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From Balletics to Ballistics: French Artillery, 1897–1916

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ABSTRACT

The fighting on the Western Front during the First World War was characterized by the mass use of artillery and, thanks to scholarship from recent decades, is now understood as a crucible for learning and innovation. This article follows the trajectory of French artillery capabilities, mental and mechanical, from the late 19th century through to 1916.

Introduction

The First World War, fundamentally, was an artillery war. Central to every tactical question was the use of artillery: that of the attacker and the defender. The reason for this is largely technological. With the development of accurate, quick-firing artillery field armies would possess an unprecedented level of firepower. The 1890s introduced an era in which massed infantry charges could be largely turned back by artillery alone. These modern field guns could, if they chose, engage their targets from four to six kilometres away, thus freeing them from the constraints of their counterparts in the 1860s and 1870s, whose shorter ranges exposed them to deadly small-arms fire.

Against this new killing power there was little that infantry could do; little, that is, except dig. Trenches have always provided soldiers with protection from firepower. The same basic principles which Vauban had perfected in the 17th Century remained of vital importance well into the 20th. That the war on the Western Front was essentially a siege operation of unprecedented complexity and duration was not lost on the leadership of the French army. Joseph Joffre, commander-in-chief of the French army from 1911 to 1916, frequently made statements such as, '[this war] is a

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siege; thus, long and difficult'.¹ Such comparisons were not the sole purview of officers in GQG (*Grand quartier général*). General Cugnac, who commanded 18^e DI (*Division d'Infanterie*) in 1915 stated that, 'The old principle of our fathers remains true – you cannot attack a wall without having destroyed the bastions' flanking positions, without demolishing the ramparts.'²

The trenches and other field fortifications which stretched from the English Channel to the border of Switzerland from 1914–1918 were dug not only to protect the infantry from the awesome effects of modern firepower, but also in response to a force–space ratio which did not permit large-scale flanking manoeuvres. Any attack would have to be launched head on. This unprecedented defensive network posed a serious problem to any would-be attacker: how could a force successfully quit its protective trenches, cross open land, and then capture enemy trenches without suffering undue or, in any case, unsustainable losses. This problem was the central focus of military thought on the Western Front, and still generates a large part of the sustained interest in the First World War, scholarly and otherwise.³ Here, the parallels to old fashioned siege warfare begin to lose their relevance. The Central Powers were never going to be starved into submission without suffering serious military defeats, in the way a besieged town might. Likewise, the defensive structures built up and down the Western Front were easily and quickly replaceable. In a traditional siege one must only break the enemy defences once. On the Western Front the defences might be broken only to have the enemy retreat a few miles and

¹Service historique de la défense (SHD), 16N1905; « *C'est une opération de siège, donc longue et difficile* ».

²SHD, 22N573; « *Résumé de l'attaque du 11 Mai sur la côte 140* », 1 June 1915; « *Le vieux principe de nos pères reste vrai – on ne peut pas attaquer une courtine avant d'avoir détruit les organes de flanquement des bastions, avant d'avoir démo[u]lé les caponiers* ».

³The number of works that focus on the problems posed by trench warfare are legion and beyond a proper recounting here. Especially important for the thought leading up to this article were Michel Goya, *La Chair et l'acier : L'Armée française et l'invention de la guerre moderne (1914–1918)* (Paris: Tallandier, 2004); William Philpott, *Bloody Victory: The Sacrifice on the Somme and the Making of the Twentieth Century* (London: Little, Brown, 2009); Gary Sheffield, *Forgotten Victory, The First World War: Myths and Realities* (Chatham: Review, 2001); Paddy Griffith, *Battle Tactics on the Western Front: The British Army's Art of Attack, 1914–1918* (London: Yale University Press, 1994); Robin Prior & Trevor Wilson, *Command on the Western Front: the Military Career of Sir Henry Rawlinson 1914–18* (Oxford: Basil Blackwell, 1992); Gary Sheffield & Dan Todman, *Command and Control on the Western Front : The British Army's Experience 1914–1918* (Staplehurst: Spellmount, 2004) and more recently Aimée Fox, *Learning to Fight: Military Innovation and Change in the British Army, 1914–1918* (Cambridge: Cambridge University Press, 2018).

throw up a new, and perhaps even stronger, defensive position. In short, the problem was enduring.

Leaving aside important political considerations like clearing the Germans out of occupied France and Belgium, the Allies were only ever going to win by attacking the increasingly strong German defences. Such attacks would be costly, and required overwhelming firepower to ensure success. Artillery was the only weapon which could destroy or neutralise enemy trench-works and allow infantry to cross the killing zone and close with the enemy. This article will examine how French theory and practice concerning the employment of artillery changed as a result of the challenges posed by the Western Front. From the pre-war training of the French army, to the early battles of manoeuvre, through to the development of the trench network this article will map the evolution in French thought and practice in order to demonstrate not only that great strides and innovations were made in the First World War, but that they were made with startling speed. This speed is not only impressive in and of itself (having not yet been fully recognized by historians); it begs a reconsideration of the developmental trajectory of armies on the Western Front.⁴ Given the life or death pressures of war it should not be surprising that armies innovated rapidly to try to save lives and secure victory. What is amazing is how far they progressed from pre-war thinking and practice.

Artillery from 1878–1914

The vast majority of the guns that were available to France in 1914 were produced in the 1870s and 1880s. These guns, the de Bange series, accounted for two-thirds of the French arsenal (8,150 out of a total 12,214), yet only 120 of them were attached to active field units in August 1914 (a little more than one-third of the 308 heavy guns and mortars with which the French army marched to war).⁵ They were, in many ways, guns of a different era. Designed and crafted in the years after (and largely in response to) the French humiliation in the Franco-Prussian War, the de

⁴Older works, including Bruce Gudmundsson, *Stormtroop Tactics: Innovation in the German Army, 1914–1918* (Westport, Connecticut: Praeger, 1989) and Douglas Porch, *The March to the Marne: the French Army 1871–1914* (Cambridge: Cambridge University Press, 1981) have successfully cemented the idea of the French army as a bumbling organization, in contrast to the supposedly more dynamic German army. More recent works, especially Goya's monograph and PhD thesis, challenge these assumptions. Unfortunately, Anglophone scholarship has been slow to take up Francophone research into their historiography.

⁵Robert Doughty, *Pyrrhic Victory: French Strategy and Operations in the Great War* (Cambridge, Mass.: Belknap Press of Harvard University Press, 2005), p. 29; Émile Gascoquin, *Evolution de l'artillerie pendant la guerre* (Paris: Imprimerie Nationale, 1920), p. 29 & Goya, *La Chair et l'acier*, pp. 148-150, 162.

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Bange guns provided the range and power that French artillery had previously lacked. What the de Bange guns could not boast, however, was rapidity of fire. While the guns were 'virtually brand new' in 1914 (having never seen action), they were designed in a time before the invention of hydraulic recoil, which meant that the guns would have to be re-positioned and re-aimed after every shot.⁶ This being the case, they were only capable of three shots a minute under the best circumstances. In the field, one shot a minute was the norm. Compared to the 10 to 15 shots a minute which more modern guns were capable of, the French reliance on the de Bange guns put them at a serious disadvantage. The French have been frequently slighted for having overly long artillery preparations in the First World War.⁷ It is worth remembering that these preparations were not long by choice, but by necessity. It took a certain amount of tonnage to destroy or neutralize enemy trenches. With guns that could only reasonably fire one round a minute the French had no choice but to let the guns take as long as needed if they wanted to have any reasonable chance of success. Barbed wire was never caught off-guard by a surprise attack.

