery was of little use and heavy artillery was

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[25] John Eisenhower, *Intervention! : The United States and the Mexican Revolution, 1913-1917.* (New York : W.W. Norton, 1993), XIV.

[26] Ibid, 99.

nonexistent. The rifle and bayonet were the main weapons. When the army left Mexico little did it know that everything it had learned on the Plains chasing Native Americans and quashing second-rate powers within the sphere of the Monroe Doctrine was about to be thrown to the wayside. It was about to be called to the big leagues.

While Pershing was chasing Villa in the deserts of Mexico, the greatest battles in human history were raging in France. Verdun commenced in February and the Somme started in July of 1916. Both battles demonstrated the culmination of years in armament design and two years of constant near static warfare. The Great War started as a battle of movement but after the Race to the Sea, the line stalemated. Improvements in weapons over the last fifty years rendered the defense superior and trench warfare was the result. A slow war of attrition where industrial and financial might would decide the winners developed. The armies on both sides of the Western Front scrambled to supply heavy artillery, which had been absent in the fast-paced design of armies in 1914.

By 1916, European industry had fully mobilized for wartime production. The war in 1914 was based on élan; by 1917 it was based on how effective the belligerent industries produced material. Victory was now decided by who could continue to keep war material flowing to the front lines. Artillery became the primary consumer of this industrial output by the needs of more munitions and bigger guns.

Modern, quick-firing artillery had been proven a formidable force in the Russo-Japanese War. It wasn't until 1914 that it was proven to skeptical Europeans. Throughout the Great War, the vast majority of all casualties were caused by artillery. Europeans had built bigger pieces that fired heavier projectiles to distances never before imagined. By 1917 European heavy artillery production was adequate and

new, more efficient and standardized designs were appearing on the field. While the United States was paying attention to their little war on the border, it spent few resources and little time building new pieces for the changing face of battle. Only one project in field artillery had taken place and by April 1917, was still not completed: the M1916 3-inch gun, the planned replacement for the M1902.

When the United States entered the war on 6 April 1917 the army possessed 544 M1902 3-inch guns. These were spread from the Philippines to the Atlantic Ocean. To compliment the piece, 60 M1906 4.7-inch guns were in American arsenals.[27] The entire arsenal had 604 modern guns, none of them heavy. In perspective, when the British attacked the Somme on 1 July 1916, the German army had 476 guns in the sector, many of these heavy.[28] It must be considered that this had been a quiet sector. In other words, the entire arsenal of the largest industrial country in the world was barely adequate for the defense of a quiet sector of the Western Front by 1917. To say the least, the U.S. needed miracle to arm the AEF in a very short time. The daunting task fell into the lap of the Ordnance Department.

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[27] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 61.

[28] Robin Prior, and Trevor Wilson. *The Somme*. (New Haven: Yale University Press, 2006), 55.

1917: MOBILIZING FOR WAR

A strategic transformation occurred as the United States entered the Great War on 6 April 1917. Russia had been pushed to capitulation and the Hapsburg Empire of Austria-Hungary was relegated to German vassalage. More importantly, France showed great duress for the first time. The involvement of the United States represented the greatest variable: would the U.S. arrive in France in sufficient numbers before it was all decided?

France had constantly bled since 1914 in futile attempts at offensive warfare. The 1917 spring Neville offensive seemed to be a continuation of this strategy. The French *poilu* had seen enough needless bloodshed though and by April and May entire units started refusing to go over the top. The act of defiance continued until General Robert Neville was replaced by General Philippe Pétain, who realized that the French armies were at the breaking point. He convinced the high command that a defensive position was necessary to both regain confidence and morale within the units. He also realized that time favored France. With the American entrance into the war, all France had to do was to hold on until the American soldiers could arrive, and then sheer numbers of men and material would overwhelm the German foes.

The American peacetime regular army was puny in comparison to contemporary European armies. The post-1900 force was well equipped, but surplus equipment had not been built up to aid a rapid expansion of forces. Artillery was the weapon of greatest need. It took the longest to produce of all land weapons in 1917 and therefore stockpiles were necessary for a quick build-up of forces. The department had four options for rectifying this deficiency: it could alter the equipment of the AEF; it could also produce them within the highly trained and specialized government arsenals, which took time. It could expand the civilian sector into military

production, or it could purchase abroad, if possible suppliers existed. In some regard all four of these occurred.

The strategy of unit development that the United States followed in the Great War was determined more by necessity than by choice. Two interconnected restrictions more than anything else would determine the composition and equipment of the AEF: shipping tonnage and artillery. Pershing created the AEF with "square divisions," meaning every division had four infantry regiments, two machine gun battalions, and three artillery regiments. Two of the artillery regiments were field pieces and one heavy.[29] Each regiment required 24 guns, so therefore each division required 48 field pieces (75mm) and 24 heavy guns (155mm howitzer). The American army had enough artillery once it entered the war to outfit ten divisions with M1902 guns with sufficient spares to replace worn and damaged guns. Most of this artillery was in the Philippines so the decision would have required recalling all pieces. Enough existed in April 1917, however to outfit all divisions until March 1918.[30] This strategy of pulling all M1902 guns would have had several drawbacks. Most guns would have been shipped to Watervliet Arsenal for relining before service in France.[31] Also, the gun's removal would have eliminated all training pieces for units in the United States until new ones could be produced. Another problem was that the M1902 fired the 3 inch (76.2mm) shell. No other army in Europe used this round. Every round would have to be produced and shipped from the United States, which took away tonnage from moving more important supplies such as men and raw materials, which could not be supplied in France. Consequently, it would have become

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[29] David Trask, *AEF and Coalition Warmaking 1917-1918*. (Lawrence, Kan.: University Press of Kansas, 1993), 18.

[30] John J.Pershing, *My Experiences in the World War*. Volumes I (New York, Frederick A. Stokes Co., 1931), 106.

[31] The M1902 would have likely needed relining just like the M1916. This was to delay required maintenance and extension of the lifespan of guns for service in France.

increasingly more difficult to keep the AEF supplied as the army grew, taxing the merchant marine increasingly with every additional man in France. As Sir Harry Wilson stated at the Supreme War Council in December 1917, "*C'est toujours un question de tonnage.*"[32] Thus the strain of shipping demanded that United States accept the 75mm and 155mm French pieces.

Interestingly, little analysis of the AEF artillery and its ramifications on the effectiveness and even development of the American Armies under General John J. Pershing has been conducted. American divisions were notoriously large; nearly double the size of their European counterparts. American divisions, though, were given a compliment of 48 field guns. This is the same number as a British division and four less than a French division by this time. Therefore American divisions had much higher ratio of bayonets to guns than everyone else on the Western Front. This came at a time when artillery was taking a bigger role on the battlefield. By 1917 it was widely accepted that artillery was inflicting the highest amount of casualties of the combat arms. France had increased the number of 75mm guns per division from 48 to 52 and before the end of the war had increased it even more. Why would the United States purposely lighten their divisions of artillery in comparison to their European counterparts? One of the possible explanations appears that the lack of available artillery had forced Pershing to accept a larger division so that what was accessable could be in reasonable numbers.

In April 1917 a "crisis" formed in the United States. The need to arm the newly raised AEF created havoc among industry with predictable results. Hoarding slowed the effective deployment of equipment, and created general chaos that continued until August 1918. The United States realized early on that the war would

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[32] Captain Peter Wright, *At the Supreme War Council*. (New York, London, G.P. Putnam's Sons, 1921), 41.

in all likelihood last longer than the immediate crisis. In fighting a war that was to last into 1919 or even 1920 or later, the U.S. developed a strategy of protracted warfare in the field.

Industry in the United States was to be geared for the long haul to achieve the army's goal. Few, if any predicted that the 1919 campaigning season would not happen. Based on these parameters the Ordnance Department tackled the armaments dilemma.

United States field artillery was caught in a transition period in 1917. The old M1902 gun was slated for replacement. By 1917 improved technology had rendered the M1902 obsolescent and thus the transition was considered essential by the Ordnance Department. The 15 years of experimentation and outside knowledge both influenced the next generation design: the M1916.

From 1895 until 1918 artillery technology grew at a quicker rate than every other weapon. In 1897 France made the first truly modern field piece with the legendary "French 75." By 1911 that piece had been surpassed by a second generation of field artillery. Leading this generation was the Italian Model 1911 75-mm designed by retired French Colonel Joseph-Albert Deport. On the Italian 75, the gun tube was not the radical piece of engineering as previous artillery improvements had been; the carriage was. Older models like the French 75 had a box carriage with a solid one piece trail, which was simple and rugged in construction but limited the barrel in elevation. The range of guns with this carriage was severely hindered by the horizontal depression that could be reached before the breech would rest on the carriage. The Deport carriage attempted to eliminate this problem by removing the one piece carriage and replacing it with a split carriage. The carriage would be folded in times of transport, but when put into battery the legs would fold out similar to a

pair of scissors. This allowed much greater flexibility in range with no alteration to the barrel.[33]

It was this improvement that the US Ordnance Department wanted to capture with the new M1916. The split trail offered the advantage of greater range, but advances in design also allowed the barrel greater traverse, or motion allowed from side to side, without moving the carriage. The split trail was not a silver bullet though. Because the new design could be further depressed, the recoil mechanism had to be planned in a second-generation design that allowed for variable recoil lengths. The higher the degree of elevation, the more the recoil had to work harder to place the tube back into battery. Not only did it have to overcome the initial recoil but also increasingly the gravitational vertical force that was not factored in with older, less flexible designs.

The production model M1916 had been made in some number before the war broke out. According to drawings, serial #1 was finished by 14 March 1916, 33 more pieces had been produced by 3 April 1917. Beginning with gun #35, all M1916s were initially made in 75mm. The first 34 guns were sent to Sandy Hook Proving ground for testing, and were returned to Watervliet for relining into 75mm bore which had become the U.S. standard on 5 June 1917.[34] This process had been completed by 7 November. The gun had several modifications, which were simply identified by an "M" designation. Serial #1 was the only M1916 produced. 2-34 were known as M1916 MI. Numbers 35 through 263 were the first guns modified to the 75mm calibre and were known as MII. 263 through the end of production were MIII. This final version appears to have been at the request of manufacturers who found the complicated mechanisms of the recouperator too difficult to manufacture. The

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[33] Hogg, 59.
[34] Harvey Deweerd, "American Adoption of French Artillery 1917-1918," *Journal of American Military History* Summer 1939, 110.

modification was for the simplification of the forging and final assembly of the recouperator only. It appears that the only modification with the barrel is the absence of the latch catch that is missing in the parts list for the MIII. The first drawings for the modified 75mm gun were submitted on 16 June 1917, quickly after the first meeting between Crozier and André Tardieu. General drawings for the MIII were started in November 1917 and completed by 7 February 1918. Most contracts for the M1916 were let before December 1917 and therefore most guns finished before 1919 were likely built to the MII specifications.[35]

It is possible the United States might have found a way to avoid converting to French calibres. The 3-inch is identical to 76.2mm, the standard bore of Russian artillery. France produced rounds for the Russian artillery nearly the entire war at André Citroen's plant in Paris.[36] Had the Russians left the war earlier, the current orders for Russian shells could have been converted to the American design. No cablegrams or contemporary sources mention the option of using the factory to continue producing ammunition in France for the American made pieces. It is unclear why this option was completely discarded. In all likelihood, the Russians were seen as being more stable than they really were. By June the United States decided to reengineer the current M1916 to the French calibre, and eliminate their need to worry about ammunition from the United States.

The wholesale transformation of artillery came at the best possible time in the process. Existing MI models were used as the test beds and then relined as required by the redesign, allowing for an extensive testing without worrying about wear and tear.

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[35] Architectural drawings, Record Group 156, Records of the Chief of Ordnance. Entry 4. Level 3 Architectural Records Section, NARA. Entry 4 contains several drawings containing the above documentation. About a dozen drawings mounted on wood make up the folder and between submission dates and tables complementing the actual drawings can the information be inferred. Particular dates for the MIII are taken from the tracing "75 M.M. Field Gun Model 1916 MIII General Drawings."

[36] Service Historique de l'Armée de Terre, Château de Vincennes : Paris, France 16 N 705.

As a result, the gun that did go into production was thoroughly tested. All guns made after serial #34 were made already in the 75mm and required no lining before proofing and shipment to France. The gun continued to be tweaked and modified through the production stages, but actual production appears to have never been hindered by improvements.

