

The Establishment of the French War Machine in the First World War



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Short Abstract

The First World War placed enormous pressures on the home fronts of all belligerents as they sought to provide the unprecedented levels of armaments required by twentieth century warfare. France proved to be both militarily and industrially unprepared for the task and was almost defeated in the early months of the war as the army was severely constrained by shortages of shells and artillery. However, by 1918 French industry was able to produce more materiel than Britain while also supplying the arriving American Expeditionary Force. This thesis explores how this tremendous feat was achieved by examining the actions and interests of the high command, the government and the industrialists. Throughout the war, the specific needs of the French commanders would fluctuate, but the desire for quantity and speed of delivery was constant, often at the expense of quality. The Ministry of War attempted to appease both the army and the industrialists in order to mobilise industry rapidly to meet the requirements of the front line. Despite the apparent success of its efforts, the government's response to the pressures of war was *ad hoc* and reactionary. It had little time to formulate a cohesive plan, nor could it ignore the short-term necessities in favour of a longer-term strategy. Thus it created and faced a number of problems that complicated the mobilisation process, which the government sought to resolve through an increasing reliance on bureaucracy and state intervention in a previously liberal economy. Ultimately, as output expanded, constraints on the army eased, and industry was able to supply armaments in both high quality and large quantities, facilitating an operational approach that became ever more reliant on materiel as manpower resources dwindled. French efforts thus demonstrated the importance of economic management in wartime and greatly influenced post-1918 planning for future wars.

Long Abstract

The First World War placed enormous pressures on the home fronts of all belligerents as they sought to provide the unprecedented levels of armaments required by twentieth century warfare. France proved to be both militarily and industrially unprepared for the task and was almost defeated in the early months of the war as the army was severely constrained by shortages of shells and artillery. However, by 1918 French industry was able to produce more materiel than Britain while also supplying the arriving American Expeditionary Force.

This thesis explores how such a tremendous feat was achieved by examining the actions and interests of the high command, the government and the industrialists. The relationship and interplay between these three key groups has been overlooked by First World War historians, who have chosen to focus on industry and the front lines as distinct subjects, separate from each other, when in fact the links between the two are of vital importance to their evolution and progression between 1914 and 1918, and an exploration of how France was able to end the war in such a strong industrial position.

The study draws on primary research conducted in the French military archives of the *Service Historique de l'Armée de Terre* at Vincennes, Paris, as well as private papers held at the *Archives Nationales*. It also utilises the wartime archives of Schneider-Creusot, the largest private armaments firm in France at the start of the war and an integral part of French economic success by 1918. These archival sources are supplemented by the private accounts, diaries and memoirs of generals, politicians and industrialists.

The thesis takes a chronological approach, exploring the state of the French nation both militarily and industrially on the eve of war. It then examines the initial response to the demands of war, the gradual adjustment to the specific needs of the army in 1916 as armaments production developed, and finally the reaping of the rewards of the structures laid out earlier in the war in 1917 and 1918 as both the French and the American army received artillery and shells in considerable quantities, supplying the materiel-intensive battles of the final two years. It also assesses the longer-term problems that faced the Ministry of War that could not be resolved quickly, if at all: the shortages of manpower and raw materials, and the issues of quality, finance and modernisation.

Within the chronological structure, the thesis analyses three key areas. First, it explores the impact of poor supply on tactics and operations at the front lines, and the efforts of the generals to cope with restricted capabilities. French offensive capacity was limited until late 1917, and the French high command was forced to adapt in order to make the most of the resources available to them. This was a strong stimulus to tactical development, resulting in the rise of neutralisation fire and a heavy emphasis on the importance of accuracy.

Second, it examines developments at the Ministry of War, from the scrambled decision making of the first two years of the war to the increasingly structured and planned approach that emerged by 1918 under the guidance of Ministers of Armament Albert Thomas and Louis Loucheur. Compromises were made on all sides in order to balance the interests of the army and the home front, while seeking to manage shortages of raw materials and manpower.