Recognising the inefficiency of the de Bange guns for modern warfare, the French army did attempt to retrofit many of the guns to make them more serviceable for operations on the Western Front. The de Bange 120L (long barrel), the most common de Bange heavy gun available, was the first in the French army to be coupled with motorised tractors, which greatly increased the guns' mobility (although there seemed to never have been a large number of these tractor-pulled 120Ls).⁸ Likewise, plans were considered for retro-fitting 120Ls with the *affût Mourcet*, a crude recoil system, which would have increased their rate of fire. Ultimately, production of the *affût Mourcet* was not pursued; the French decided that the *affût Mourcet* would have been a waste in light of the 220 modern 105Ls that had been ordered soon after the outbreak of war in 1914.⁹ Unfortunately, it would take some time for these new guns to be produced and reach the front lines (the order only being completed in 1916), which left the French with little option but to continue to slog on with its slow-cadence fire. This problem was exacerbated when the order of modern, quick-firing 105Ls was reduced from 220 to a mere 36 after the decision was made to rely on modifying existing French 75s to allow them to play roles normally reserved for heavy guns.

⁶Gascouin, *L'Évolution de l'artillerie pendant la guerre*, p. 28; « presque à l'état de neuf ».

⁷Goya, *La Chair et l'acier*, p. 155 ; Barthélemy Edmond Palat, *La Grande guerre sur le front occidental*, (Paris: Chapelot, 1927), p. 237.

⁸Gascouin, *L'Évolution de l'artillerie pendant la guerre*, p. 33.

⁹Goya, *La Chair et l'acier*, p. 161.

While the French were trailing the Germans in terms of heavy artillery production, they led the world in field artillery. The vaunted French 75mm field gun had reigned supreme since its debut in 1897. The first gun to be fitted with a hydraulic recoil system, the French 75 was the world's first modern artillery piece. Despite its early development, it remained a superior weapon, being markedly more effective than its German 77mm counterpart, which had been designed after the unveiling of the 75.¹⁰ Even before war-time modifications the 75 boasted a longer range than the 77 (by 1,000m). It was also quicker-firing, and more accurate. It would remain an important part of the French war machine throughout the conflict, taking on roles as diverse as counter-battery fire, wire-cutting, and the delivery of poison gas.

Several attempts were made to enhance the accuracy and flexibility of the 75 in the years just before the outbreak of war. Most were attempts to get the 75 to fire a more arced shot, thus helping to overcome the shortage of high-arc heavy artillery that the French army suffered from (a shortfall made all the more evident by very public German advances in heavy artillery from 1905 onwards). The *plaquette Malandrin* was one potential solution. It was, in essence, a set of wooden fins which attached to a 75mm shell, causing it to fall sharply as it lost momentum.¹¹ The *plaquette* saw limited use in the early years of the war, although assessing how often it was used and how effective it was is profoundly difficult. The only definite use of the *plaquette* known to the author was by the 34^e DI in the build up to its attack on the village of Chantecler in June, 1915.¹² Chantecler was elevated above the French position, rendering terrestrial observation all but impossible. Aerial reconnaissance could not discern damage done by *plaquette*-equipped 75mm shells from other damage done in the division's preparatory bombardment (nor were they likely to have even tried). The 75's limited payload and relative inefficacy against established trench-works obscures any inquiry into the practicality of the *plaquette*. If the 75 was not strong enough to tackle the defences around Chantecler it is irrelevant whether or not the sharp drop-off provided by the *plaquette* actually occurred. In the end, the verdict on the usefulness of the *plaquette* is probably best answered by its rarity in the source material.

Very similar was the *cartouche réduit* (the 'reduced cartridge'). The reduced cartridge manipulated the charge of each round in such a way as to cause the shell to fall abruptly, thus allowing the 75 to effect 'plunging' fire. This, however, came at a cost: the range of the 75mm was reduced from 6,500m to 2,000 to 4,000m.¹³ As with the *plaquette*, evidence of use of the reduced cartridge is slim. Ultimately, neither could

¹⁰Ibid., p. 154.

¹¹Doughty, *Pyrrhic Victory*, p. 31.

¹²SHD, 24N741; « *Compte-rendu au sujet de la mission de l'A.D. 34* », 24 May 1915

¹³Gascouin, *L'Évolution de l'artillerie pendant la guerre*, p. 123.

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hope to fill the role of heavy artillery, owing to the deficient range and striking power of the 75. A lack of modern heavy artillery (of which the French had only 104 pieces extant on the outbreak of war) was to be a major preoccupation of all armies on the Western Front (even the German) and was the primary driver which gave the early trench battles their shape and scope.

If France was innovative in its field artillery design it was purely reactive in its approach to heavy artillery.¹⁴ Germany led the way with heavy-gun production, and unveiled Europe's first modern heavy artillery batteries to be organically attached to infantry formations. This forced the French military into an uncomfortable situation. Doctrinally the French did not see the need for heavy artillery batteries to be attached to infantry. Heavy artillery was reserved for sieges, a type of operation completely outside of the French emphasis on speed and mobility on the battlefield.¹⁵ Heavy artillery was worse than existing field guns at hitting exposed infantry, it was argued, which would make them an actual hindrance, not just an unnecessary expenditure.¹⁶ Supporting the bureaucratic inertia which hindered the French procurement of modern heavy artillery was a range of very valid questions. Would the heavy guns slow down the rapidly moving infantry and field guns? Would they ever be able to deploy in time to take part in the great battles of manoeuvre that were expected? How could the logistics network supply heavy guns with enough ammunition with the armies constantly on the move? How were artillery crews supposed to use guns whose range could be up to 10km when artillery crews could only observe fire up to 4km in the best of circumstances?

By contrast, the strategic position of Germany made the adoption of heavy artillery batteries an absolute necessity. All along Germany's western border were great forts (Liège, Namur, Verdun, Belfort) that Germany would have to assault eventually. The need to assault these forts, and to take them quickly, was reinforced by Alfred von Schlieffen's estimation that France would need to be crushed in a few short weeks if Germany was to avoid fighting a two-front war with France and Russia. Germany's early adoption of heavy artillery was not a result of great tactical foresight, but a response to clear and unavoidable strategic realities. France, on the other hand, did not expect to assault any major forts (aside, perhaps, from Metz), and expected to fight the next war in open terrain. Its doctrine and equipment reflected this. Bureaucratic inertia and budgetary insufficiencies kept the French from adopting

¹⁴David Stevenson, *Armaments and the Coming of War: Europe, 1904–1914* (Clarendon Press: Oxford, 1996), p. 57.

¹⁵Robert M. Ripperger, 'The Development of French Artillery for the Offensive, 1894–1914', *The Journal of Military History*, 59/4 (1995), p. 616.