The decision to adopt French artillery seems to be multifaceted. Political, technical, and even logistical reasons forced the main American procurement effort into the French decision. The entire issue of amalgamation of American troops into existing French and British units created the first major controversy for Pershing. Both countries fought hard to acquire fresh American blood to invigorate their bleeding armies. The French though had sent early in the conflict *Maréchal* Joseph Joffre to provide assistance to the U.S. and especially Pershing. His influence in shrugging off much of the French pressure eased French-American relations.[37] The British still insisted well after Pershing had made up his mind, with Wilson's approval, to badger the issue. This led the Americans to feel that the French were a less hostile audience which allowed for easier discussions with the French envoys. If the Americans had accepted amalgamation, artillery acquisition might have been less important because the units would have already had the built-in infrastructure without having to mobilize the American industrial base, at least for these armaments.

Pershing was not the only officer that had to make the decision. The Ordnance Department was still in charge of procuring artillery, even in this emergency situation and it felt that the British guns were inferior to those of France.[38] No British field guns were ever used by Americans in forward areas, and those of British procurement were only used to train troops in rear camps. The American government did accept

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[37] Robert Bruce, *A Fraternity of Arms*. (Lawrence, Kan.: University Press of Kansas, 2003), 46-47.
[38] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 96.

the British 8-inch and 9.2-inch howitzers for front line service, but these were more of a stopgap until French designs could be procured for the British patterns were seen as inferior.

Logistically, it made sense to use French pieces. All ammunition would also have to be procured through the respective governments of origin that produced the artillery. The railways from English controlled ports to British troops were overtaxed by the summer of 1917.[39] This would only get worse if American ammunition would also have to be moved. The French had rebuilt their stocks since Verdun's lows, enough to supply American artillery with plenty of rounds. The existing railway system in French areas was still in good shape and the extra ammunition would not overburden the system. One munitions train was made up of 30 railroad cars and weighed 500 tons at full capacity, carrying 50,000 75mm rounds.[40] This was only enough ammunition to feed about seven divisions of field artillery for one day at the average daily usage for the French army at Verdun.[41] The First American Army alone would need four such trains just to feed the field artillery per day. Also, French ammunition would not require ship-borne movement, freeing up badly needed tonnage.

France managed a far larger segment of the Western Front than their British counterparts. Accepting French guns meant that the AEF could be placed in many more places as compared to a similarly British equipped force. The American forces would be limited to either the Channel region or a small area between the French and British armies. French armaments could be delivered to the relatively quiet sectors in eastern France that would be key to training before major battle.

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[39] Pershing, p 81.

[40] Maj. Condée, *Lecture on the Supply of Ammunition- September 1917.* (Washington: Government Printing Office, 1918), 14-16.

[41] Ibid, 13. 150 rounds per gun per day X 48 guns per division = 7,200 rounds per division, 50,200 rounds for 7 divisions.

With the obvious choice of French armaments in hand, the two countries commenced discussions in the middle of June 1917 in Washington, D.C. Meetings between General. Crozier representing the United States Government and the French High Commissioner, André Tardieu, proceeded for a month and concluded 14 July. The primary result of this meeting was an agreement between the two countries for the French to provide American forces with the 75mm gun and the 155mm howitzer.[42] By 1 August the two guns had been procured in such levels as to support the first 10 divisions, along with ammunition.[43] The agreement was the first stepping stone towards the final goal, but did not meet all of the AEF's needs. The agreement only guaranteed French supply to the first million men to arrive. When the AEF's deployment plan switched from the ambitious one million to the logistically absurd five million man army, more artillery would have to be requested. The agreement was for the main two weapons needed, the light field piece and the medium howitzer. The agreement did not mention the medium gun, the famed 155mm *Grande Puissance Filloux,* (very powerful designed by Filloux) or GPF gun, which was just being built. Nor did it include heavy howitzers or the very heavy 240mm howitzer. These would have to be ironed out later, but the Tardieu agreement did at least provide the AEF with a start as it arrived on French soil.

In August another agreement, this time taking place in France, gave the U.S a supply of 155 mm GPF guns. André Tardieu and Pershing, likely aided by newly promoted General Williams, agreed on 22 August for a monthly delivery of 12 guns per month in 1917 and the same or greater in 1918. This gave the AEF a high velocity medium range weapon that would be essential to coming offensives.[44]

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[42] Crozier, 219.
[43] Summary of AEF Cablegrams Record Group 156, Records of the Chief of Ordnance. Entry 511, Box 1, NARA. (henceforth cited as "cablegrams") 1 August 1917 (273-6 Page A).
[44] Crozier, 223.

In the autumn of 1917 Col. House was sent to Europe to gain access to the rest of the weapons necessary for all divisions that would arrive in 1918. The House commission met with both the British and French authorities and by 5 December, 1917 had arranged for all troops that arrived in 1918 to be outfitted with European made arms.[45] The House commission did the majority of the legwork for the Interallied Ordnance Agreement that was signed by the Supreme War Council. The United States, at least officially, now had the artillery and ammunition for the First Army through June of 1918.[46] The agreement was even more impressive in light of the Italian collapse at Caporetto. The defeat created a massive shortfall in allied artillery that had to be sent to replace the Italian stock lost. This breakthrough allowed several strategies for the Americans to pursue. First, it allowed the AEF to be sent over en masse without equipment that took up vital tonnage. Second, it allowed the United States to gear up its factories for the 1919 campaign season when the Second and Third Armies of the AEF would be outfitted with American-made arms. The United States would be allowed to take the strategy of long term production instead of worrying about the emergency that had emerged in April.

While officers of the Ordnance Department were trying to acquire guns from the allies, those back home were trying to gear up industry to produce pieces no matter how the bargaining came out. The task of transforming America's industry to a wartime footing was a monstrous job. Luckily some precedent had been set but the task of outfitting a modern fighting force still loomed as the biggest battle of the war.

The United States had some experience with procuring large amounts of ordnance in an emergency status. The Civil War created a need for equipment in 1861 similar to that in 1917. When the U.S did finally enter, most of the friction caused in

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[45] Ibid, 225.
[46] Crowell, *Government War Contracts,* XVIII.

1861 and 1862 was largely avoided because laws enacted in regard to procurement were still on the books and therefore the time consuming task of legislation making was avoided.[47] Ordnance still had to find firms that were willing, and even more importantly, able to build artillery pieces. In this regard the U.S. had willing executives, but lacked the experience or building space. Only two American firms had experience in building artillery, both for the British during the first years of the war. Bethlehem Steel and Midvale Steel, both of Pennsylvania, had been producing the British 18-pdr and 8-inch howitzer under British contract.[48] These two firms represented the sum total of all ordnance experience located outside of the federal armories. Although these firms had experience, they also had their current contracts that they had to fulfill for the British which would take them through the end of 1917 or later. An early agreement between the British and American governments allowed U.S. orders to be placed with these firms once the current contracts had been fulfilled. Therefore the only private industry that could produce artillery would be busy for the immediate future. Private industry with little to no experience would have to be pursued to fill the orders.

Finding American factory space took up most of 1917. Many companies were willing to undertake the projects, but lacked the space or equipment to build them. As a result the government became the funding source for a whole array of modernization in American industry. The biggest of these projects was to build a completely new foundry at Neville Island, outside Pittsburgh. The factory, once completed, would produce up to 200-18-inch guns simultaneously. This production capacity was unheard of in the United States and would have rivaled the Krupp works of Germany. United States Steel was to build and operate the facilities on behalf of

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[47] Ibid. 19.
[48] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 21.

the United States, and once the conflict ended the works were to be kept by the government and become an arsenal, possibly a replacement for Rock Island, because the cost of the construction was paid for by taxpayers. This factory, when built would have been capable of producing the long range guns that only Watervliet could build and would give a distinct advantage if the war became protracted past 1920. The plan for long range 14-inch 50 caliber similar to the M1910 MI guns was to include capability for 165 tubes that could be mounted on 80 carriages, which allowed for spares as soon as the tube wore out. This was to be completed by the 1920 campaign season.[49] The contract for this massive complex was let in July 1918 with plans for it to produce 120 million dollars in gun products.[50] The building was only partially finished when the war ended, and all construction stopped by January 1919 with the last settlement following in February of that year.[51] Not all projects were so massive, however. Most improvements were for either new buildings to increase output of existing facilities or additions to previous works. Two examples of these fruitful projects were with Dodge Brothers of Detroit, Ohio, and Wisconsin Gun Company of Milwaukee.

Dodge Brothers was one of the first parties interested in producing artillery for the government. A new building was built at their Detroit automotive plant to build the French 155mm howitzers and guns. When finished, the plant produced five complete 155 GPF guns a day and 12-155 howitzer recouperators a day, an amazing

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[49] Cablegrams, NARA 16 Feb 1918 (607-1 Page U).

[50] Contract # P7466-666-C Record Group 156, Records of the Chief of Ordnance, Entry 148, Volume 8 NARA. Contract for 120,000,000.00 with an end profit of 2,733,244.73 for U.S. Steel Corp.

[51] Exhibits and reports submitted in connection with the claims of the US Steel Corp., Pittsburgh Pa, relating to the construction of the Neville Island Gun Plant 1919-1920. Record Group 156. Office of the Chief of Ordnance, Entry 292. NARA.

feat for a span of just over a year for a company that had previously only built cars and trucks.[52]

Wisconsin Gun Company was also a recipient of government funding to enlarge their facilities. Contracts were let in September 1917 for production of M1916 guns at a rate of three forging finishings a day. Before guns could be produced though, a new manufacturing building had to be constructed and machinery delivered and assembled.[53] This time consuming process was the norm for virtually every contract for the production of artillery. Because of a lack of finishing ability, the final stages of manufacture were hardest hit, and subsequently saw the longest delays in production.

Gunmaking was broken down into two parts: forging and finishing. Creating a raw forging required foundries that could create the massive general casting. The 155mm GPF had a casting that was almost 20,000 pounds, which caused difficulties creating ordnance that demanded tolerances of plus or minus a few thousandths of an inch. These castings would then be moved to a finishing facility where the recouperators and barrels would be finished to the fine specifications needed. A few of the contractors were able to complete both stages in house, but most only had the expertise to complete one before sending it to another firm for the specialized work. Travel increased the time needed to complete the piece and also taxed the railway system. In the end the positives outweighed the negatives because the pieces would be built, which was better than the alternative.

Geographically, the contracts were limited to a relatively small section of the United States. The band of Midwestern and upper Atlantic states gained the greatest

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[52] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 71.

[53] Miscellaneous Contracts for Ordnance and Ordnance Equipment 1917. Record Group 156, Office of the Chief of Ordnance.

share of contracts. Only one contract was placed for a vendor west of the Mississippi and that was for gun armor. The vast majority of contracts were placed in the band around the Great Lakes from Wisconsin to New York, more commonly now known as the "Rust Belt."[54] No artillery contracts were placed on the Pacific Coast or the South. This discrepancy makes sense since both California and the South were underdeveloped industrially in 1917 and placement of contracts with spread out firms would have increased the time and confusion of supply. The badly needed experienced workforce was centered on the old industrial towns that had worked with metal fabrication before the war, and therefore no massive migration of skilled labor was necessary.