Third, the study discusses the role of industrialists and the changing relationship between the state and industry throughout the war. While in 1914, the factory owners possessed all

the power as the Ministry of War relied heavily on private industry to keep France fighting, the government gradually wrestled back control as the war progressed through an increasingly interventionist approach that clashed starkly with pre-war liberalism. Nevertheless, self-interest continued to override patriotism, with profits ever-present at the forefront of the industrialist's mind.

The mobilisation process had three phases. The first was characterised by the French administration's struggles to respond to the urgent needs of the army as the artillery rapidly ran out of shells in the intensive battles of the early months of the war. The loss of the northern industrial heartland, coupled with the lack of preparation for a lengthy conflict in Plan XVII, left considerable structural problems for the Ministry of War to overcome, and quality, in terms of the type of materiel produced and the manufacturing processes, was quickly sacrificed. Two key figures, Alexandre Millerand, the Minister of War, and Albert Thomas, *Sous-Secrétaire d'Etat de l'Artillerie et des Munitions*, worked tirelessly to accommodate the demands of the front lines and to engage private industry in the war effort. They relied heavily on the administrative structure and experience of the *Comité des Forges*, and the entrepreneurial spirit of factory owners, rather than immediately turning to requisitioning. While this proved fruitful in the first two years of the war (particularly for industrialists), the Ministry of War subsequently found it difficult to reassert control over private industry, exemplified in the struggles over contracts and quality of production in 1915 and 1916.

The second phase emerged in spring 1916 as shell production finally reached acceptable levels and restrictions on the artillery eased. The focus shifted from purely providing armaments in significant quantities to producing materiel deemed most tactically useful for the army's engagements at the front, resulting in the significant artillery programmes of

May and July 1916. This represented recognition of the need to pursue a longer-term and more rational strategy to war production that tied closely to the specific requirements of the army.

Ultimately, as output expanded, constraints on the army eased, and industry was able to supply armaments in both high quality and large quantities, facilitating an operational approach that became ever more reliant on materiel as manpower resources dwindled. French efforts thus demonstrated the importance of economic management in wartime and greatly influenced post-1918 planning for future wars.

Throughout the war, the specific needs of the French commanders fluctuated, but the desire for quantity and speed of delivery was constant, often at the expense of quality. The Ministry of War attempted to appease both the army and the industrialists in order to mobilise industry rapidly to meet the requirements of the front line. Despite the apparent success of its efforts, the government's response to the pressures of war was *ad hoc* and reactionary. It had little time to formulate a cohesive plan, nor could it ignore the short-term necessities in favour of a longer-term strategy. Thus it created and faced a number of problems that complicated the mobilisation process, which the government sought to resolve through an increasing reliance on bureaucracy and state intervention in a previously liberal economy.

The study highlights the often forgotten role of France and her economy in the war effort through the examination of the relationships between industry, the army and the government. It brings to light the pivotal roles of key men such as Thomas and Loucheur in their efforts not just to mobilise the home front, but also to manage prominent individuals, such as Joseph Joffre, the commander-in-chief until December 1916, and Robert Pinot, the

head of the leading industrialists' organisation. It charts the immensely successful economic recovery between 1914 and 1918, which laid the foundations for post-war stability and revealed the potential for future Total War.