¹⁶*Ibid.*, p. 607.

modern heavy artillery until 1910; an act pursued more because the Germans had heavy guns than because the French had in mind a specific role for them.¹⁷ It was then that the French first began to procure modern Rimailho 155CTRs (*court tir rapide*) and 105Ls. This program was expanded under Joffre from 1911, although it was not without incident; bureaucratic infighting would stunt or reduce many procurement efforts.¹⁸ As a result, the French army would have only 140 modern heavy guns in August 1914: 104 155CTRs and 36 105Ls.¹⁹

Pre-War Artillery Doctrine

Discussing French doctrine before the Great War is not as straightforward as discussing hardware and procurement. This is largely because the French did not have a clear doctrine in the early 1900s. Douglas Porch claims that the French army of the early 1900s was simply incapable of producing or applying any set doctrine: a result of bureaucratic wrangling and even unprofessionalism.²⁰ Porch attacks the French high command for trying to substitute metaphysical concepts like *élan vital* (the idea that, by their very 'Frenchness', French soldiers could overcome modern firepower) in place of a modern, scientific doctrine. More accurate is Michel Goya's assessment, which acknowledges the French army's large body of doctrinal and theoretical writings on war, but still asserts that this disparate collection of works did not represent a true 'doctrine' in any meaningful sense of the word.²¹ Joffre himself admitted that the French had no real doctrine, at least up until 1911. In his memoirs he wrote that his primary goal upon becoming *Chef d'état-major général* was the creation of 'a firm doctrine for war, known by all and unanimously accepted'.²² If Goya is correct it is nevertheless still useful to examine some of the pre-war writings on artillery to get a sense of how influential members of the French military establishment were thinking.

Hippolyte Langlois was one of the most important French military thinkers in the late 19th and early 20th centuries. Commissioned into the artillery in 1858 he went on to serve in the Army of Metz during the Franco-Prussian War. By the late 1880s he had become Colonel Langlois and was appointed professor of artillery at the *École de*

¹⁷Goya, *La Chair et l'acier*, p. 160.

¹⁸Doughty, *Pyrrhic Victory*, p. 31.

¹⁹Doughty, *Pyrrhic Victory*, p. 29; Gascouin, *L'Évolution de l'artillerie pendant la guerre*, p. 29 & Goya, *La Chair et l'acier*, pp. 148-50, 162.

²⁰Douglas Porch, *The March to the Marne: The French Army 1874–1914* (Cambridge: Cambridge University Press, 1981), pp. 214-6.

²¹Goya, *La Chair et l'acier*, pp. 110-2.

²²Joseph Joffre, *Mémoires du Maréchal Joffre (1914–1917)* (Paris: Librairie Plon, 1932), p. 29; « *Avant tout, il fallait doter notre armée d'une doctrine de guerre ferme, connue de tous, et unanimement acceptée* ».

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guerre. Langlois would go on to be a *Général de division* (a two-star general). He served on the *Conseil supérieure de guerre*, and would be ultimately be elected into the *Académie française*. After joining the *École de guerre* Langlois embarked on an influential publishing career. In 1892 he produced *L'Artillerie de campagne en liaison avec les autres armes* ('Field artillery in liaison with other arms'). In this treatise Langlois stressed the importance of mobility and 'dash' in the artillery, which he considered to be uniquely French strengths, harking back to Napoleon.²³

Langlois was a firm proponent of the centrality of artillery to modern warfare. Artillery, he claimed, allowed the attacker to amass a local firepower advantage, and thus overwhelm the enemy at a chosen point. The idea of focusing on the decisive point (or *schwerpunkt*) was an idea rooted firmly in the campaigns and battles of Napoleon (one potential criticism of Langlois's 1892 book is that certain passages are strongly Napoleonic with the infantry marching in column, trailed by a grand artillery train, etc.).²⁴ It was a concept made all the more relevant, many felt, by the vast expansion of Continental armies. As one could now attack the enemy at virtually any point along a line extending hundreds of miles the choice of location for any attack was paramount. The process of concentrating force for a local attack without overly-weakening other sectors inspired much debate. Foch's chapter *L'Économie des forces* in *Principes de la guerre* bears testament to this (and even opens with a quote from *l'Empereur* himself).²⁵ That many batteries of artillery could be secretly concentrated at the decisive point, could fire simultaneously, and all on the same area, made artillery the principal and most powerful arm on the modern battlefield according to Langlois. Once engaged, the artillery should concentrate its bombardment, and blanket the enemy with shell-fire to catch hidden artillery emplacements and induce shock.²⁶ Above all, this was to be done quickly: Langlois saw speed/tempo as the most important attribute for an attacker. Nevertheless, he did allow for changing circumstances in the field and held that, above all else 'the position of the artillery ought to respond to the tactical goal'.²⁷

The foundation for the doctrine, however loosely defined, that informed the employment of French artillery in 1914 was laid in 1903. That year the French army produced the *Règlement provisoire de manœuvre de l'artillerie de campagne* (Provisional

²³Hippolyte Langlois, *L'Artillerie de campagne en liaison avec les autres armes* (Paris: Librairie Militaire R. Chapelot, 1908), p. 247.

²⁴*Ibid.*, pp. 278-84.

²⁵Ferdinand Foch, *Œuvres complètes, Tome I: Les Principes de la guerre*, (Paris: Economica, 2008), p. 168.

²⁶Ripperger, 'Development of French Artillery', p. 601.

²⁷Langlois, *L'Artillerie de campagne*, p. 255; « la position de l'artillerie doit répondre au but tactique ».

regulations for the manoeuvre of field artillery). The *Règlement* was a manual intended to cover the majority of aspects related to service in the artillery. As such, the first third of the *Règlement* deals entirely with training, gymnastics, and the proper forms of march and dress becoming of an artilleryman. The sheer amount of gymnastics in the *Règlement* is staggering, but we have to place it in the context of late 19th century France. In the years immediately after the humiliating defeat of 1870–1 gymnastics were seen as offering France a way to better prepare its young men for a military life.²⁸ Just as flying clubs proliferated in post-Versailles Germany, gymnasiums offered a pseudo-military outlet for French people (especially young men). This practice bled into military practice, and edged out some of the more practical and scientific aspects of artillery training. Ballistics and the higher art of artillery service, for example, are only belatedly covered.

The *Règlement* broadly agrees with Langlois' 1892 work, stating that 'speed of fire is the essential property for field artillery'.²⁹ Being written after the introduction of the French 75 it is not surprising that rapidity of fire was held to be of great importance. This emphasis on high-speed artillery fire (aimed over open sights) blanketing enemy positions with shrapnel was supported by Ferdinand Foch in his influential *Principes de la guerre* (also published in 1903): 'A quarter of an hour's quick fire by mass artillery on a clearly determined objective will generally suffice to break its resistance, or at any rate make it uninhabitable, and therefore uninhabited'.³⁰

The *Règlement* anticipated the use of artillery at short to medium range (typically between 1,000 and 3,000 metres with 4,000 being the longest range discussed).³¹ This was largely done to accommodate the observation of artillery fire, which the *Règlement* stated was to be done from within the immediate vicinity of the gun (in theory to allow for the gunfire to be quickly adjusted, ensuring accuracy). The *Règlement* does provide some equations for ascertaining the difference in altitude between the battery and its target, but failed to prepare artillerymen for firing from defilade or calculating wind resistance, the effects of barrel wear or other practical issues that a gun crew would have to consider in the field.³² One area in which the *Règlement* is reasonably advanced was in its discussion of *tir progressif*, in which an

²⁸Eugen Weber, 'Gymnastics and Sports in Fin-de-Siècle France: Opium of the Classes?', *The American Historical Review*, 76/1 (1971), p. 73. Weber's article remains the classic work on the subject.