While ordnance officials were trying to create factories and increase production stateside, they also had to acquire designs to produce at those factories. The conversion of the M1916 has already been discussed, but the US was trying to find other guns to make up the field artillery deficit. The British had produced the 18-pdr field gun in the United States before 1917 and it seemed logical that this design be converted to 75mm and be added to the arsenal of useful tools. As soon as the current contract with the British government was complete, Midvale Steel converted the design from 18-pdr (3.3-inch) to the 75mm (2.95-inch) and branded it the M1917. The piece was a quality product but the Americans, probably because of a perception of inferiority about British pieces, decided to keep the gun stateside for use as a training gun. It was found to be especially useful as a preliminary training gun for heavy artillery crews. This was the same fate as the M1902 3-inch guns that the U.S. had in

[54] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 51.

the arsenals before the war. The only M1917 guns that actually made it to France never were intended to be used in the front line.[55]

During the time most ordnance officers were frantically trying to line up contracts and compute factory capacity, the most experienced gun designer in the department was in France. Attached to Pershing's staff, General Williams's job was procuring designs of European guns. Interestingly, until 7 August 1917, the Americans were only contemplating building the French 75 in the United States. It was at this date or later that the final decision to diversify the American production of field guns took place.[56] Williams had the task of trying to convince the French to give up their state secret of the 75mm gun. He also acquired drawings from the new 155 GPF, the 155 howitzer, and even some railroad mounts for larger guns. It appears that most of the time he was working directly with Schneider et Cie., the original designers of almost all of France's ordnance in the field by 1917. Although it seems counterintuitive to send the best gun designer out of the country as the industrial base is being transformed, Williams actually performed a much more demanding task than the stateside jobs. In a few short months, Williams procured drawings and working examples of every major artillery piece that would eventually be made in the United States. Shipped on the earliest available transport, these pieces became models that could be studied and taken apart by manufacturers to help visualize the drawings. This sped up the American production by months, perhaps even years. No other officer was as knowledgeable about the needs of the Ordnance Department, except for Crozier, and was able to speak knowledgeably to the best gun designers in the world about what those needs were. It is unlikely that the plans would have arrived at all in 1917, but Williams somehow had sent plans for all three weapons systems by the end

[55] Cablegram, NARA, 25 April 1918 (1199-1 Page Z).
[56] Cablegram, NARA 7 August 1917 (6-5 Page B).

of the year.[57] As a tribute to his efforts, the French awarded Williams with the Legion d'Honneur, a rare feat for an off the battlefield exploit.[58]

Once the drawings arrived in the States, they had to be translated into English and imperial measurements instead of the standard French. The metric system was virtually unheard of in the States in 1917 and unexpected delays soon developed. Minor technical problems such as thread pitches on bolts caused huge headaches for designers who had never used French specifications before. Either American industry would have to adapt to the French system, or the plans would have to be adapted to fit the American system. These delays cost the department precious time.[59]

The arrival of the blueprints, especially those of the 75mm, demonstrated the great secrecy that surrounded the French weapons industry. The first blueprints arrived without all of the dimensions necessary to build the piece. Not until February 1918 did the complete blueprints arrive.[60] Only in May were drawings for gauges completed by the Ordnance Department.[61] Apparently, the original blueprints that were given to the Americans were the same ones that the French used, but apparently for security sake, it appears that not all of the dimensions were put on drawings. Only those artisans who built the gun actually knew the exact dimensions, making it almost impossible to build the piece outside of the factory it was designed in. All of these

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[57] Cablegram, NARA 8 Nov 1917 275-6 Page G Blueprints for the French 75 left St Nazare 16 October on the transport *City of Atlanta*. The 155 howitzer had arrived in the U.S. before 26 November 1917 because Ordnance had somehow broken a few of its pieces including "*the poignes du levier* de culasse for gun number five two two is broken at the angle" 26 Nov 1917 (448-2 Page I).

[58] *Biographical Register of the Officers and Graduates of USMA*. Volume 6, (Seeman & Peters printers, Saginaw Mich., 1920), 684.

[59] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 26.

[60] Ibid, 81.

[61] Drawings for French 75, Record Group 156. Records of the Chief of Ordnance. Entry 4, Level 3.Gauge drawings appear to be the only drawings that exist in the holdings of the National Archives. Additional documentation from other drawings is necessary to procure a more accurate timetable of the availability of drawing to the American manufacturers.

problems culminated in 1918 when the recouperator became the biggest bottleneck in production.

While the American industry was gearing up to build guns, some officers of the Ordnance Department went on a recycling spree. Before the war, the vast majority of artillery made in terms of dollar amounts and tube numbers were the seacoast artillery. The United States had little fear of being attacked by the Imperial German navy. The British and American fleets, along with the naval blockade allowed for a more offensive strategy. It also allowed for America to divert some of the investment of the last 20 years of coast artillery into the land army. The plan was simple: dismount existing guns in coastal forts and mount them on a carriage that was moveable in the field. With these new guns, the U.S. could provide some degree of long range artillery cheaply and quickly. All that was needed was a few carriages to mount them on.

Both France and Britain had experimented with transforming pieces, but neither had the coastline, nor the extensive reserve that the United States had. It seems that the majority of work in 1917 revolved around the conversion from coast to field. This was a good use of time, for the French still had yet to deliver blueprints to the Americans. On 8 Aug 1917 a cablegram was sent to Williams in France stating "100 6 inch guns are being pulled from coastal along with 50 8 inch guns and about 50 5 inch guns."[62] The project was to start deliveries in November and be completed by 15 March 1918.[63] These smaller guns were to be supplementary until the larger 155 guns could replace them in theory, but, great care was taken to make sure that spare tubes could be floated for each gun mounted when these guns wore out. These guns started

[62]Cablegram,, NARA, 8 Aug 1917 (121-5? Pg B).
[63] Cablegram, NARA, 17 Sept 1917 (188-1 Page C).

arriving on 16 July 1918 in France in numbers.[64] Even in the emergency stage, the American effort was demonstrated not for 1918, but for 1919 or perhaps 1920.

There were constant efforts to turn every existing piece of artillery into usable stock on the Western Front. Guns larger than 8-inch were available, albeit in smaller quantities. Previous experience on the Western front showed that long range heavy artillery was necessary. 10-inch, 12-inch and 14-inch guns along with the 12-inch howitzer became the backbone of the American program. Even the brand new 16-inch gun designed for the Panama Canal was discussed in the conversion process. These larger guns though could not be moved in the field. The required special mounts on railway cars because of the weight of the tube itself and the massive recoil. American designs in these railroad carriages demonstrate the abilities of the old guard in the Ordnance Department. The French were using the car itself as a recoil mechanism, which required it to be moved by a locomotive every time it was fired back into position. The device was much easier and cheaper to design and build, but the requirement of keeping a locomotive at full steam anywhere near a possible target in a warzone tempted disaster.

American designs revolved around a recoil mechanism mounted into the railroad car so that the gun would not have to be reaimed every time the gun was displaced. This design was much more complicated than the French carriage, but the tradeoffs were potentially great. The United States by 1914 was arguably the greatest country in design of coastal artillery, and their ordnance projects for France represented the zenith of coast artillery and their potential. The days of coastal forts were already waning and the opportunity for the United States to use its immense investment over the last 40 years appeared to reach maturity in France.

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[64] Cablegram, NARA, 16 July 1918 (1457-1 F Page 9).

The American railroad recoil carriage represented the true qualities of the career ordnance officers who had spent their lives designing mechanisms for the various forts and defensible areas on America's vast coastline. The mechanisms between the railway and coastal mounts were different in nature for a delicately balanced "disappearing" carriage was out of the question for a railroad mount. The understanding of physics in regard to absorption and displacement of massive amounts of energy created in the discharge had been cultivated. It is unfortunate that historians have largely overlooked the success of the coast artillery conversion and focused on the "failure" of the field artillery production.

The amount of money that this "recycle" program saved the United States overall has also not been analyzed. The vast majority of the Ordnance Department budget over the last 20 years had been spent building these massive pieces. The pieces would have become obsolescent before the next war and therefore their use was the only chance that existed since aiming at the German fleet was unreasonable.

The program also saved energy that could have been spent in creating a long range gun program from scratch in 1917. Gun design for large guns is very much a science that requires the skilful blending of physics with materials that are available at the given time. Like the capital ship programs of the late 19th and early 20th centuries, guns became obsolescent within a matter of years, much quicker than any other military weapon on land until the age of the aircraft. The time it takes to create such a massive project such as a long range gun is measured in years and decades, not the months that the department was given to arm the AEF. The amount of manpower required to create a similar weapon system suite would have taken well into the 1920s. It would have also diverted much needed factory space and labor that was eventually used to create field pieces and medium range guns that were to outfit the

AEF in a more numerous order. The stresses that the project would have created on the usable skilled labor pool, both in design and manufacture, made such a project cost inhibitive. The American style of manufacture in 1917 did not allow for both field and railway guns to be produced from scratch within the acceptable time allotted.

Congress has a long tradition of bureaucratic delays for projects and artillery was no exception to this rule. The Ordnance Department went to war with an outdated peacetime acquisition policy virtually all contracts had to be approved by Congress. This worked when almost everything was made in arsenals. Wartime needs forced the creation of advisory boards to manage the resources of the country without having to constantly gain permission of Congress. The most famous and useful of these boards was the War Industries Board (WIB). After its founding on 27 July 1917, the board went to work trying to calm the madness that had erupted while trying to manage supply and demand and limit hording in uncertain times.[65] Controlling everything from lathes to hand saws was the first step to improving efficiency for American industry. The board was famous for its use of corporate tactics and how it could be used in a wartime situation. Not until the ascension of financier Bernard Baruch in March 1918 to the chairman role did the WIB significantly increase the capacity of American war production.[66] The vast majority of the revisions and boards were only set up in 1918 to help out in the management of war product production. Although the Civil War had laid the basic bedrock for American mobilization, relearning modern industrialized warfare mobilization took time.

In the history of American industry, 1917 represented a radical year of development. Although the war was only a few months old for the Americans, reform

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[65] Trask, 14.
[66] Ibid, 27.

had been set in place that would alter the landscape of American military might. New factories were being built at the government's expense to produce massive orders of military equipment. A new generation of steel workers would be cultivated to work the massive castings of guns with tolerances that had been virtually unheard of outside of government arsenals. The metric system that came with French designs was first used throughout American industry. All of these would add up to long term ramifications for the American industry. First it would have to produce the weapons to win the war, and making guns was the best way to get back to making butter.

1918: THE WAR MACHINE COMES ONLINE

1918 became the year of production for the United States. The entire Second U.S. Army would be outfitted with American made weapons that were to culminate in the 1919 summer campaign. No one could have predicted that the whole process would be for naught, but until November 1918, the Ordnance Department dutifully performed the task of providing for the AEF by any means possible, either through procurement or production.

1918 started with United States preparedness in about the same place as 1917 had started. American armies were being raised stateside, but the equipment to arm them still was not being produced in numbers. France was able to provide Pershing's current needs, but it was unknown how long the generosity would last. Americans had performed a good deal of the legwork in 1917 for substantial industrial gains. Early in 1918, the very last of the major political decisions were decided and a relative status quo was finally achieved. It took nearly a year for the War Department to control its newfound power and needs.

In December 1917 under pressure from Congressmen and others, Secretary Baker offered his resignation over the mobilization debacle. President Wilson denied Baker's request. The creation of the War Council which followed along with a shakeup in the War Department gave Baker power that had lacked from the peacetime structure of the Secretary position before and had led to missteps in 1917.[67] It would not be until 1 January though that the Secretary of War became the most powerful person in the War Department, eclipsing the career officer Chief of Staff position for the first time in history.

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[67] Ibid, 25.

Part of the 1 January mix-up was the elevation of the role of Assistant Secretary. The Assistant Secretary of War had been all but important throughout the history of the War Department. On that date the position assumed the role of Director of Munitions, freeing up the Chief of Staff to work on the mobilization of the army for France, a job that better suited the position. France and Great Britain realized early on that a high ranking position dedicated solely to armaments production was needed. America turned to the number two man in the War Department to complete this task. Benedict Crowell became the first Director of Munitions and held the position throughout the entire war. However, Crowell was not a career military man. His peacetime vocation was laced with work in the steel industry and had connections with many heads of corporations that were producing ordnance on contract. He was able to act as a mediator between the Ordnance Department officers who knew little about mass production and civil business practices and the business executives who knew little about the particulars of artillery.[68]

Part of the January 1918 remix was the creation of the Purchase and Supply Branch of the War Department. This branch replaced several earlier departments and was the first major attempt to unify purchasing for the government. The Purchase and Supply Branch reduced inefficiency of American industrial mobilization, the lack of coordination between branches, and even within branches. This increased organization would become the backbone of the American build-up in France. America had the industrial might, but learning how to control and focus its power became the struggle which was beginning to be mastered with the development and maturity of the larger War Department as the AEF took to the field in its first actions.

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[68] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 11.

Although procurement rules had been formulated well before 1917, the act of writing contracts and efficiently receiving delivery of these goods became a time consuming process. The Ordnance Department was in the sticky situation of having to procure a product that was ill suited for the production styles of existing American industry infrastructure at the beginning of the war. A massive building spree would have to be completed before the guns could roll off the lines. Seventeen major building projects had developed out of the initial need for more capacity of war production. These factories were built according to the initial contract and were an embedded portion of the contract process. The building would be paid for by the government and the risk taken upon by the entrepreneurs was minimal.

Table I. Factories built or expanded for artillery contracts.