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The writing of this thesis has been a long and arduous process that would not have been possible without the support of a number of people. First, I would like to express sincerest thanks to my supervisor, Professor Sir Hew Strachan, for his guidance, for providing the initial inspiration for the thesis, and for sparking my passion for military history seven years ago. Similarly, I am grateful to Dr Adrian Gregory, Professor Stéphane Audoin-Rouzeau, and Professor Patrick Fridenson for their support and advice. Second, I have been fortunate to receive financial support from a number of sources: The *Allocation de these* from *L'Institut de recherché stratégique de l'École Militaire* (IRSEM) and a Scatcherd European Scholarship facilitated the conduct of archival research in Paris, as well as grants and awards from the Society for the Study of French History, and the Association for the Study of Modern and Contemporary France. Third, Lincoln College has been home for a significant part of my life, and the community has made studying an enjoyable and sociable experience over the past four years, along with those who have provided company in the Radcliffe Camera and on coffee breaks while writing up. Special mention must go to Mo, Natalie, Lizzie and Jackie for all their help, advice, and humour, as well as James and Laurie, for keeping me sane. Finally, words cannot express my gratitude for the support of my parents, Keith and Isabelle, and my sister, Hannah, for supporting my studies, pushing me to succeed, and for their patience during the times when it appeared the research would never end. I hope this thesis goes a small way to making you proud.

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Abbreviations

<i>Les armées françaises dans la grande guerre</i>	- AFGG
Service historique de l'armée de terre, Chateau de Vincennes	- SHAT
Archives Nationales	- AN

N.B. In the notes, I have adopted the convention used by other historians to identify sources in the French official history, *Les armées françaises dans la grande guerre*. For documents, AFGG, 612-748, 265, for example, designates tome 6, vol. 1, annexes, vol. 2, annex no. 748, page 265. For the narrative in the official history, AFGG, 61, 203, for example, designates tome 6, vol. 1, page 203. Similarly, AFGG, 3, 412, designates tome 3, page 412.

Introduction

The First World War was the first truly industrial war, with home front economies crucial to the war effort. This thesis explores the relationship between the French high command, industrialists and the government during the First World War, and the efforts of the latter to increase production to meet the needs of the army. It examines how it came to be that a supposedly stagnant economy, hampered by severe territorial losses, was able to produce more matériel and munitions than Britain by 1918, while supplying the arriving American army.¹

It highlights the often forgotten role of France and its economy in the war effort, and the pivotal roles of key men such as Alexandre Millerand, Albert Thomas and Louis Loucheur as they sought to mobilise the home front but also to manage the French high command, Parliament, and leading industrialists.

While historians have previously addressed events at the front lines and the efforts to mobilise and produce armaments, these have traditionally been tackled as separate topics, distinct from each other. However, the efforts of the army relied entirely on the ability of the home front to provide the matériel and munitions with which to wage war, and while the high command had to adapt to the requirements of a modern industrial war, it had to do so with limited supply, which influenced not just the tactics employed but also the entire strategic approach. The thesis therefore explores not just the transformation of the French economy for war production and the myriad of problems involved, but also the link between the front lines and the home front, and the extent to which they were able to cooperate and coordinate their efforts for the benefit of the army. This ties into a broader

¹ Allan Reed Millett and Williamson Murray, eds., *Military Effectiveness* (Boston: Unwin Hyman, 1988), 195.

exploration of the impact of the war on the state's relationship with the economy and the longer-term implications for the post-war period.

Scope

To ensure that the thesis remains concise and focused, it has been necessary to define and restrict its scope. While the topic of armaments production could be incredibly broad, the study centres on artillery and munitions, particularly field and heavy artillery. Due to its immense destructive capacity, the number of casualties it inflicted, its huge importance throughout the period in pre-war debates, and its tactical evolution, artillery is the logical choice. The production and use of trench artillery, such as 58mm mortars, will not be discussed, as they played a very different tactical role to the longer-range models. Given more time and space, an examination of the development of aviation, tanks and small arms would provide an even greater analysis of the relationship between industry, the government and the front lines, particularly considering the rapid evolution that the former two weapons underwent during the war. However, the primacy of artillery transcends the entire timeframe of the study, whereas aeroplanes and tanks only came to the fore after the war began and new industries had to be hastily organised to take on their production.

The First World War is an enormous subject with interdependent topics that are all important in telling the story of its conduct and management. Inevitably, in order to fit in with the scope of the thesis, certain areas have had to be omitted or covered only briefly in order to focus on the crux of the argument.