²⁹*Règlement provisoire de manoeuvre de l'artillerie de campagne*, (Paris: 1902), p. 66; « *La rapidité du tir...est la propriété essentielle du canon de campagne* ».

³⁰Joseph C. Arnold, 'French Tactical Doctrine 1874–1914', *Military Affairs*, 42/2, (1978), p. 64.

³¹*Règlement provisoire*, pp. 92 & 130-143.

³²*Ibid.*, p. 109.

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artillery battery would fire two rounds per gun before increasing their range by 100m and firing a further two rounds.³³ This was repeated four times for a total of eight rounds fired in quick succession to create a sweeping effect of shell bursts over a designated area. This practice would not only become the standard procedure for anti-aircraft fire but would also be the rough model for what would become the 'rolling barrage'.³⁴

Contemporary wars naturally had an impact on how the French army thought about the use of artillery. The Russo-Japanese War (1904–5), for example, was held up as evidence to support the idea that guns were best employed atop hillocks, firing over open sights. This conclusion was based on the poor performance of the Russian artillery when it attempted to fire from defilade.³⁵ The Russo-Japanese War was also used to support the French doctrine of blanketing enemy areas with shell fire; the argument was that the vast tonnages of munitions expended were proof that weight of metal was the most important factor in deciding victory. Interest in contemporary conflicts was pervasive. Just four years before his death Langlois published *Lessons from Two Recent Wars*, an analysis of the Russo-Turkish War (1877–8) and the South African War (1899–1902). In this volume Langlois discussed artillery in terms that were very firmly in line with wider French doctrinal thinking. The passive defence (an unacceptable option for the post-1871 French army) was derided as surrendering the initiative, and thus placing one's troops at the mercy of enemy artillery, which would retain freedom of action and concentration. Langlois stated clearly that frontal attacks were inherently difficult and would likely be very costly (a long-standing concept in the French army, not a last-minute thought in 1913 as some have argued), but that technological developments still advantaged the attack over the defence.³⁶ Langlois presciently discussed the value of 'field fortifications' (trenches), stating that:

If...we were to construct numerous trenches forming a strong firing line, were to securely protect their flanks and support them in the rear by other trenches, one behind another, we should arrive at a position which would be invulnerable against artillery. This invulnerability would depend not so much on the strength of any one or of the component parts, but on their number and their extension.³⁷

³³Ibid., p. 93.

³⁴Pierre Joseph Louis Alfred Dubois, *L'Artillerie de campagne dans la guerre actuelle 75 & 90* (Paris: L. Fournier, 1916), pp. 163-165.

³⁵Ripperger, 'Development of French artillery', p. 604.

³⁶Paul Strong & Sanders Marble, *Artillery in the Great War* (Barnsley: Pen and Sword, 2011).

³⁷Hippolyte Langlois, *Lessons from Two Recent Wars [The Russo-Turkish War and South African Wars]* (London: Mackie and Co, 1909), p. 138.

While Langlois is deserving of some praise for conceptualizing a grand network of field fortifications he failed to propose any methodology for dealing with them. In his book he did not discuss how such a defensive network could be attacked, nor did he suggest that such defences were invulnerable to artillery simply because French artillery was not heavy or powerful enough to attack them (a politically difficult thing to say, as the 75 was still embraced as the centrepiece of the French armoury).

This unwillingness to stretch the analysis that final step to considering a solution for a very real problem (trench-digging had become a major component of field battles the world over in the early 1900s) persisted through to the outbreak of the Great War. The last major French work of doctrine to appear before the war was 1913's *Décret du 28 octobre 1913 portant règlement sur la conduite des grandes unités (service des armées en campagne)*: [Decree of 28 October 1913, Regulations for the Direction of Larger Units (the service of armies in the field)]. The Decree relegated artillery to a greatly reduced role on the battlefield (far from its position as queen of the battlefield, conferred intellectually by Langlois, Foch, and others) stating that 'the artillery has as its essential mission to support the forward movement of the infantry'.³⁸ Artillery would help infantry get across the killing ground, but would do little else; it certainly would not be the principal arm on the battlefield. The regulations went even further to state that artillery's role on the battlefield would be principally morale-centred (a boost for friendly troops, and a demoralizer for the enemy). Such an understanding of the utility of artillery on contemporary battlefields would be sorely tested in the Great War.

La Guerre de Manœuvre

1914 would prove to be a trying year for the French army. In its five months of war 1914 would claim enough French casualties (301,000 dead, many more missing or wounded) to be the second-bloodiest year of the war for the French.³⁹ To a large extent this was owing to the fact that the entire French army was engaged in regular battle. Poor French performance in battle, however, did not help. The artillery was frequently left behind by the infantry who would impetuously advance into battle without waiting for artillery support. When artillery was brought to bear it was done on an entirely *ad hoc* basis, without liaison between batteries or a co-ordination of efforts across most formations.⁴⁰ Despite this chaos there were instances in which

³⁸*Décret du 28 octobre 1913 portant règlement sur le conduite des grandes unités (service des armées en campagne)* (Paris: 1913), p. 39; « l'artillerie a pour mission essentielle d'appuyer le mouvement en avant de l'infanterie ».

³⁹Lieutenant-colonel De Chasteigner, '1915 : Le Martyre de l'infanterie. Un exemple: Les Éparges', *Revue historique des armées*, 21/ 2 (1965), p. 8.

⁴⁰Gascouin, *L'Évolution de l'artillerie pendant la guerre*, pp. 74-76.

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French artillery was able to successfully intervene in a battle and influence the outcome of events. At times the artillery filled the role designated to it in pre-war doctrine firing over open sights upon massed German infantry.⁴¹

These instances, combined with the celebrated performance of the 75 at the 1914 Battle of the Marne, would cement in the minds of many the enduring centrality of field artillery, to the detriment of heavier guns.⁴² As the trenches were dug in late 1914, however, the 75 began to show some of its inadequacies. Despite the fact that guns were firing at relatively short ranges artillery still had difficulties providing close infantry support. This was one of the major challenges for the French army from 1915, and a range of solutions were proposed. Flares were probably the best and quickest option available. French flares came in three colours (green, red, and white), but were hindered by the fact that the white flare was practically invisible in daylight.⁴³ As flares were not always abundant the use of flags and other visual symbols (including hand and arm signals) were encouraged, especially in communicating over relatively short ranges.⁴⁴ Telephones were the clearest means of communication, but were subject to lines being cut by enemy fire, and also to accidental damage done by French infantry moving through the trenches. During the Second Battle of Champagne (September 1915) French formations tried to deal with the problem of close fire support by sewing white squares on the backs of advancing French infantrymen.⁴⁵ The white squares would signal to the artillery where the front line was, allowing them to engage in close support with less fear of inflicting friendly fire casualties. This proved less than effective.

Far more pressing than the difficulties regarding close fire support was the task of maintaining an adequate number of guns and shells in the field. French artillerymen were, on the whole, not taking very good care of their guns at a time when their guns were being asked to fire previously unthinkable quantities of munitions. Intense firing programs, such as those on which every attack relied, would cause many guns to fatally malfunction (typically, more guns were lost this way than were lost to enemy action).⁴⁶ From February 16–22 Fourth Army lost 10% of its field guns (86 of

⁴¹Ibid., pp. 87-88.