Firm	Location	Product produced
U.S. Steel	Gary Indiana	15,000,000 lbs. forgings 155 how, 240 how.
Edgewater Steel Co.	Pittsburgh, PA.	5,000,000 lbs. forgings 155 GPF, 240 how.
Tacony Ordnance	Tacony PA.	3,000,000 lbs. forgings 155 GPF, 240 how.
Watervliet Arsenal	Watervliet, NY.	250 240 how., 155 GPF
Symington Anderson	Rochester, NY.	heat treating facilities
Hess Steel	Baltimore, MD.	20,000 tons steel ingots
Bullard Engineering	Bridgeport, CT.	800-155 GPF
Standard Steel Car Co.	Burnham, PA.	5,000,000 lbs. forgings 155 GPF, 155 how.
Bethlehem Steel	So. Bethlehem, PA.	4,700,000 lbs forgings 4.7-inch gun, 155 how.
Standard Forgings	Indiana Harbor, IN.	5,000,000 lbs. forgings 75mm gun, 155 how.
Heppenstall Forge and Knife	Pittsburgh, PA.	5,000,000 lbs forgings 75mm gun, 4.7-inch gun
American Brake and Shoe	Erie, PA.	3,000 155 how.
Northwestern Ordnance	Madison, WI.	500 4.7-inch guns
Chaulkis Mfg	Detroit, MI.	700 75mm guns
Wisconsin Gun	Milwaukee, WI.	1,000 75mm guns
Symington Anderson	Rochester, NY.	3,000 field guns
Buckeye Steel	Columbus, OH.	2,000,000 lbs. 75 gun forgings

In reality, those who accepted government contracts and completed them had a good chance of advancing their market share in comparison to their competitors. Raw materials became a scarce commodity early in the war. Once the numerous boards and committees were set up, rationing of necessary materials meant that those conducting work on government contracts gained access to raw materials first. This act would naturally push out producers who had not taken contracts so that they would be shuttered for the duration of the conflict or their facilities would be taken over by firms (in proxy of the government) so that the space could produce war material. These factories would be returned and the owners compensated after the termination of the crisis.

Before the war, government contracts were made on a bid basis, with the lowest bidder receiving the order. As the wartime need increased, the system became increasingly cumbersome and time consuming. President Wilson pushed aggressively for a cost-plus style of contract where companies would produce goods and then would be paid a percentage of the total cost for compensation. Generally, this percentage was 10% above the total cost. After the war it was this policy that sparked controversy with war profiteering, although the 10% rule was considered a fair price by pre-war standards.

An interesting aspect of the American experience in the war was Wilson's insistence on winning the war in France without losing it on the home front. Within the first days of the war, the government laid out sweeping requirements for labor in factories producing goods at the expense of the U.S. Government. No employee working in factories producing government goods could work any longer than 40 hours within a given week without compensation. This sweeping reform, which is now commonplace in the United States, did not become part of peacetime law until

1938 with the passage of the Fair Labor Standards Act.[69] This law was much stricter than the labor laws of the other allied countries where nearly the entire population, including the elderly and children, were mobilized for wartime production. The French went as far as 12 hour shifts 6 and 7 days a week for the duration of the war in order to keep the army supplied with necessary equipment.[70] The massive American workforce pool was a luxury that other countries simply lacked. Labor shortages were minimal and in some areas such as the Great Plains there was an excess of labor. The only major shortage in the ordnance producing areas seems to be focused around Philadelphia.[71] This shortage was important because of the sheer amount of war material being produced in the city. Not only were ordnance contracts being fulfilled but the city was the center of the biggest shipping hub of the region. During the war, the massive Hog Island was built. It contained 50 slips for ship construction, at the time the biggest in the world. Philadelphia was also one of the more popular locations with which to ship out weapons made in the Midwest and Pittsburgh because of the city's close proximity to the factories as compared to other ports.

On 20 May 1918 the headaches of controlling the magnitude of contracts ended with the Overman Act. The act eliminated middleman interference that had delayed some contracts, not just in the Ordnance Department but the entire War Department.[72] The act also banned unwritten contracts that had been awarded in haste during the early months of the war. The bill represented a solidification of policies that had evolved over the first year based on what worked and what did not. The streamlined contract process along with more insistence on free trade and as little

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[69] Fair Labor Standards Act, U.S. Code 29 (1938).
[70] SHAT 7 N 1262.
[71] Crowell, *Government War Contracts*, 90.
[72] Ibid., 7.

government interference in market control as possible became a hallmark for the U.S. industrial experience.

As previously stated, the Ordnance Department placed orders for both forgings and completed guns. United States Steel received the largest contract for raw forgings with 15,000,000 pounds broken down into 155 mm howitzer and 240 mm howitzer variants. The raw forging made up the most difficult metallurgical casting processes. It was apparent from the list of new buildings that American industry was not ready in its current state. Even Watervliet Arsenal, which had been the only peacetime supplier to the U.S., had to build additional facilities to deal with the new workload.

Once the castings were produced they had to be made into polished, finished products. This task favored a larger pool of companies because it did not require massive amounts of furnaces and forging equipment. The task of finishing became the major source of delays for ordnance production, as work could not start at finishing facilities until the casting had been completed. Very few factories for forging were completed before April 1918. Those that had been completed were producing forgings for the smaller 75mm guns and the 155mm howitzer of French pattern. The larger 155mm GPF gun and the 240mm howitzer, both of which France was having a hard time providing, were lagging behind in the U.S. As soon as buildings were completed, the machinery could be moved in and actual forging started. By 1 May only about half of the buildings were completed and production was just starting.

Watervliet Arsenal, Tacony Ordnance, Edgewater, and the U.S. Steel plant were on average only about 70% complete by the beginning of May. These four plants produced all 240 mm howitzer products. The only plants that were capable of producing the new massive weapons were also the furthest behind in construction.

Without these guns, the Second Army could not be armed with the superior weapon it was supposed to work with. It would be stuck with the British designed 8-inch and 9.2-inch howitzers that were significantly less powerful than the French piece. The British howitzers had a range of about 6 miles. The Schneider designed 240mm fired a heavier projectile nearly 10 miles.[73] This range difference was huge on the Western Front where range had become everything for heavy artillery.

Field guns, just like their heavier cousins were not exempt from delays. Although the factories for the guns were completed much more quickly, the guns proved to be much more difficult to manufacture than was initially expected. The barrels for field guns were relatively complex but did not require the heavy construction techniques of the larger pieces. Modern steel artillery tubes were not made out of one piece of steel, but were composed of two or more pieces that were assembled together similar to putting a jacket on oneself. The outside tube was heated which caused expansion. The expanded tube slid over the longer inside piece and allowed to cool. When the outside piece cooled, it had shrunk to a size that compressed the tube and created more absorbance and resistance for the ballistic explosion within the tube. This technique allowed more powerful charges to be used, but was also a virtual necessity with the very rapid burning smokeless powder that created a more violent explosion.

The French 75 had the breech mechanism built into the end of the barrel. This device, called the Nordenfelt Breech rotated to allow a new shell to be inserted, and then rotated back to seal the breech. This ingenious device allowed for the quick

[73] Hogg, 218.

firing techniques of modern artillery without having to use an interrupted screw design that had become prevalent in nearly every other European artillery piece.[74]

The American M1916 gun was a two piece device, unlike the French gun. The barrel was separate from the breech. The M1916 used another ingenious design of a breech block that slid on a horizontal plane at the end of the breech to seal gasses by using a brass casing. The M1916 was possibly the first production gun in the world to use this design and is now standard on virtually every artillery system in the world. The breech block design offered several advantages over the Nordenfelt and interrupted screw designs. First, the piece could be fired much more rapidly than previous designs because the breech could be closed just as the round was inserted without having to wait for the hand to move, because the breech block would physically move the hand without the chance for pinching. Second, no fine machining or threading into the breech was necessary which made manufacture much easier and quicker compared to other models. The M1916, paired with the new carriage, could have possibly been the most advanced field artillery piece in the world. Just like the French 75, it was going to become a huge challenge to produce outside of the armories it was designed in.

While completed barrels were being produced for both the M1916 and the M1897, the real problem emerged with manufacture delays. The recouperator for both weapons was a fine piece of machinery. Recouperators were the Swiss watch of artillery production; great detail has to be placed at its production. To demonstrate the difficulty of producing this piece of the puzzle, French designers informed the Americans that the Germans had captured hundreds of French 75s on the battlefield over the last three years and had tried to reproduce the piece. After three years of

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[74] Ibid, 39.

trying, not a single model had been produced in Germany. The French designers said it could not be done outside of the French factories, but nevertheless the Americans wanted to try. It was the biggest industrial power in the world, how hard could it be? It would soon find out why the Germans had not produced a replica.

The Americans received the blueprints for the French 75mm late in 1917. After realizing that they were incomplete, the revised drawings arrived in February 1918. Factories had been built and tooled, and all that was needed was to produce a piece. The barrel and carriage were simple enough to build but the recouperator proved to be the most difficult piece of them all, just like the French had said. Even with the help of the Schneider engineers whom the French government had sent over with the drawings, the Americans could not crack the code to the heart of the 75. The main contract for the piece was given to Singer Sewing Machine to make 2,500 of these pieces. It was thought that the company which was accustomed to detailed work could build the piece better than anyone else. Even they struggled, but the government was willing to compensate those who were willing to try; the Singer contract was for 15% profit above cost, 50% higher than nearly every other wartime contract.[75] France had spent years training artisans for building the finely polished slides of the recouperator. Americans on the other hand were used to building Model Ts. Apples and oranges would have fit together better. It merged handcrafted excellence with the assembly line that required little skill or training. If it could be done, it would be one of the greatest accomplishments of the war for the U.S.

U.S. workers eventually proved it could be done, but it came too late to make a difference. The recouperator was the last part to be completed. The first American made gun was fully assembled in April 1919, too late to see action in France, but the

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[75] Contract # P4560-454C assigned 8 May 1918. Record Group 156 Record of the Chief of Ordnance, Entry 148, Volume 1, NARA.

U.S. proved though that it could be done. The hand mirror polished slide was so foreign to American industry that it took immense amounts of time and patience, two things that the Americans lacked during the crisis. Ordnance officers quickly realized that outside of Watervliet, Bethlehem, and Midvale, French weapons could not be built on a timely basis, and forgings for many French designed weapons were sent across the ocean for completion with the skilled labor.

Americans did not have to rely exclusively on the French 75 for domestic production. The M1916 had been produced before the war and had been proven to be a good gun. It outperformed the 75 in nearly every category and best of all, everything was designed to sync with standard American practices. However, the M1916 did have its setbacks on the road to full production.

The gun had reached production at the government arsenals by the American entry into the war, and had been proven that it was buildable in the United States. Blueprints were available early on and factories were given contracts to produce the piece. It quickly became apparent that American companies would have a difficult time making the recouperator. The M1916 had a second generation recouperator that was required by using this split trail. If the gun was fully elevated, the long recoil might hit the ground or damage the gun. The gun had to include smaller recoil when highly elevated in comparison to its more traditional horizontal position. This twin stage mechanism had been perfected by the Ordnance Department, but its overly technical construction was taxing to the average contract holder. A conclusion was reached that the M1916 was too difficult to build and 80% of all contracts for the weapon were cancelled and replaced by orders for the simpler French design. In hindsight this change was unfortunate as delays from the French piece were considerably more than the American design. The M1916 would make up the only

75mm combat guns shipped over to France before the war ended and offered the most promise of evolution for the army. Interestingly, it appears that very few of the original guns that had been relined by November 1917 made it to France. These 35 guns would have been nearly enough to outfit one division with artillery but few were shipped. Therefore, it appears that a real need for training guns was apparent by the end of 1917 and did not lift until well into 1918. Regular shipping was to begin in earnest in November 1918 with 72 guns to be shipped per month with 60 pieces each subsequent month.[76] Why first line guns would be relegated to the same role of the M1902 is unknown. Why reline the guns if they were not intended to go to France where the 75mm munitions was required?

The third field gun created did not have nearly the teething problems that the others had. Before the American introduction into the war Midvale Steel produced the British 18-pdr field gun in its plant in Philadelphia. The entire process was well understood for its manufacture and could be easily converted once the British orders were completed. For seemingly unknown reasons today, the M1917 was never designated for front line action; it was produced exclusively as a training gun. The M1917 was the only field piece that had an interrupted screw type breech which was very similar to other heavy artillery that the Americans were using and therefore probably made the most sense as a smaller training bed for the more complicated heavies. Another possibility is that the 18-pdr design did not react as well to the conversion to 75mm. The M1916 only had 1/20 of an inch reduced in the barrel as compared to the British design that went from 3.3 inches in bore diameter to 2.95 inches, a third of an inch difference. Changing the original plan must have altered the ballistics of the gun enough to make it subpar against the more readily available

[76] Cablegram, NARA 9 July 1918 (1412-2 D Page 8).

French guns in France. The gun also was designed to operate on a spring recoil mechanism instead of the more reliable, but much more difficult to manufacture hydropneumatic recouperator.[77] Nevertheless, the gun was the first of the three after the war to be deemed obsolete and decommissioned while the M1916 and M1897 both were used well into the 1930s.