First, the thesis concentrates on the Ministry of War and the Ministry of Armaments, which, under the guidance of Alexandre Millerand, Albert Thomas and Louis Loucheur in particular,

managed the expansion of war production. It has not been possible to focus on the financing of the war effort, as this would require the examination of an entire new ministry, the Ministry of Finance, and a number of the key individuals involved, such as Alexandre Ribot and Louis Klotz. While the funding of the production of huge quantities of armaments was hotly debated, and the granting of credits, the raising of loans, and the overall strength of the French fiscal economy were of great importance to the management of mobilisation, it represents such a large area that it would not be feasible to include it in this study.

Second, the thesis examines the tactical role of artillery at the front and the role that industrial production played in the development of the weapon's use. It does not provide a narrative of the military conduct of the war, as this area has been tackled by a number of eminent historians in many of the "traditional" military histories and warrants little additional discussion in this context.²

Third, it is not possible to explore the social implications of the French government's economic policy, particularly with regard to the use of manpower in armaments factories. The thorny issue of labour is tackled in Chapter 4 but only from the point of view of its influence on the expansion of production, rather than examining wages, the increasing involvement of women in war production, and industrial disputes. Horne, Fontaine, and Cayre have focused heavily on this area. An examination of the workers' relationship with their employers and the government would provide an interesting fourth dimension to the research, but it would require the extension of the study beyond a reasonable length.³

² William James Philpott, *Bloody Victory: The Sacrifice on the Somme and the Making of the Twentieth Century* (London: Abacus, 2010); Hew Strachan, *The First World War* (Oxford: Oxford University Press, 2001); Anthony Clayton, *Paths of Glory: The French Army 1914-18* (London: Cassell, 2005).

³ John Horne, *Labour at War: France and Britain, 1914-1918* (Oxford: Clarendon Press, 1991); Arthur Fontaine, *French Industry during the War* (New Haven, Conn.: Yale University Press, 1926); Yves Cayre, *Histoire de la Manufacture d'armes de Tulle de 1690 à 1970* (Tulle: MAT, 1973).

Fourth, the thesis explores the government's relationship with both the army and industrialists, focusing on its efforts to balance the interests of all involved. However, it avoids a discussion of the political side of the war. The French political structure was relatively unstable, with five different ministries between 1914 and 1918, but an analysis of the ebbs and flows of the *union sacrée* would detract from the actual actions of the key figures. *Sous-Secrétaire d'Etat* Albert Thomas represents the exception because of his relatively novel situation as a Socialist, which meant that many others in government and Parliament treated him with suspicion, and his political loyalties ultimately played a part in his fall from power.

Finally, it has not been possible to include a discussion of logistics, both of the supply of raw materials to the factories and of armaments to the front lines. Shipping is explored briefly with regard to the import of iron, steel and coal for the armaments industries but Saibène, Fayle and others provide more comprehensive studies.⁴

Source Material

The evidential base for the thesis comes primarily from the French military archives of the *Service Historique de l'Armée de Terre* at the Chateau de Vincennes, Paris, supplemented by the documents of the French wartime government at the *Archives Nationales*, Paris.

⁴ Henri Cangardel, *La marine marchande française et la guerre* (Paris: Les Presses universitaires de France, 1927); Étienne Clémentel, *La France et la politique économique interalliée* (Paris: Les Presses universitaires de France, 1931); C. E. Fayle, *The War and the Shipping Industry* (London: OUP, 1927); C. E. Fayle, *Seaborne Trade* (London: Murray, 1920); Alan Major Henniker, *Transportation on the Western Front, 1914-1918* (London: HM Stationery Office, 1937); Archibald Hurd, *The Merchant Navy* (London: Murray, 1921); Marc Saibène, *La marine marchande française de 1914 à 1918* (Rennes: Marines, 2011).