⁴²Émile Rimailho, *Artillerie de campagne* (Paris : Gauthier-Villars, 1924), p. 109.

⁴³SHD, 19N1686; « Note au sujet de l'emploi de fusées signaux comme liaison entre l'Infanterie et l'Artillerie ». 3^e Bureau, X Army, 26 April 1915.

⁴⁴SHD, 24N741; « Note pour les C.A. », 10^e Armée, 2 May 1915.

⁴⁵SHD, 19N735.

⁴⁶Rémy Porte, *La Mobilisation industrielle, « premier front » de la grande guerre?* (Cahors: 14–18 Éditions, 2005), p. 69.

860) due to excessive barrel-wear and subsequent malfunction.⁴⁷ 34^e DI, which had been a part of Fourth Army at the time, would again find itself suffering from gun shortages four months later. In its preparation for an attack on the village of Chantecler the division had only 20 fully-operational guns (six were firing at reduced capacity: four could only fire shrapnel shells for fear of causing a barrel rupture, and two were firing erratically); the division had effectively lost over one-third of its full paper complement to malfunction.⁴⁸

While the number of guns lost to malfunction (including barrel rupture) were greatly reduced as the war continued (a result of meticulous barrel oiling and the increased use of replaceable barrels) it posed a serious industrial problem to the French war machine.⁴⁹ The loss of France's industrial north-east in the initial German advance of 1914 put incredible strain on France's ability to keep its armies supplied with the ever-increasing materiel needed to conduct modern war.⁵⁰ The loss was especially trying as France did not simply need to replace spent munitions and lost weapons, but needed to create an entirely new armoury of heavy artillery, which was sorely lacking. This lack of modern weaponry made itself sorely felt in the initial trench battles.

La Guerre de Tranchée

In December 1914 the French army launched its first, concerted trench offensive. This effort, the First Battle of Artois, was launched by Tenth Army, under the command of General Louis de Maud'huy. Initially, Tenth Army's three corps were to make a simultaneous assault aimed at capturing Notre Dame de Lorette, a dominating piece of high ground just over a kilometre north-west of Vimy Ridge. It was always going to be a difficult operation, but the lack of artillery exacerbated the situation. When it became clear that there was not enough heavy artillery to support the action the attacks were staggered to allow the artillery to concentrate on each sector in turn. Thus, the entirety of Tenth Army's heavy artillery would support the actions of XXI CA on 16 December, X CA on the 17th, and then XXXIII CA on 18

⁴⁷État-major de l'armée, , *Les Armées françaises dans la grande guerre* (AFGG) (Paris: Imprimerie Nationale, 1923), *Tome II, Annexe 288*.

⁴⁸SHD, 24N741; « *Le Général de Lobit comt la 34 DI à M. le Général cdt la 17^e CA* », 12 June 1915.

⁴⁹J Campana, *Les Progrès de l'artillerie: l'artillerie française pendant la guerre 1914–1918* (Paris: Imprimerie la Renaissance, 1923), p. 43.

⁵⁰Porte, *La Mobilisation industrielle*, p. 63.

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December.⁵¹ Despite this measure (which was not at all out of line with pre-war theories of concentration) the artillery preparation was still woefully inadequate.⁵²

The French simply did not have enough guns or shells to yet launch a successful attack against a well-defended trench network. As a stop-gap, increasing numbers of older guns (primarily de Bange) were being pressed into service, including the 58mm cannon, which would be one of the principal wire-cutting tools of the French in the early trench battles. These weapons, however, were not built for modern war, and had serious problems beyond their slow rate of fire. The 58mm was a notoriously inaccurate weapon; if it was not for its ability to fire 50kg shells in a high arc at close range (mortar-fashion) it would likely not have been put into field service. Firing in a controlled test environment 58mm crews were unable to put more than one in five shells within five metres of the intended target.⁵³ The inaccuracy of the 58mm cannon was exacerbated by a quirk in the manufacturing of 58mm shells whereby some shells had their fins welded on and others were bolted on. Shells with wings bolted on tended to lose those wings mid-flight, resulting in the shell landing on its side or rear and then failing to detonate.⁵⁴ Fully 25% of shells with bolted-on fins failed to detonate for this reason. This put strain on logistical networks to provide more shells to make up for the 'duds', and also made essential preparatory tasks, like wire-cutting, all the more difficult.

Despite the many technical and logistical difficulties with which the French contended in 1915, the year was full of important innovations. The truly complex nature of the problem facing any attacker in the war was understood by tactical commanders very quickly. Most celebrated among the 'early adopters' of artillery-centred warfare is Andre Laffargue. A young officer who had served in the Artois region, Laffargue wrote a widely-distributed pamphlet entitled *Étude sur l'attaque dans la période actuelle de la guerre: impressions et réflexions d'un commandant de compagnie* (called 'The Attack in Trench Warfare' in its English translation) in response to what he felt were the 'flagrant tactical failures' of the French army up to that point.⁵⁵ Read in all the major armies on the Western Front (copies were captured and translated by the Germans) the pamphlet set out a firepower-intensive vision of how offensive trench battles should be conducted, while also stressing caution to avoid

⁵¹ AFGG, *Tome II*, p. 177-8.

⁵² Marie-Émile Fayolle, *Cahiers secrets de la grande guerre* (Paris: Librairie Plon, 1964), p. 63.

⁵³ SHD, 22N163.

⁵⁴ SHD, 22N163.

⁵⁵ André Laffargue, *Étude sur l'attaque dans la période actuelle de la guerre: impressions et réflexions d'un commandant de compagnie* (Paris: Plon-Nourrit et Cie, 1916) [Note: I reference the 1916 edition here].

unnecessary infantry casualties. Laffargue gave artillery five key roles, most of which have to do with the destruction of enemy defences (he assigns separate roles for the destruction of barbed wire, trenches, and machine guns); the other two roles were counter-battery fire and the firing of a barrage to keep enemy reserves from joining the fight.⁵⁶ Laffargue argued persuasively that the French army needed more mortars, as they were the best weapons available for wire-cutting according to Laffargue, and also advocated better reconnaissance and maps.⁵⁷

Despite Laffargue's reputation in the historiography, it would be best to consider his work for its implication (that the French army was becoming more tactically refined) rather than its impact. Pamphlets read are not pamphlets followed, and there is a dearth of evidence to support there being any actual effect of Laffargue's writing.⁵⁸ Furthermore, the ideas in Laffargue's pamphlet were not particularly new when he published them in Autumn 1915. His emphasis on the importance of mapping and reconnaissance had already been laboured by Philippe Pétain (who had also served in Artois).⁵⁹ Far worse, many of Laffargue's firepower-intensive recommendations were already official doctrine by Spring 1915; thus raising the possibility that Laffargue's pamphlet attacking French methodology was in fact inspired by existing French doctrine and methodology. What the historiography has seen up to now as a forward-looking cry in the wilderness by a desperate and intelligent young officer may well have been a simple act of plagiarism.