The first two M1916s were floated on the transport *Malo* on 28 April, 1918.[78] Although these guns would have arrived 10 days later, they were not put into action. Crowell's first post-conflict report states that only a handful arrived in France before the war ended. Of these, not a single one fired a round in combat.[79] These two accounts do not make sense together, for why would Americans not use their own guns, even after they had been in the country for nearly eight months? The American made guns might have been used for training purposes for the Second Army that was founded in October, but why wait to put the pieces in line? It may have been as simple as waiting for a full regiment of 24 guns to arrive before putting it in action to simplify supply of spare parts, but nevertheless, the Ordnance Department did have American made pieces in France with ample time to see action. Their lack of use was the decision of those in combat arms.

In 1917, the US entered with a number of heavier guns in 4.7-inch designated M1906 in the arsenals. This gun seems to have been left behind as a useful weapon on the Western Front by manufacturers for no apparent reason. The gun had a more powerful shell and range than any 75mm gun. More, the gun was already tested and had been in service for a decade and had proven to be a solid platform. The gun did weigh considerably more than field guns and required more animals to pull it, but it was still a workable solution. Nevertheless, only contracts were let with three

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[77] Hogg, 213.
[78] Cablegram , NARA 2 May 1918 (1242 Page Z).
[79] Crowell, *Americas Munitions 1917-1918*, 71.

companies to produce the 4.7-inch: Heppenstall and Bethlehem for forgings and Northwest Ordnance for 500 complete guns. These orders were quite small in comparison to the over 6,000 field guns ordered, of which not a single working blueprint was accessible.

The greatest reason for not throwing the American industrial weight into the 4.7-inch was yet again the supply issue. No matter how many pieces that could be produced and floated, every single shell had to come from the United States because no European power produced an equivalent version. A great weapon option withered on the vine because of the lack of regular tonnage that could be given to the supply of ammunition for the AEF. The 4.7-inch just like the 3-inch, was fated to a decision early on within the Ordnance Department to focus its attention on weapons that could not only be delivered to the AEF, but also had a solid supply of ammunition possible without the need for transoceanic transport. This may have been a response to the fears of a powerful U-Boat threat, or a pre-existing policy, but at this time, the reason remains unknown.

The total amount of heavy artillery that existed in American arsenals in 1917 amounted to zero. It is an amazing feat that in just two short years the U.S. was able to build up an arsenal containing hundreds of guns and the capacity to build thousands more, many in the largest sizes possible. This struggle was not unaided. Nearly every piece that was made in the United States had its design rooted in Europe. Proven French and British designs became the core with which the arms build-up was centered around. Without the aid of the allies, it is unlikely that any building program for heavy artillery would have been past the drawing board when the war ended. This building program centered around about half a dozen different designs, all of which

had proven reliable and necessary on the Western Front. The first were the famed French 155mm pair of weapons.

The 155mm howitzer was first designed by Schneider early in the war and modified late in 1916 (although classified as a 1917 variant) to accept a cheaper powder bag instead of precious brass casings. The Americans only built this 1917 variant and the French only issued the updated piece to American units.[80] The gun had a range of 11,500 meters and weighed in at a svelte 3,300 kg.[81] The piece was widely produced in France and was also slated for major production in the States. After the field gun, the 155 howitzer represented the next most important weapon to the AEF in terms of numbers. Each division had two regiments of 24 field guns and one regiment of heavy howitzers of 24-155mm howitzers were needed for every division sent to the trenches. France was able to supply most of the needs of the Americans for the First Army, but American production would be needed to outfit the Second and Third Armies. Some of the largest ordnance contracts went out for these howitzers. Also, of all the contracts let, they were the most completed of the French designs attempted by American industry. The largest contract of the war with U.S. Steel was let in conjunction between the 155mm howitzer and the 240mm howitzer. American Brake and Shoe received an order for 3,000 complete pieces, of which 12 pieces a day were to be finished at full output.[82] At that rate, the AEF could be outfitted completely as it came across and not have any reliance on the French. A full division's guns could be produced in two days from a single factory. The crash program was much more successful in output than the sister program of the 155 suite.

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[80] Cablegram, NARA 29 October 1917 (251-3 E Page E).
[81] Hogg, 213.
[82] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 51.

The 155mm GPF was to become the long range weapon for the AEF. The gun had a range of 16,200 meters, and was quite accurate, which outranged virtually every other weapon that was not railroad based.[83] It was designed from the ground up in the French arsenal by Col. Filloux, unlike most guns that were designed by private firms such as Schneider. The guns, unlike previous French models, were not readily available to the American forces due mainly to the relatively new nature of the weapon, which was being first fielded as the Americans arrived. The French and Americans needed to be outfitted, unlike the previous pieces that had already been supplied to the French army's content. The 155 GPF demanded a larger factory space to build it due to its massive size; it weighed more than double that of its howitzer counterpart. This required American industrial forces to build factories to handle the load. The most famous of these was the new Dodge Brothers works in Detroit which built a completely new factory to build the piece. At full capacity this factory would crank out 5 completed guns a day.[84] Other factories were built including Bullard Engineering which was to produce four guns a day and several factories that provided the massive forgings to be worked.[85] The gun was to be the long range workhorse of the AEF as it entered 1919, but unfortunately would not come into full production until after the armistice. Luckily, Pershing was able to get some from the French, just not in the necessary complete numbers. It would be this gun that most of the American field artillery would have roots in for the rest of the century.

After medium artillery, the next important pieces of ordnance were heavy howitzers. These heavy howitzers would be the first weapons not issued to divisions, but attached to corps and army level units for specific purposes. The British agreed to

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[83] Hogg, 213.
[84] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 51.
[85] Ibid 51.

provide for this piece of ordnance as much as it could, but early on the Americans had decided that using British designs were a stopgap until the French designs could come online. The heavy howitzer program was the best footed of all weapons systems for manufacture in the United States because the British had been building guns under contract since 1916. The program would be the first to produce models that could be transferred to troops in France.

Midvale Steel had received a contract in 1916 to produce the newly designed 8-inch Mark VII gun that was to replace all other 8-inch guns in British units. The real advantages of the 8-inch were that it was maneuverable by utilizing the new tractor technology and that it spewed a massive 200 lb. shell 12,300 yards.[86] The best part for the U.S. designers was that it required no alterations to the design to go into full production, unlike the 18-pdr that had to be modified to accept the 75mm shell. Also, the plant that the 8-inch was built in was already constructed, outfitted, and the personnel trained in the art of making the piece. All that the Americans had to do was wait for the British contract to run out and to build it under license. The American made 8-inch started regular shipments in May 1918 when 24 were floated and therefore was the only heavy artillery made in the U.S. during the war to see action.[87] The British design was not planned on being the main heavy howitzer for the AEF. The only known company to get contracts for the 8-inch was Midvale Steel, as one firm could make more than enough for the limited run that was necessary for the First Army.

The second British heavy artillery that was made for the U.S. forces was the 9.2-inch howitzer. This gun was not nearly as mobile as the 8-inch counterpart but nevertheless was put into production in the United States. The howitzer had a longer

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[86] Hogg, 216.
[87] Cablegram, NARA, 13 June 1918 (1510-8 Page 4).

range by almost a mile over the 8-inch gun and fired a projectile weighing almost 50% more. Nevertheless, the gun was limited to a static war due to its heavy built construction. Unlike the 8-inch the 9.2-inch had to be taken apart into three pieces every time it was placed. Included in those three pieces was a box that had to be filed with 11 tons of dirt to keep the gun in place.[88] Also unlike the 8-inch the 9.2-inch had not been constructed in the U.S. before 1917. Bethlehem Steel was designated as the sole constructor of the piece and got to work on it, along with all the other pieces it had been assigned to produce.

The last major gun that was to be produced in the United States was the French designed 240mm howitzer. This piece, designated very heavy artillery, was the grandest piece on an engineering basis that the U.S. attempted to build. The most ambitious part of the plan was to produce an artillery piece that had never been put into production in France, let alone in a country not known for artillery excellence. Designed by Schneider, the howitzer was still only existent in drawings, but held the hopes and dreams of the AEF in 1919. The two British designs were to be a stopgap above all until the supposedly superior designed 240mm could be placed in service. The Second and Third Armies of the AEF were to be issued exclusively the French weapon after it had been made in the United States. Watervliet Arsenal took up the challenge of producing this gun, which proved much more difficult to build than any other gun previously produced in the United States. Even with representatives from Schneider on hand to assist the Americans at every turn the production process crept at a snail's pace. Only one of these guns was built before the end of the war and the first model that was built blew up on the first test firing at Aberdeen. It was not until

[88] Hogg, 79.

the late 1920s that a working production model was ready for issuance to U.S. troops.[89]

Not only did gun steel have to go into making each gun, but the new style of warfare meant that gun armor would also have to be made for each piece. This safety device was critical for crew survival, but it was also hard to make. Very few American firms before the war made armor for there was really no need. The Government found five firms that were able to make the necessary special alloys for each gun. Henry Disston & Sons, Crucible Steel, Mosler Safe Co., Universal Rolling Mill Co, and Minneapolis Steel and Machinery were willing to transfer over lines for the purpose. These firms were given the task of producing 15,000 tons of armor to outfit the American made pieces.[90] In some cases the designs were modified to ease production. An example of this is the 155mm howitzer. The French made pieces had a curved shield that bent at the contours of the wheels. Americans found this much more difficult to make, so a straight shield was modified to do the job.[91]

These nine weapons were the sum total of American gun manufacture in the United States from 1917 until the end of the war, and in a few cases, after. Virtually every contract except the two British howitzer projects were supposed to come online in 1918 so that the American armies that were being fielded for the final push in 1919 would be outfitted with American-made pieces. The 1919 campaigning season would become the tribute to American ingenuity and industrial flexibility if the ambitious build could be pulled off within the given timeframe.

One weapon system did make it to the front lines and fired a shot, but it was not designed by the Ordnance Department. The United States Navy announced in

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[89] Ibid, 109.
[90] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 72.
[91] Ibid, 87.

January 1918 that it were preparing to send a battery of 14-inch 50 caliber MK 4 naval guns mounted on railway carriages. These guns were to arrive in France by 1 June 1918, making them some of the quickest guns to come online.[92] These guns were made from surplus tubes of the *Tennessee* class battleships mounted on carriages designed and made by Baldwin Locomotive Company. The guns were operated by the USN while in France, under the command of Pershing. The guns showed extreme promise, for they had some of the longest ranges of any gun on the Western Front. Much has been written on these pieces, unlike the conversion program of the army. Although their development was important, it had very little effect on the Ordnance Department's projects and therefore falls outside this study.

As factories expanded and came online in the United States, the AEF also expanded and became a respectable unit on the field. By January 1, 1918, only four combat divisions had been floated to France. The first three months of 1918 saw little major movement in troop numbers and it was not until the Ludendorff Offensive in April that a surge in manpower exponentially increased the amount of combat units in France. In May alone, eight divisions arrived in France. Granted, these units were not combat ready, but the huge upswing meant that they would also have to be outfitted with artillery. Eight divisions needed 384 75mm guns and 192 155mm howitzers along with the complementary corps level guns. The French were able to keep the American units supplied even as this massive force of recruits arrived.

As Pershing became more familiar with the European battlefield, the role of the AEF changed also. On 25 June 1918 Pershing requested an increase in the divisions allotted to European service. This increase would create an 80 division AEF, (which was equivalent to 162 allied divisions due to the huge American divisions)

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[92] Cablegram, NARA, 24 January 1918 (687-4).

spread between three armies. These divisions were to be ready for combat before 30 June 1919.[93] Although this jump would treble the American commitment, it did not have any effect on the situation of the Ordnance Department. The looking at the sheer amount of contracts let makes it apparent that this was originally in the plan well before June. The Ordnance Department had let contracts out for this number well before. A fair representation of this is an analysis of contracts let for 75mm guns, which would be most affected by an increase in divisions. By 20 April 1918, contracts had been let for 6,855 75mm guns. This number only included orders for guns that were to enter combat, also known as the M1916 and M1897. The number also does not include the guns purchased from the French government to which was enough to outfit the entire First Army of 30 divisions. These 6,855 guns would be enough to outfit 143 divisions, much more than the needed 50. Pershing and the War Department had planned at an early date even more divisions than the 25 June statement, or, a major reorganization of the American division was planned similar to what the French did in 1918 when it increased 75mm allotments from 52 guns per division to 60 guns per division.[94]

The only other alternative to explain this massive overstock is that possibly the Ordnance Department expected some manufacturers to fail at producing artillery and over-ordered to guarantee that the AEF was given sufficient weapons by June 1919. If this is the case, it was not mentioned in either the weekly reports to Pershing nor mentioned in cablegrams between the Washington office and ordnance officers in France. The only hint exists between Washington and France on 2 October 1917:

> "Reference your cable 214-5- attention is called to special report on Artillery appended to organization project sent by William S. Graves

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[93] Trask, 78.
[94] SHAT 10 N 146.