A wide range of collections have been examined but particularly those of the *Comité de Guerre* (Series 3N), the Ministry of War (5N), Poincaré, Buat, Galliéni and Clemenceau (6N), the Ministry of Armament (10N), and the high command (16N). I have also consulted the private papers of Abel Ferry (1 K 94), General Herr (1 K 11), and General Micheler (1 K 113).

The *Archives Nationales* contain the papers of the key figures: Albert Thomas (94 AP), Paul Painlevé (313 AP), and Alexandre Millerand (470 AP), whose stories are pivotal to the thesis. The archives of Schneider-Creusot, the major private armaments factory in France during the war, have also been consulted for the first time, although relevant information was disappointingly lacking.

A number of printed primary sources have also contributed to the study, although the majority have already been used by previous historians. However, articles in the *Revue Historique des Armées*, *Revue Militaire Française*, and *Revue Militaire Générale* provide a rarely used but extremely valuable source for analysis of pre-war military planning and post-war assessments on the conduct of the war from the military and industrial perspective. The French official history, in all of its 106 volumes, has also proved a useful starting point for much of the research.

Finally, the memoirs of Joseph Joffre, Raymond Poincaré, Louis Loucheur, Emile Fayolle, Alfred Micheler, Emile Herbillon and Louis Baquet provide valuable accounts, particularly of relations between the high command and the government. Nevertheless, as with all memoirs, great care must be taken to ascertain the justifications behind their writing and the veracity of their stories.

Historiography

Despite the wealth of research that has been conducted on the First World War, there is a surprising lack of modern literature on the mobilisation effort and its coordination with the army for France, Britain or Germany. The French historiography tends to focus on cultural and social aspects, and the memory of the war, neglecting more “traditional” studies on the conduct of the war and the importance of the economy.⁵ Much of the work that has been conducted on these areas dates back to the inter-war period or the 1960s, when the war underwent reassessment during its fifty-year anniversary, but the archives were not yet open. Similarly, for Britain the only major works are Adams, Lloyd George and the History of the Ministry of Munitions, while Feldman provides the definitive work for Germany. All of these, however, neglect the importance of relations with the military.⁶

The French approach to mobilisation differed from Britain and Germany. The French Ministry of War sought to coordinate and balance the desires and demands of state, industry and military command: the three key pillars that this thesis seeks to explore. By contrast, in Britain the government was the primary agent in dealing with industry, with the military isolated, and in Germany, the military high command worked closely with industry, and the state was largely by-passed.⁷

The works relevant for this subject are those covering the pre-war state of the army and industry, the conduct of the war at the front lines and the tactical development of the

⁵ Elizabeth Greenhalgh, “Writing about France’s Great War”, *Journal of Contemporary History*, 40 (2005), 601–12.

⁶ R. J. Q. Adams, *Arms and the Wizard: Lloyd George and the Ministry of Munitions, 1915-1916* (London: Cassell, 1978); David Lloyd George, *War Memoirs of David Lloyd George* (London: Nicholson & Watson, 1933); Munitions Ministry of, *History of the Ministry of Munitions*. (London, 1918); Gerald D Feldman, *Army, Industry, and Labor in Germany, 1914-1918* (Princeton, N.J: Princeton University Press, 1966).

⁷ Leonard V Smith, *France and the Great War, 1914-1918* (Cambridge: CUP, 2003), 64.

army, the management of the war both at the front and at home by the various governments serving between 1914 and 1918, and the role and development of industry and armaments production in particular. Whilst there is a great deal of excellent research that focuses on each of these areas, it is rare that they expand from their specific areas and examine the wider relations between the army, the government and the home front, as this thesis seeks to do.