In April 1915 the French army produced its first broad doctrine on trench warfare. The doctrine places artillery in a privileged position, as Laffargue would go on to do, and insisted that artillery prepare attacks methodically.⁶⁰ The new doctrine assigned the artillery four roles (destruction of enemy defences, counter-battery fire, direct support of infantry attacks, and the bombardment of enemy soldiers), all of which broadly agree with the five roles that Laffargue would later propose. The importance of aerial reconnaissance was heavily stressed, as was adequate observation, reconnaissance, and mapping.⁶¹ Infantry–artillery liaison, especially via telephone, is held up as essential for the effective employment of artillery. This is in stark contrast to the pre-war army which assigned only 500m of telephone wire to each battery (additional supplies were hurriedly purchased in Paris and Switzerland in the early

⁵⁶*Ibid.*, p. 8.

⁵⁷*Ibid.*, p. 47.

⁵⁸Goya, *La Chair et l'acier*, p. 206; Griffith, *Battle Tactics on the Western Front*, p. 56 & Gudmundsson, *Stormtroop Tactics*, p. 173.

⁵⁹SHD, 24N1991; « *Le Général Pétain, Commandant le 33^e C.A. à Monsieur le Général Commandant la 10^e Armée* », 27 May 1915.

⁶⁰SHD, 19N735; « *But et conditions d'une action offensive d'ensemble* », 16 April 1915.

⁶¹SHD, 19N735; « *But et conditions d'une action offensive d'ensemble* », 16 April 1915.

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months of the war).⁶² Heavy artillery and mortars are highlighted as the most important weapons for the destruction of enemy defences (especially barbed wire), while the 75 is given the bulk of the responsibility for engaging enemy infantry (through shrapnel barrages) and for counter-battery fire. In short, the French had managed to develop a fairly accurate understanding of the necessities of trench warfare within a few months of the solidification of the trench network along the Western Front.

In this new model for trench warfare the famed French 75 saw a reduction in its role on the battlefield. Partially this was due to unchangeable facts of the 75mm design: it would forever be too light, and fire shells at too flat a trajectory, to have a serious destructive impact against field fortifications. As such, the single most common French artillery piece could only be used in certain roles, such as the firing of barrages to hinder enemy movements or efforts at improving their trench network.⁶³ The importance of the 75 would arguably continue to diminish as the war progressed, making way for the dominance of heavy artillery and mortars in the larger, later battles of the war. Even traditional field-artillery roles, such as direct-fire support, were being eroded by light mortars (like the British Stokes mortar) and other trench guns, especially the 37mm.⁶⁴ Nevertheless, the 75 did have serious contributions to make in the two most transformative artillery developments in 1915: the rolling barrage and the delivery of asphyxiating gas shells.

The rolling barrage was one of the most important artillery procedures in the First World War. In effect, a rolling barrage was an artillery barrage (a wall of fire and steel created by shrapnel or high-explosive shells) which would advance at a set pace in order to provide a protective curtain for advancing infantry. Its use was a crucial means of suppressing enemy infantry, allowing advancing troops to cross the killing zone with minimal small-arms interference. In theory, advancing troops would be able to reach an enemy trench before its would-be defenders had time to emerge from their deep dugouts. The close-range fighting that would ensue would strongly favour the attackers, especially if they were armed with sufficient grenades for engaging enemy troops still emerging from underground shelters.

Historians cannot, and probably never will, agree on when the very first rolling barrage was fired; most, however, agree that it was used within the first year of

⁶²Goya, *Le Processus d'évolution tactique*, p. 232.

⁶³SHD, 16N2095; « *Recherche de la permanence de réglages de l'artillerie* », 14 July 1916.

⁶⁴*Ibid.*, « *Le Canon de 75 est par excellence le canon d'accompagnement de l'infanterie* ».

trench warfare on the Western Front.⁶⁵ Its first inclusion in a grand work of French doctrine is easier (and potentially more important) to pinpoint. In the new trench warfare doctrine issued in April 1915 the rolling barrage is very clearly established as the standard procedure for any serious infantry attack: 'at the hour fixed for the infantry attack the artillery will increase its range *progressively* to make, in front and on the flanks of the attack, a longitudinal and transversal barrage to shelter the infantry so they can advance'.⁶⁶ That this fundamental trench tactic, which is frequently cited as first appearing in Autumn 1915, was elucidated as a key and basic aspect of French doctrine after a mere five months of trench warfare warrants a rethinking of the timeline along which Allied innovation and adaptation in the trenches took place.

To illustrate the level of refinement achieved in rolling barrages in 1915 let us consider one early example. On 9 May 1915, 77^e *Division d'Infanterie* (DI), part of Philippe Pétain's XXXIII *Corps d'armée* (CA), fired one of the more successful barrages of the year. Starting at H-hour (10.00) the barrage rolled forward for ten minutes before resting at *ouvrage 123* (a trench-work noted on divisional maps).⁶⁷ Here the barrage waited for a sign from the infantry to show that they too had reached *ouvrage 123*, and were ready to continue their attack. In doing so, it prevented the barrage from advancing too far beyond the advancing infantry, and also gave the artillery a chance to roll back the barrage to support the infantry if the attack stalled. The infantry, thanks to a detailed artillery preparation and well-paced rolling barrage, reached *ouvrage 123* without meeting much organized resistance, and signalled their readiness to continue. As the barrage moved on from *ouvrage 123* it fanned out towards the division's different objectives. Arguably it did so too slowly (the division suffered vicious enemy flanking fire while advancing over open country behind the barrage). Nevertheless, it was a crucial aspect of the division's attack which won some four kilometres of ground, 600 prisoners, and a handful of German machine guns and heavy artillery.⁶⁸

⁶⁵Doughty, *Pyrrhic Victory*, p. 194; Goya, *La Chair et l'acier*, p. 190; Strong & Marble, *Artillery in the Great War*, p. 70.

⁶⁶SHD, 19N735 « *But et conditions d'une action offensive d'ensemble* », 16 April 1915; « *À l'heure fixée pour l'attaque de l'infanterie, l'artillerie allonge progressivement son tir, pour faire, en avant et sur les flancs de l'attaque, un barrage longitudinal et transversal à l'abri duquel l'infanterie peut progresser* ».

⁶⁷SHD, 25N172; « *Emploi et rôle de l'artillerie dans la zone de la DIVISION* », 5 May 1915.

⁶⁸SHD, 22N1832; « *Compte-rendu sommaire des opérations de la 77^e division pendant les journées des 9, 10, & 11 Mai* ».

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Equally important to the development of the rolling barrage was the development of artillery-delivered poison gas. After the Germans made the first successful asphyxiating gas attack on 22 April 1915 the Allies were anxious to retaliate. The British would pin their hopes on an emulative gas attack (utilising a cloud of chlorine gas) during the battle of Loos on 25 September. The French asphyxiating gas programme, which had existed since January 1915, took a different path.⁶⁹ The French examined the utility of chlorine clouds after Second Ypres, even to the point of making an organisation and doctrine for so-called 'Z companies' to deploy the gas, but were unable to source enough chlorine to actually launch such an attack.⁷⁰ Even if enough chlorine had been on hand the French had a severe shortage of gas masks, which precluded infantry from advancing into the gassed area. As an alternative, the French began to experiment with delivering gas via artillery from May 1915.