(Col.) further observations of conditions British and French armies confirms conclusions transmitted in that report. The whole matter of Artillery for A.E.F. was thoroughly considered by Headquarters Staff and Baker Mission, especial attention being paid to employment of the 3.8-inch howitzer. Our plans for gun power now exceeds that desired either by British or French and is considerably more than they actually have. Other troops..... should not be overbalanced by excess artillery."[95]

This cryptic note does not fully make sense for every American division was equipped with half of the artillery to bayonet ratio that the French and British armies had. The only thing it may be leading to is the plan for heavy equipment, including the 240mm howitzer, but these were no further than the drawing board.

After the massive push in May, six divisions were delivered in June, four in July, and three in August. To keep up with Pershing's request for 80 divisions, an average of six would have to be sent every month, along with their artillery for the Second and Third Armies. This never even came close to happening.[96] September and October saw no deliveries of combat divisions and little delivery of artillery. Pershing's goal was lofty, but it could not be delivered by the limited shipping that was available to the allies, even after the initial surge in wartime transport ships were commissioned. It would have been a miracle at best for Pershing's troops and their American made artillery, if it could be made, to arrive before the given 30 June 1919 deadline. The May surge proved that shipping more than four or so divisions was hazardous to the situation in France, for industrial raw materials were just as

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[95] Cablegram, NARA, 2 October 1917 (197-4 Page D).
[96] *U.S. Army in the World War,* United States Army Organization Vol. 1, Center of Military History, (Washington: Government Printing Office, 1988), 142.

necessary as manpower. The fine balance was never discovered and is doubtful that it would have been achieved before the lofty deadline.

The influx in May of American divisions did have long term ramifications on how it would be supplied with artillery. French industry had become reliant on importing U.S. steel to produce the armaments that it were cranking out for the Americans. The May surge caused troops to be shipped and virtually nothing else. Raw materials did not make it to France, starving the cannon makers and curbing the American arming. Pershing complained that the guns were not arriving on time, but after discovering why, it seems that tonnage of steel picked back up. After May, no more massive attempts at moving troops occurred. It may have been this reason of unbalanced tonnage that affected that strategy.[97]

Starting in August and September, the French orders that it had promised the United States were coming due. The First Army had been provided with artillery, but as the Second Army arrived, no sign of American production had arrived with them. France scrambled to provide for both the French and American needs at the same time. It was quickly decided to send to France unfinished 75mm and 155mm recouperators that would speed up French output. Since the Americans did not have a hard time making the castings, but found it increasingly difficult to crack the code of the 75, it was logical to send these pieces to France for finishing. It increased the capacities of French workshops where labor was available and freed up the building stockpiles of unfinished castings in the U.S.

Just as the American deliveries were picking up enough to supply units in France, the situation on the Western Front altered greatly. July 1918 saw the resumption of maneuver on plains that had seen static warfare since 1914. The

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[97] Pershing Vol I, 222.

movement appeared just as American made weapons were about to be deployed. The return to mobile warfare created havoc with the new weapons that had been built for the static sieges but lacked mobility in the campaign that has now come to be known as the "100 Days". Almost all artillery had been supplied by narrow-gauge railway that moved from the ammunition bunkers to the pieces. Everywhere artillery went ammunition would have to be carried by vehicle or new tracks had to be laid, both were time consuming and inefficient, especially going through No-Man's-Land after four years of carnage. The movement also slowed down the replacement of weapons in the AEF. Units were moving so fast that little time was available for replacement and training that was necessary with the newly arrived pieces. Most American weapons that arrived in France after about 1 July had no chance of ever firing a shot because higher priorities took precedent before the new pieces. It would not be until after 11 November that this equipment would reach the troops, and therefore very little equipment, even if it did arrive before the armistice, ever saw action, which accounts for the lack of fired American pieces in the after war reports.

CONCLUSION

In the last three months of the war, the U.S. industrial investment finally started paying dividends. The Ordnance Department started collecting ordered weapons, albeit in a slower rate than had been expected. Orders that were scheduled to be delivered in April arrived in August at best. The entire process was tardy in its results, but nevertheless the arrival of weapons gave hope to Pershing's grand 80 division army.

In the short term, the ambitious American program for self sufficiency in artillery production for the AEF was a failure. The American effort was too much in too little time. The duration of the war was not long enough for American industry to gain a wartime footing. The wartime conversion is not only the conversion of factories, but also requires the workforce to become trained for creating the new product, the rationing of necessary raw materials, nationalizing the rail system, culling promising leaders from peacetime civilian sectors to wartime offices and giving them enough time to learn how to effectively complete the tasks needed and assigned, and gaining enough tonnage to transport equipment, personnel, raw materials, and sustainment all at sufficient and exponentially increasing numbers. If any one of these sections is not completed, the entire process is thrown off and delayed. In the case of the Americans in the Great War, the weakest link was personnel. Workers and engineers were thrown into producing a product that was foreign to their prior training. They had nothing to fall back upon and since the leaders were also untrained, a steep learning curve had to be taken.

Not all systems had the same pitch to the learning curve. The 8-inch howitzer of British pattern saw no learning curve because workers had received sufficient training on manufacture before. On the other hand the French 75mm gun and the

240mm howitzer were almost insurmountable. The 75mm gun had such a refined, polished recouperator that it took a year for production models to arrive, and the 240mm never was operational, even in the small testable stage. The 240mm never should have been attempted in the United States. The program was extremely expensive, with $17,450,000 being set aside for the carriage alone and no results.[98] The extended performance in comparison to the British 9.2-inch howitzer was not enough to warrant such a risky endeavor.

The American program was too ambitious for the resources available in the U.S. and the needs of the forces in France. The over ordering of field guns mentioned in the previous section is a great example of this. Unneeded strains were placed on the system for overestimated perceived needs and were not lowered until it was too late to make a difference.

Although these statements are bold, they still take into effect the view of hindsight. Even if the war would have continued past 11 November 1918, the AEF would have been left vulnerable by the American effort in the critical 1919 campaign. Most gun orders, with the exception of the two British products, were months behind and the sudden influx of deliveries would have taxed the shipping system to much the same effect of March 1918. The sheer amount of gear and men that were required for the 1918 deadline would have overburdened the system on quite possibly a greater scale than the earlier breakdown. It was virtually impossible to get 50 combat divisions and all of their equipment over the Atlantic in six months.

The best possible option for the United States would have been pursuing a hybrid strategy leaning on the best capabilities of both domestic and foreign industry. The United States had little problem making the raw forgings. The bottleneck came in

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[98] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 97.

finishing. France on the other hand was starving for raw materials that created its own crisis since the first weeks of the war when it lost nearly all of their natural reserves in Eastern France. It had the workforce to transform raw forgings into polished diamonds that so ached American efforts. From the initial stages, the best strategy would have been to produce the forgings and other raw materials in the U.S. and ship them to the more efficient French factories for finishing. The French in June 1918 for example were producing 33 75mm guns and 13 recouperators a day. They also produced 60 155mm GPF guns a month and 140 155mm howitzers a month. This compared to 60 M1916s being produced a month in the U.S. at maximum output.[99] This was after France had been was low on resources, and the above numbers do not represent the complete output, just a snapshot of the current status. Therefore France, if supplied, could have easily out produced a fully mobilized United States. This shared system would have been mutually beneficial and would have sped up the process considerably for both parties.

The mutual supply system would have also not cost the Americans any more than their own program. If anything, the program would have been cheaper due to less needed infrastructure. France never profited from the American orders. They charged the U.S. cost price, no more, and if anything may have lost money on the endeavor.

The American arrival came at a time when France was out producing what its armies could use. As has been mentioned before, French forces were actually increasing artillery per division in late 1918 and appear to have not suffered adverse affects from the American allotments. Some historians argue that the American allotment of artillery crushed the capabilities of the French armies in late 1918, but this seems to be much more from the collapse of the French from exhaustion than the

[99] Cablegram, NARA, 5 June 1918 (1231-1 Page 3).

siphoning of artillery. As the French army ran out of manpower and new recruits, their armies stayed relatively constant in size. Their only need for artillery came from wastage of battles.[100] The moving front meant that the Germans were no longer capturing artillery, and therefore removed that constraint. Battle damage was minimal throughout the entire war and could have been replaced with reserves. The last major need for new guns is that they wear out. France by 1918 had perfected relining all of their artillery so that they could do hundreds of guns a month. Therefore little in regard to new guns was necessary to French units and new factory deliveries could therefore be diverted to the new American units.

The American Army's massive need for equipment was within the limits of French production capacity. French factories supplied 288 75mm M1897s a month, 140 155mm howitzers, and 40 155mm GPF guns a month by 14 August 1918.[101] This was enough to outfit roughly six divisions a month, which was more than enough to fulfill the shipping maximums of U.S. troop deliveries. With additional deliveries of raw materials and if factories could have become even more efficient and larger, the French could have easily provided all of Pershing's needs well into 1919 and beyond.

The American effort fell into the pitfall of trying to build too many different systems at the same time. The French 75 was a monumental task that took too much energy for the gain. The best strategy would have been to concentrate the efforts of the country into one field piece instead of three. The M1916, especially in the MIII simplified format was the superior gun of the group. It was also the only American made piece that should have seen action in France since it was being built before the war. If the effort to produce only the American design had been pursued, the problem of simplification would have been solved quicker and could have been produced in

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[100] Frederick Palmer, *Newton D. Baker: America at War*. (New York : Dodd, Mead, 1931), 274.
[101] Cablegram, NARA, 14 August 1918 (6-4 Page 10).

greater numbers and with greater efficiency. It is still likely that this piece would not have met all of the needs of the AEF which was roughly 300 pieces a month to outfit completely the Second and Third Armies.

No American made field artillery was supposedly fired before the end of the war. This claim does not stand since the M1916 was being shipped in April 1918 and the 34 guns that had been modified to 75mm in November 1917 could have easily made it to France in time for November 1918. The claim of early accounts seems to be numbed by the end production numbers of guns. 143 75mm guns had been shipped before the war ended. This supplemented the 1,828 French guns that had been purchased in France. Only 64 complete 4.7-inch guns had been floated to France, but reports are unspecific if these guns include the prewar supply. 577 155 GPF guns had been produced, with 16 floated, but none fired a shot. At least 199 naval and coastal guns had been modified for service in France and several had been floated. On 13 December the first 8-inch howitzer was proof fired, 96 guns had been floated before 11 November.[102] To say the least, several projects were producing pieces, but they were not arriving in levels sufficient to outfit new units or even to replace battlefield losses.

On the day the war ended, 25,000 ordnance contracts were still outstanding.[103] This number includes all ordnance contracts, including small arms so it is a bit deceiving. Still, it represents the sheer amount of outstretch the Ordnance Department had achieved. This must be tempered by the fact that only two private firms along with the government arsenals were producing ordnance in 1916.

The war effort was not cheap though. $4,142,483,822.16 was eventually spent on all ordnance. About 1/3 of this was ammunition, which was more than the actual

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[102] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918.*, 82, 91-92, 83, 85.

[103] Crowell, *Government War Contracts*, 23.

artillery itself.[104] Of that, 325,000,000 were spent on building and expanding factories.[105] The entire cost of outfitting the AEF totaled 12 to 13 billion 1918 dollars.[106] Amazingly, 87.3% of this was spent in the United States.[107] Most of the American cost of the war was directly infused back into the domestic economy. This stimulus into the economy would have long term effects that lasted well after the guns went silent. Although the short term effects of the war have been studied, the long term effects could not be realized until the Americans mobilized for another world war.

The infusion of taxpayer money into the wartime industries allowed a quick modernization of America's heavy industries, especially the steel industry. America was the number one industrial power in 1919, surpassing virtually everyone else combined in steel production.[108] These new factories were more versatile than their previous states and allowed for a more technical American style of manufacture.

America now also had a more skilled work force that was trained in more precise and accurate engineering techniques that had been rare before. The introduction of ordnance specifications to the general industrial public created the potential for more ambitious industrial ventures because a skilled workforce had been created to build recouperators and gun barrels. The lack of production capability in early 1918 and produced weapons in 1919 represents a growing education and capability of the American shop floor.