The preponderance of the 'short war illusion' in the public's perception of the First World War has resulted in a number of important works on the pre-war years, exploring the reasons for the French army's lack of preparation for the style of conflict that it faced in August 1914. Four books stand out in this regard: those of Porch, Stevenson, and more recently Quéloz and Cosson. Porch provides a useful chronological study of the development of French doctrine between the Franco-Prussian War of 1870-71 and the First World War. He seeks to readdress the idea of the primacy of 'the spirit of the offensive' expounded in earlier works, tying *élan* into a broader tactical system, but the book contains inaccuracies. For instance, he refers on several occasions to General 'Banquet', author of *Souvenirs d'un directeur d'artillerie*, whose name was actually 'Baquet'. This mistake has subsequently been repeated in Millett and Murray and copied by Goya.⁸ The works of Quéloz and Cosson provide a long-overdue assessment of pre-war doctrinal discussions within the *École Militaire* and elucidate the confusion and conflict between differing tactical approaches that vied for supremacy between 1900 and 1914.⁹ Stevenson's book brings the debate full circle, tying Porch's discussion of the armaments debates into the broader

⁸ Douglas Porch, *The March to the Marne: The French Army, 1871-1914* (Cambridge: CUP, 1981); Joseph C. Arnold, "French Tactical Doctrine 1870-1914", *Military Affairs*, 42 (April 1978), 61-67; Millett and Murray, *Military Effectiveness*, 1988; Louis Baquet, *Souvenirs d'un directeur de l'artillerie* (Paris: Charles-Lavauzelle, 1921); Michel Goya, "Le Processus d'Evolution Tactique de l'Armée Française de 1871 à 1918" (Université de Paris IV, 2008).

⁹ Dimitry Quéloz, *De la manoeuvre napoléonienne à l'offensive à outrance: la tactique générale de l'armée française, 1871-1914* (Paris: Economica, 2009); Olivier Cosson, *Préparer La Grande Guerre : L'armée Française et La Guerre Russo-Japonaise* (Paris: Les Indes savantes, 2013).

political picture.¹⁰ Nevertheless, they are each restricted by their scope. Quéloz, Cosson and Porch lack a discussion of the wider economic context in which these developments occurred, while Stevenson neglects developments in military thinking. In particular, they are all limited as they stop in 1914 and therefore fail to discuss the impact of the war.

The conduct of the war at the front has received the greatest attention, although French studies have shifted focus to violence, mourning and the anthropology of war under the influence of Stéphane Audoin-Rouzeau and Annette Becker at the *Historial de la Grande Guerre*.¹¹ The majority of recent scholarly work on the development of tactics and events at the front has come from Anglophone authors, with the exception of Michel Goya, whose thesis on the evolution of the French army presents a comprehensive overview of its tactical development over the course of the war and the years preceding it.¹² It complements similar recent works by Gudmundsson, Philpott, Greenhalgh, and Doughty, and provides significantly greater depth than more general studies such as that of Clayton.¹³

Joseph Joffre's memoirs provide a detailed, if favourable, account of his time as commander-in-chief, while Pétain's actions are covered by the extensive works of Guy Pedroncini, which explore the general's doctrinal approach and the sweeping changes he introduced. Nevertheless, it overplays Pétain's role and foresight in an attempt to rebuild

¹⁰ David Stevenson, *Armaments and the Coming of War: Europe, 1904-1914* (Oxford: Clarendon Press, 1996).

¹¹ Smith, *France and the Great War, 1914-1918*; Stéphane Audoin-Rouzeau and Annette Becker, *1914-1918 Understanding the Great War* (London: Profile, 2002); Jean Jacques Becker and Annette Becker, *La France en guerre (1914-1918). La grande mutation*, vol. 6 (Bruxelles: Éditions Complexe, 1988); Jean-Jacques Becker, "L'évolution de l'historiographie de la Première Guerre mondiale", *Revue historique des armées*, 242 (2006), 4–15.

¹² Goya, "Le Processus d'Evolution Tactique de l'Armée Française de 1871 à 1918."