The delivery system which first found its way into use was a 75mm shell filled with a mixture of carbon disulphide (CS₂) and phosphorus.⁷¹ This shell was not only asphyxiating but also incendiary (courtesy of the phosphorus), and produced prodigious quantities of smoke; attributes that combined to make it a potentially very effective counter-battery weapon. 10,000 CS₂/P shells were produced in quick order (with a further 40,000 being ordered on 31 May), and on 10 June were being rushed to the front to be tested against the enemy. There would be no time for training artillery crews in the proper use of these new shells as the French were at that time in the final stages of preparing a renewed general offensive in the Artois region. Instead, instructions were simply sent forward with them detailing their proposed use. The instructions from GQG were that the shells were best used against fixed and flammable defences in the German rear areas. One Thousand shells would need to be delivered quickly in order to inundate one hectare of terrain with enough gas to have an effect.⁷² This necessitated spreading the shells out amongst 75mm batteries to keep any one battery from having too great a load; the shells were highly unstable and GQG wanted to minimize the risk of gas being unleashed on friendly troops as a result of an untimely barrel rupture.

The shells were first used on 16 June by IX, XX, and XXXIII CAs serving under Tenth Army, part of the *Groupe provisoire du nord* commanded by Foch. While the incendiary effects were far weaker than had been hoped (fires had been set in

⁶⁹SHD, 16N826; « *Rapport sur l'organisation du service du matériel chimique de guerre, présenté par M. D'Aubigny, Deputé* », 25 August 1915.

⁷⁰SHD, 16N826; « *NOTICE sur le procédé d'émission de gaz asphyxiant au moyen des appareils système Z 2 et sur l'organisation des compagnies des sapeurs chargés de la mise en œuvre de ces appareils* », Ministère de la Guerre.

⁷¹SHD, 16N707; « *Compte-rendu du 14 Mai 1915* », GQG.

⁷²SHD, 16N707; « *Note pour la D.A.* », 9 June 1915.

Angres, but apparently nowhere else), the overall effect of the shells had exceeded expectations.⁷³ Fired primarily against known concentrations of enemy batteries, the launch of gas shells silenced German artillery for an hour-and-a-half across the front of XX CA, and seriously weakened the German artillery activity before IX CA.⁷⁴ Used again on 17 June, the gas shells produced much the same effect, a silencing of the targeted batteries. Within a week-and-a-half reports of these astounding results had reached the War Ministry where they were well received. Plans were immediately put into effect to vastly expand the use of poison gas shells by the French army, especially for the counter-battery role in which they had proven so effective. By the end of 1916, 25% of all French shells produced would be for the delivery of poison gas; these shells formed a cornerstone of French artillery fire for the rest of the war.

French artillery also improved its defensive policies.⁷⁵ Joffre's 1914 decree that artillery do more to hide its presence from German aircraft was expanded upon, and local corps and divisional commanders worked hard to ensure that their troops did not reveal too much to the Germans.⁷⁶ Batteries were encouraged to move frequently between various pre-prepared emplacements, thus making them harder to detect and engage by the Germans.⁷⁷ This suggestion was made along with the idea that batteries needed to keep better records on their target registration so that batteries could inherit an emplacement and not have to begin their registration from scratch as they would have pre-existing data to rely on. After the French successes with poison gas as a counter-battery weapon GQG recognized the importance of supplying French *artilleurs* with protection from gas to keep French batteries operational during battle.⁷⁸ French artillery also worked to improve its defensive fire plans, emulating the Germans' use of pre-sited artillery barrages to disrupt German attacks.⁷⁹ Despite these and other French artillery refinements there were still certain problems which proved very difficult to solve.

Enduring Challenges

While the advances made in the early stages of the war were impressive, they still required extensive refining before they became the war-winning methodologies of

⁷³SHD, 16N707; « *Compte-rendu au sujet des obus spéciaux de 75* », 23 June 1915.

⁷⁴SHD, 22N573; « *Compte-rendu de la Journée du 16* », 17^e DI.

⁷⁵Dubois, *L'Artillerie de campagne dans la guerre actuelle*, p. 132.

⁷⁶SHD, 22N1472; « *Le Général Maistre commandant le 21^e corps d'armée à M. toutes les autorités* », 30 May 1915.

⁷⁷SHD, 16N2095; « *Note aux Commandants de groupe d'armées sur l'utilisation de l'artillerie* », GQG, 3^e Bureau, 30 July 1915.

⁷⁸Ibid.

⁷⁹Dubois, *L'Artillerie de campagne dans la guerre actuelle*, p. 215.

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1918. Technical problems posed by obsolescent weapons could never be overcome; the French would have to wait for the production of modern, quick-firing heavy artillery like the Rimailho 155mm *court tir rapide*. Not until such weapons were in abundance could the French consider reducing their extended artillery preparations (sometimes lasting a week or more) before every attack.⁸⁰ Likewise the problems posed by German counter-barrages, which were instrumental in halting French attacks in 1915, could not be easily solved, even with an extensive use of gas shells. As the Germans could fire pre-sited barrages against advancing French infantry their guns were able to remain silent (and therefore hidden) right up to the moment of attack. Pétain's suggestion at the time was to use aerial assets to methodically map and observe German rear areas, and for counter-battery fire to be a better managed *longue durée* operation.⁸¹ While counter-battery was already a routine activity, Pétain felt that too much was left to inaccurate reactionary barrages fired on the day of an attack when hidden German batteries suddenly began pouring fire into advancing *poilus*. As time progressed the French would get better at counter-battery fire, both in the long and short term. By 1917 then commander-in-chief Robert Nivelle would write that aircraft were essential for effective counter-battery fire in real time with one aircraft flying for two hours being able to facilitate the neutralisation of up to four enemy batteries.⁸² Such a feat was simply impossible in the early trench battles.

Aerial reconnaissance and observation was a crucial component of Allied efforts. It was only from the sky that secondary German trench systems (frequently sited on reverse slopes, which made them incredibly difficult to hit) could usually be observed. General Marie-Émile Fayolle wrote in his diary 'as for taking many successive lines, those which we cannot see will be intact'; successful attacks relied on the accurate bombardment of these secondary German positions.⁸³ Using aircraft to direct artillery fire, however, was very difficult. Aircraft could not do this if there was a great deal of artillery action on both sides: the job became too dangerous and observation too difficult. Aircraft could be fitted with wireless (*télégraphie sans fil*, or TSF), but did not have enough power to house transmission and reception units: planes could only send information.⁸⁴ The ground-based receivers were unwieldy and were best kept in one place, meaning that they could only service batteries cited

⁸⁰Palat, *La Grande guerre sur le front occidental*, p. 237.

⁸¹SHD, 24N1991; « Le Général Pétain, commandant le 33^e C.A. à monsieur le général commandant la 10^e armée », 27 May 1915.

⁸²SHD, 16N2095; « Note sur l'emploi de l'aviation en liaison avec le A.L.A. pendant les dernières opérations sur le front de V armée », 5 May 1917; no. 2.

⁸³Fayolle, *Cahiers secrets de la grande guerre*, p. 98; « Quant à emporter les lignes successives, dont plusieurs, celles qu'on ne voit pas, seront intactes ».

⁸⁴SHD, 19N1686; « Instruction sur l'emploi des avions munis de TSF dans la situation actuelle », X Armée, 30 April 1915.

closely together. Signalling, therefore, was largely visual, which meant that it easily suffered from misinterpretation, if the signals were seen at all.