The 40 hour work week was established in government factories within the first weeks of the war. This would not become law until just before World War II, but

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[104] Ibid., 96.
[105] Ibid., 121.
[106] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 32.
[107] Crowell, *Government War Contracts.*, 10.
[108] Kennedy, 244.

a precedent had been set over a wide range of the country in varying industries. Its effects shape the American work week to this day.

The United States regular army also made strides from their experiences. In 1924 the Industrial War College was set up. This school was the first army school in the United States to study events away from theatres of operation and focus on logistics on mobilized warfare. Under the influence of Bernard Baruch, the chair of the War Industries Board, the curriculum stressed fixing the problems of the army in 1917-1918. The effects of introducing ways to solve mobilization problems had some degree on the effectiveness of Lend-Lease during World War II. This topic needs more analysis, but the long range possibilities are extensive.

The introduction of the metric system into the United States had its start in the production of French artillery designs in the United States.[109] This system of measurement would not become widespread until the 1960s and 1970s, but its birth in America dates to the ordnance issue.

The adoption of French metric gun sizes started in 1917 and is still in use. The 155mm gun first introduced with the GPF in 1917 is in frontline use with U.S. combat troops all over the world. The 75mm gun would become commonplace in U.S. artillery and armored vehicles through WWII. Virtually every artillery (and later tank) piece designed since the Great War uses metric calibres.

After analysis, the short term goals of the Ordnance Department's outfit of the AEF were a failure. However, the long term ramifications of building pieces in the United States in the Great War had huge benefits and were a resounding success. It never appears in contemporary sources that Ordnance officers were trying to build a military-industry complex within the United States, but their actions had that effect.

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[109] Crowell, *The Armies of Industry: I. Our Nation's Manufacture of Munitions for a World War 1917-1918*, 28.

The boon to industrial society and the capabilities in quality not just quantity have far reaching influences.

The American production of ordnance in the Great War had little influence on the battlefield. Simply put, the war ended too early for the full project to bloom. The American struggle to produce a home-grown weapons industry had bumps and bottlenecks, but every piece that was attempted was eventually built, including the French designs that their designers said could never be built outside of France. American industry adapted and stepped onto the world stage, not by wading first but by jumping in with full force. This reaction seems unnecessary and counterproductive in hindsight, but its achievements have created a ripple effect that still affects American industry and the U.S. Army to this day.

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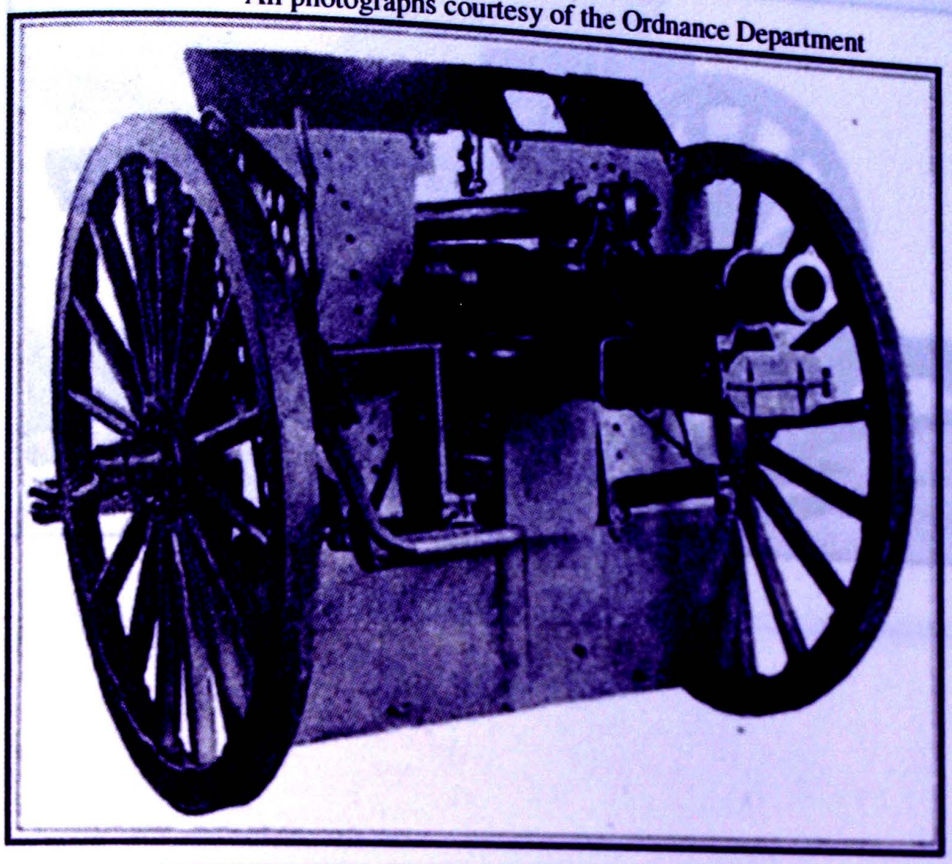
Appendix I

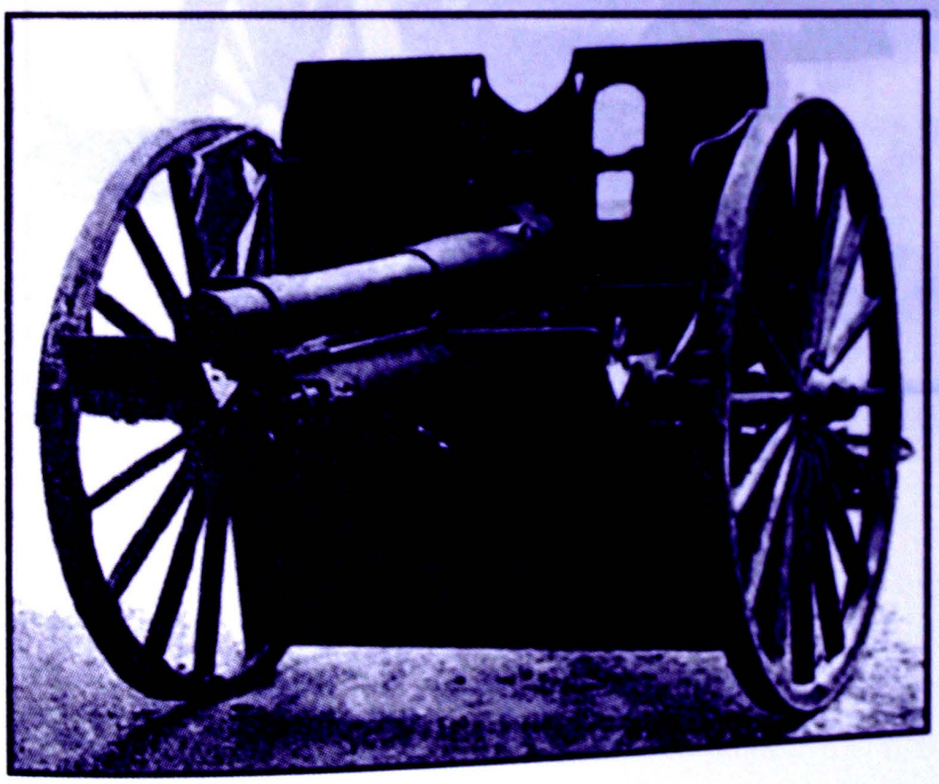
Model	Country of Origin	Calibre	Projectile weight (pounds)	Range (yards)	Muzzle Velocity (FPS)	Gun weight (pounds)	Degrees of traverse	Type of recoil
M1902 gun	U.S.	3-inch	15	8,500	1,700	2,520	7.8	Hydro-spring
M1897 gun	France	75mm (2.95-inch)	12.3	9,350	1,930	2,657	6	Hydro-pneumatic
M1916 gun	U.S.	75mm (2.95-inch)	12.3	11,155	1,876	3,045	22	Hydro-pneumatic
M1917 gun	Britain	75mm (2.95-inch)	12.3	7,450	1,876	2,945	8	Hydro-spring
M1906 gun	U.S.	4.7-inch	45	8,700	2,050	8,069	7.8	Hydro-spring
155mm how.	France	155mm (6.1 –inch)	95	12,300	1,480	2,690	6	Hydro-pneumatic
155mmGPF	France	155mm (6.1 –inch)	95	17,700	2,411	23,050	60	Hydro-pneumatic
8-in. how. Mark VIII	Britain	8-inch	200	12,360	1,522	20,048	52	Hydro-pneumatic
9.2-in. how. Mark II	Britain	9.2-inch	290	13,080	1,500	19,040	60	Hydro-pneumatic
240mm how.	France	240mm (9.5-inch)	356	17,000	1,700	37,920	20	Hydro-pneumatic

Appendix II

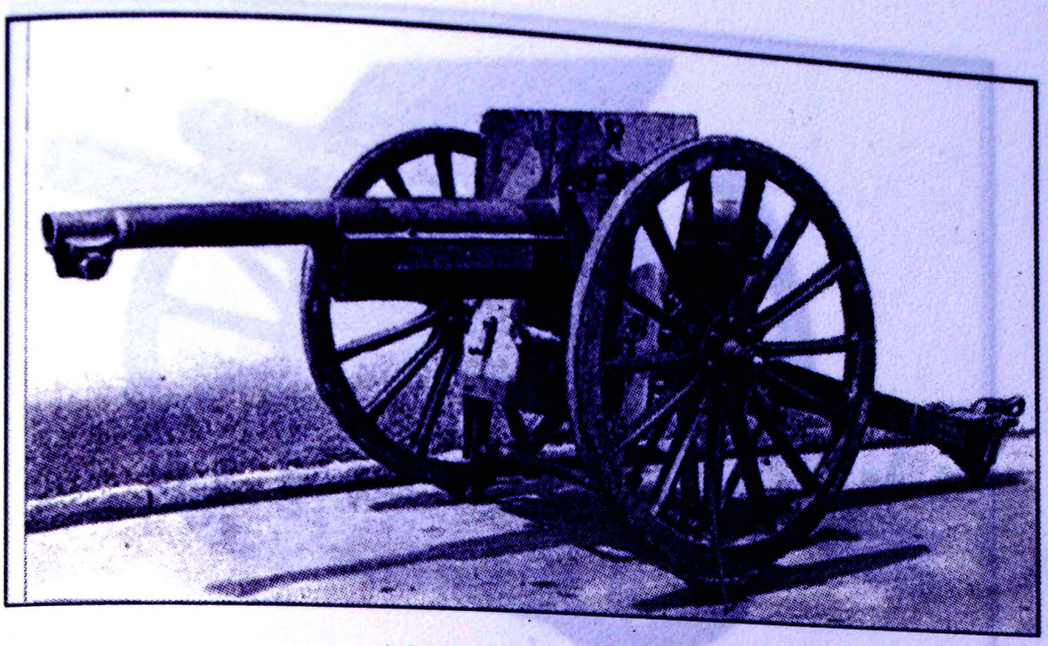
All photographs courtesy of the Ordnance Department