¹³ Bruce I. Gudmundsson, "Learning from the Front: Tactical Innovation in France and Flanders, 1914-1918" (Thesis (D.Phil.)--University of Oxford, 2009., n.d.); Robert A Doughty, *Pyrrhic Victory: French Strategy and Operations in the Great War* (Cambridge, Mass: Belknap Press, 2005); Elizabeth Greenhalgh, *The French Army and the First World War, Armies of the Great War* (Cambridge: Cambridge University Press, 2014); Clayton, *Paths of Glory*; Philpott, *Bloody Victory*.

his reputation post-Vichy.¹⁴ As a counterpoint, Barnett's 1963 work, *The Sword bearers*, provides a useful and concise comparative account of leaders of each of the major belligerents.¹⁵

The main downside of all of these accounts is that they habitually view the events at the front in a vacuum, with scant coverage of the influence of government and the home front on events at the front lines. Similarly, studies addressing the management of the war from within France make few attempts to tie in their narratives with the military picture. Research in this area is also rather dated and in need of revision. King comes closest to linking the two areas, discussing the interaction and tension between generals, ministers and politicians and building on much of the work explored in great depth by Terrail, who draws heavily on primary source material and frequently lays out the discourse of parliamentary debates verbatim.¹⁶ Pierre Renouvin offers a legalistic approach to the governmental administration of the war, exploring the processes and debates through which change was introduced, but ignoring the actual practicalities of how ministries operated.¹⁷ Finally, Rébérioux and Fridenson, and Schaper, have written biographical studies of Albert Thomas, the key political figure in the mobilisation of French industry, but their accounts focus heavily on his politics as a Socialist and his concern for workers social welfare rather than his administration of the *Sous-Secrétariat d'Etat d'Artillerie et des*

¹⁴ Joseph Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, vol. 2 (Paris: Plon, 1932); Joseph Joffre, *Journal de marche de Joffre: 1916-1919*, ed. Guy Pedroncini (Paris: Service historique de l'armée de terre, 1990); Guy Pedroncini, *Pétain: 1856-1940, 1: Le soldat*, Pétain. (Paris: Perrin, 1998); Guy Pedroncini, *Pétain, général en chef, 1917-1918* (Paris: Presses universitaires de France, 1974).

¹⁵ Correlli Barnett, *The Swordbearers: Studies in Supreme Command in the First World War* (London: Eyre & Spottiswoode, 1963).

¹⁶ Jere Clemens King, *Generals & Politicians; Conflict Between France's High Command, Parliament, and Government, 1914-1918* (Berkeley: University of California Press, 1951); Gabriel Terrail, *Au sein des commissions* (Paris: Ollendorff, 1924).

¹⁷ Pierre Renouvin, *The Forms of War Government in France* (Oxford: OUP, 1927).

Munitions.¹⁸ Fridenson's edited collection on the home front, including key works by Hardach and Hennebicque, provides a more detailed account of Thomas's work while in office, drawing heavily on primary source material that is unfortunately repeated almost word for word in Hardach's own broader work on the war.¹⁹ Carls provides the most comprehensive study of industrial management in the last two years of the war with his study of Louis Loucheur, although his scope extends well into the post-war period, while Barjot also explores Loucheur's background in some depth.²⁰ Nevertheless, this study is unique in exploring the work of Thomas and Loucheur within the wider context of the military situation at the front, and the influence that their efforts to meet the requirements of the army had on the management of industry.

The economy represents the final piece in the puzzle but is a slightly more problematic area in terms of the historiography as many economic historians have chosen to neglect the First World War, seeing 1914 as the close of the nineteenth century and therefore a convenient point to end their analysis or 1918 as a sensible place to begin.²¹ Others seek to highlight the transformative impact of the war. Kuisel draws attention to the significant shift towards increasing state intervention and the rise of economic planning that emerged during, and continued after, the war.²² The French economy is also one area in which there has been a

¹⁸ Bertus Willem Schaper, *Albert Thomas, trente ans de réformisme social*, trans. Louis Dupont (Paris: Presses universitaires de France, 1953); Madeleine Rébérioix and Patrick Fridenson, "Albert Thomas, Pivot Du Reformisme Francais", *Le Mouvement Social*, 87 (1974) 85-97.