Photography proved to be one of the best means by which aircraft could assist in tracking the development (or destruction) of enemy positions.⁸⁵ While aerial photography became a cornerstone of the wider Allied artillery efforts, it remained open to misinterpretation. Pilots might have vastly differing opinions on the state of German trenches, creating an air of uncertainty about artillery preparations.⁸⁶ Balloons offered certain advantages to fixed-wing aircraft, not the least of them being speed and clarity of communication. Balloons, however, were highly vulnerable, and could not easily observe secondary German trench networks. There was no perfect answer to the Allies' general lack of good terrestrial observation; on the western front battlefields from 1915 to 1917, the First World War was a war fought for observation posts (ridges) as much as anything.

Of course the German defensive network was not static; it was ever evolving and improving to counter Allied improvements in offensive methodology. The Germans, like the French, started off with a largely improvised trench network in late 1914. Many parts of the front were poorly organised, as lines were dug based on the random chance of battle, rather than a rational assessment of the needs of the German army.⁸⁷ This quickly changed. By mid-1915 the Germans began to take their trench defences much more seriously.⁸⁸ Secondary positions were dug, and made as strong as their forward positions, to ensure that the Allies would not be able to 'breakthrough' the German trench line out into the open. The German trench systems were progressively moulded to lie on reverse slopes and to lure Allied attackers into pre-determined fields of fire.⁸⁹ German artillery made extensive efforts to assist in breaking up the coherence of any attack with pre-planned counter-barrages. Small Allied improvements in methodology were quickly met with German counter-measures. After the French proved the value of advancing above trenches

⁸⁵SHD, 19N1686; « *Note résultat de l'étude des photographie prises en avion* », 58th DI, 21^e CA, X Armée, 1 May 1915.

⁸⁶SHD, 24N741; « *Compte-rendu, observateur aux tranchées = Dubois (3^e Groupe, 23^e artillerie)* », 1 June 1915.

⁸⁷Robert T Foley, *German Strategy and the Path to Verdun: Erich Von Falkenhayn and the Development of Attrition, 1874–1916* (Cambridge: CUP, 2005) p. 163.

⁸⁸Jean-Claude Laparra, *La Machine à aaincre, de l'espoir à la désillusion: Histoire de l'armée allemande, 1914–1918* (Mercuès: Imprimerie France Quercy, 2006), p. 121; Jack Sheldon, *The German Army on the Somme 1914–1916* (Barnsley: Pen & Sword Books Limited, 2005), p. 66.

⁸⁹Pascal Marie Henri Lucas, *L'Evolution des idées tactiques en France et en Allemagne pendant la guerre de 1914–1918* (Paris: Berger-Levrault, third edition, 1925), p. 76.

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rather than through them (to avoid slowing the impetus of the attack by forcing infantry through narrow German communication trenches) the Germans began to line even their communication trenches with barbed wire to make it difficult for French infantry advancing over the top to return to the trench network.⁹⁰ It was this war of constant innovation between the Allies and the Germans that produced the stalemate on the Western Front, not a lack of imagination.

The lessons and procedures learned in the early months of trench warfare continued to be refined as the war progressed. Artillery bombardments became increasingly scientific, and came to rely on sophisticated mathematics as indirect fire became commonplace (whether the target was behind a reverse slope, the battery was in defilade, or both).⁹¹ Of course, the mathematical skills of French artillerymen varied. Nevertheless they were expected from 1916 to be able to calculate the effects of atmospheric conditions on artillery fire, among other common range and accuracy modifiers.⁹² By 1916 French officers began to write about a more precise employment of artillery, rather than hoping for an increased mass of munitions. While in command of Sixth Army during the Battle of the Somme Fayolle implored his artillery to prioritise accuracy (saying that 1,000 shells will have no effect if not fired on a clear target), and also encouraged his artillery to aim for the neutralization of enemy trenches, rather than their outright destruction.⁹³ This shift from destruction to neutralisation was a necessity. The French could never produce enough shells to absolutely flatten the entire German front. What shells the French had, needed to be applied carefully and precisely in order to maximise the return on each shell fired. To facilitate this, observation moved from the vicinity of the battery to forward posts which increased infantry morale and yielded better results.

Artillery doctrine also continued to be refined. In April 1916, in anticipation of the coming Somme offensive, Foch produced a substantial work of doctrine for his *Groupe d'armées du nord* called *La bataille offensive* ('Offensive Battle'). In this work Foch claimed to be 'adapting' various GQG instructions to better fit 'current circumstances'.⁹⁴ *La Bataille offensive* elucidates the situation facing the Allies: a lengthy war which must be fought methodically if it is to be won. The nature of this war meant making 'larger and larger demands on our artillery, which alone is capable

⁹⁰Barthélemy Edmond Palat, *Les Grandes batailles de la guerre : Les Batailles d'Artois et de Champagne, 1915* (Paris : Chapelot, 1927), p. 127.

⁹¹Dubois, *L'Artillerie de campagne dans la guerre actuelle*, p. 17.

⁹²SHD, 16N2095; « Recherche de la permanence de réglages de l'artillerie », 14 July 1916.

⁹³SHD, 16N2095; « Note sur la préparation par l'artillerie », 28 September 1916; no. 18

⁹⁴SHD, 18N148; « La Bataille offensive », *Groupe d'armées du nord*, 20 April 1916.

of destroying enemy defences'.⁹⁵ Infantry were reduced to a secondary role; to be used only in limited numbers in order to avoid heavy casualties. Foch wrote that 'the artillery preparation is the definitive measure of infantry possibilities'; these possibilities were limited to advances of two to four kilometres in a single bound, according to Foch.⁹⁶ This being the case, battles needed to be thought of as 'operations' (although that word is not used). Thus, a series of small, artillery-dominated battles would be fought in succession to achieve a strategic aim. Ideas dating back to the writing of Langlois are brought up to explain the primacy of artillery on the battlefields of the ongoing war, including its ability to concentrate overwhelming fire. Furthermore, artillery could be used much more regularly and for a longer period of time before wearing out; infantry seemed to rapidly melt away once exposed to the war machine of earth, steel, and high explosives.⁹⁷

This is an articulation of the artillery war that would survive through to 1918. While improvements would still be made on the tactical and technical sides of artillery (the 1917 doctrine *Instruction sur le tir d'artillerie* was comprehensive regarding trench warfare; it was less effective for the war of movement in 1918), a clear conceptualisation of how artillery was going to be used in the First World War had emerged by early 1916.⁹⁸ This was a great feat of adaptation and innovation. The French army in 1914 had found itself in a war it was not truly prepared to fight, with weapons largely ill-suited to the task. This state of unpreparedness and unfamiliarity was turned around far more quickly than anyone might have expected. While the French would struggle in many of their operations in 1915, they ultimately mastered the complexities of industrial warfare from 1916 onwards. New technology, from poison gas to aeroplanes, were mastered and integrated into the French tactical-operational system. New procedures like the rolling barrage were quickly hit upon and formed a cornerstone of all offensive manoeuvres from early 1915 onwards. An understanding of this rapid and astonishing transformation is central to any understanding of the great dynamism which thrived on the Western Front.

⁹⁵Ibid.; « Ceci implique un appel de plus en plus grand à notre artillerie, qui est seule capable de la destruction des organisations ennemies ».

⁹⁶Ibid.; « La préparation par l'artillerie est en définitive la mesure des possibilités de l'infanterie. ».

⁹⁷Ibid.

⁹⁸SHD, 16N2095; « Observations sur diverses instructions du G.Q.G. », 29 June 1918.