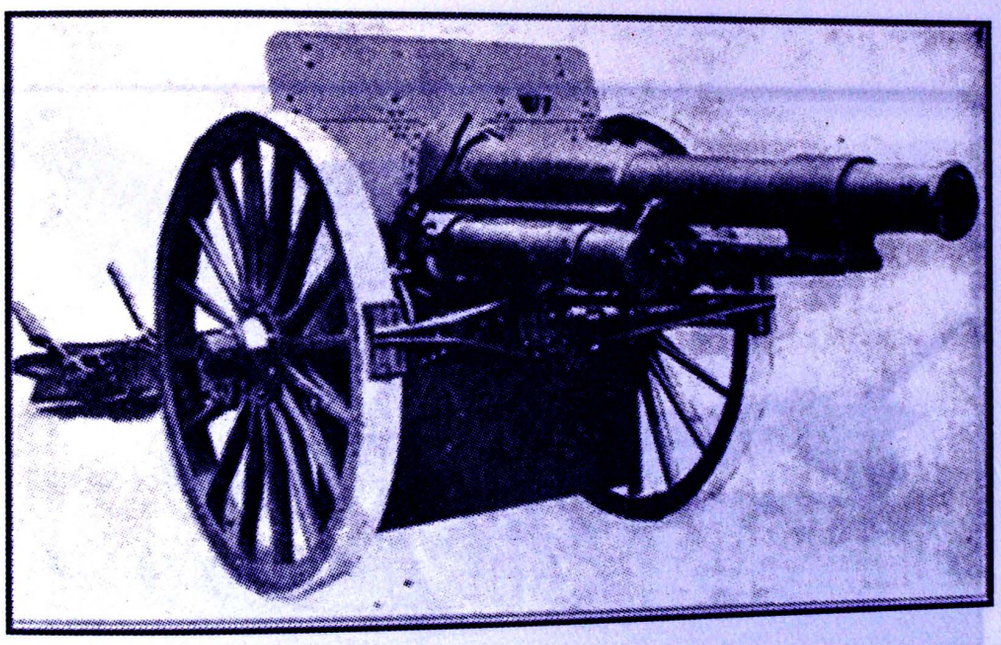
M1902 3-inch



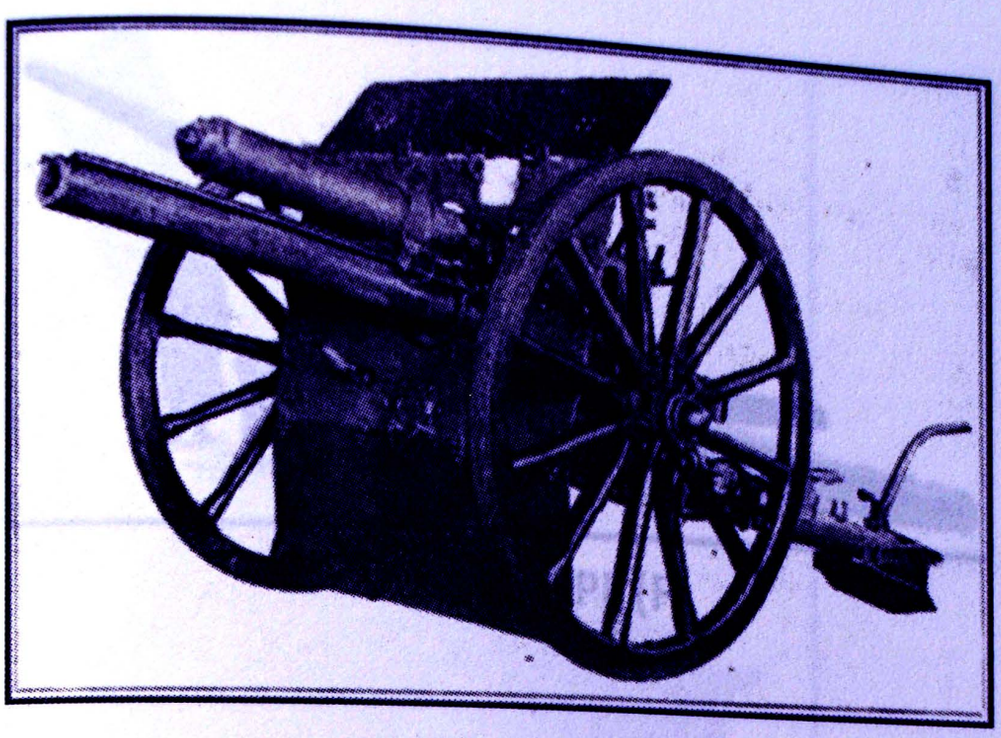
M1916 75mm



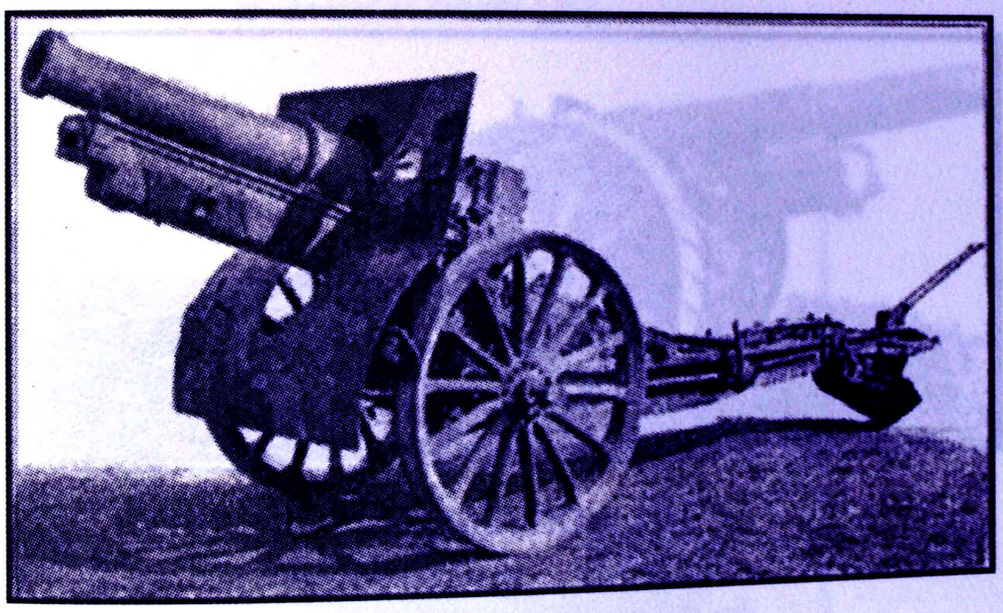
M1897 75mm(F)



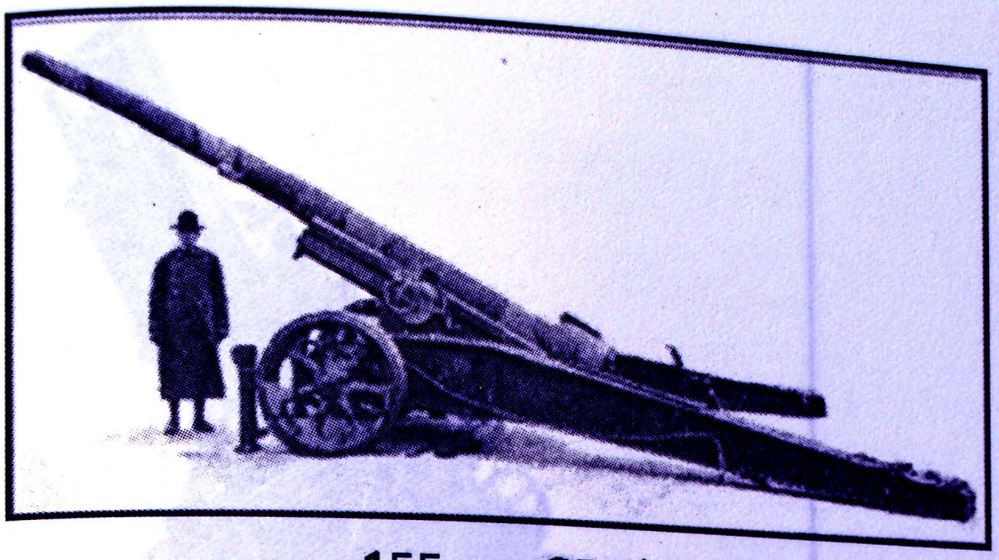
M1917 75mm(B)



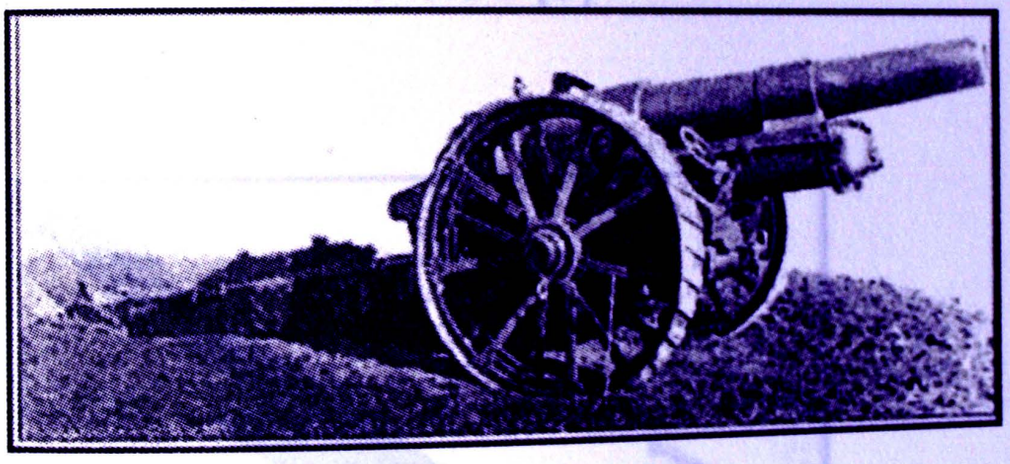
4.7-inch gun



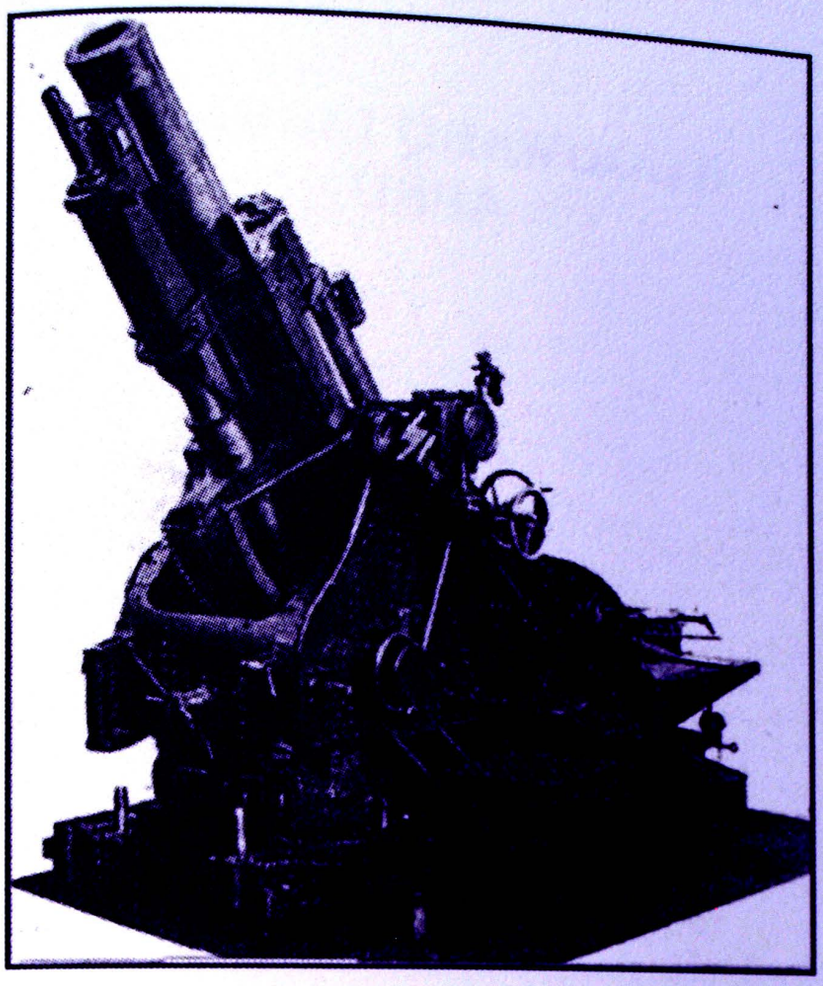
155mm how (F)



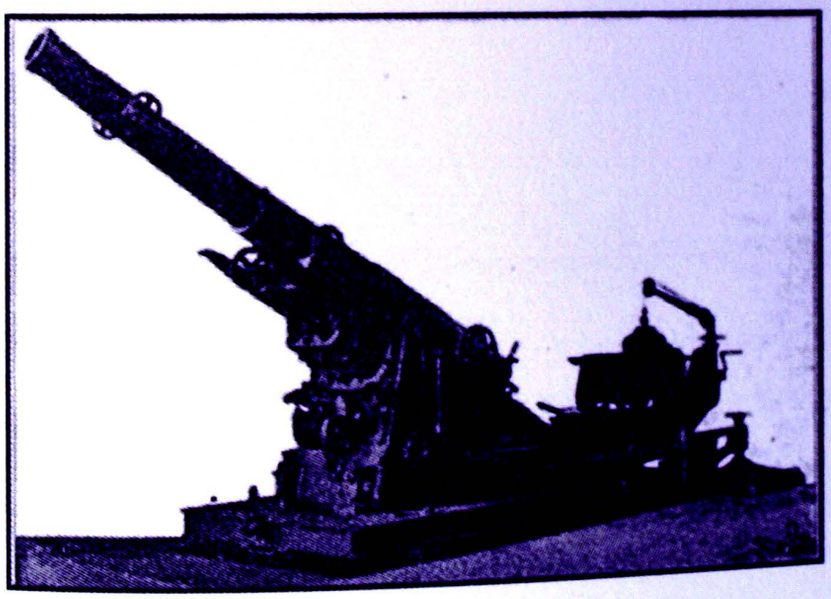
155mm GPF (F)



8-inch how (B)



9.2-inch how (B)



240mm how (F)