¹⁹ Patrick Fridenson, ed., *1914-1918, l'autre front* (Paris: Éditions ouvrières, 1977); Gerd Hardach, *The First World War, 1914-1918* (Berkeley: University of California Press, 1977).

²⁰ Stephen Douglas Carls, *Louis Loucheur and the Shaping of Modern France, 1916-1931* (Baton Rouge: Louisiana State University Press, 1993); Dominique Barjot, "La grande entreprise française de travaux publics (1883-1974) : contraintes et stratégies" (Thesis Doctorat d'État--Université de Paris IV, Sorbonne, 1990).

²¹ Dominique Barjot, Jean-Pierre Chaline, and André Encrevé, *La France Au XIXe Siecle, 1814-1914* (Paris: Presses, 1995); Rondo Cameron and Charles E. Freedeman, "French Economic Growth: A Radical Revision", *Social Science History*, 7 (1983), 3-30; Rondo E. Cameron, "Economic Growth and Stagnation in France, 1815-1914", *The Journal of Modern History*, 30 (1958), 1-13; François Crouzet, "French Economic Growth in the Nineteenth Century Reconsidered", *History*, 59 (1974), 167-79.

²² R.F. Kuisel, *Capitalism and the State in Modern France, Renovation and Economic Management in the Twentieth Century* (Cambridge: CUP, 1981).

great deal of fluctuation in the assessment of its strengths and weaknesses on the eve of the First World War. The writings of Kemp, Barjot, and Caron differ slightly in the emphasis of their praise and the specific time-periods in which they identify progress, but they all seek to redress post-1918 and post-1945 theories that portrayed the economy as backward, stagnant, and falling behind its European rivals. They all present a picture of the French economy as one that was developing well but nevertheless remained some way behind its rivals in overall terms. The broad foundations were in place that facilitated the rapid expansion and adaption between 1914 and 1918, but it required the catalyst of war to force industrialists and the state to modify their perceptions of how the economy should be managed.²³

A number of studies assess the development of the economy and the expansion of industry during the war, but many are out-dated, overly specialised on a particular area, or conversely too broad. Pierre-Cyrille Hautcoeur and Niall Ferguson both present a general economic assessment of France, with the former describing the First World War as ‘a watershed for France.’²⁴ Stephen Broadberry and Mark Harrison explore the role of economic factors in the outcome of the war as well as the longer-term effect on post-war nations and institutions, concluding that economic strength was a key determinant of victory and defeat. The book covers each of the major powers but is clearly written by economists rather than historians, leading to a reliance on theory and models on a macro

²³ Tom Kemp, *The French Economy, 1913-39: The History of a Decline* (London: Longman, 1972); Tom Kemp, *Economic Forces in French History* (London: Dennis Dobson, 1971); Dominique Barjot, ed., *Deux guerres totales, 1914-1918, 1939-1945: la mobilisation de la nation* (Paris: CFHM, 2012); François Caron, *An Economic History of Modern France* (London: Methuen, 1979).

²⁴ Pierre-Cyrille Hautcoeur, “Was the Great War a Watershed? The Economics of World War I in France,” in *The Economics of World War I*, eds. S. N Broadberry and Mark Harrison (Cambridge/New York: Cambridge University Press, 2005), 169–205; Niall Ferguson, *The Pity of War* (New York: Basic Books, 1999).

scale. Consequently, analysis of the management of war economies is lacking.²⁵ Ferguson suffers from a similar flaw, relying heavily on a statistical approach that overlooks the subtleties and many of the complicating factors involved in the day-to-day handling of the government, industrialists, and workers.

Two early books published under the post-war initiative of the Carnegie Foundation still represent the most useful starting point. Jèze and Truchy examine the financing of the war and the efforts to supply the funds necessary for the Ministry of War's ever-increasing armaments programmes.²⁶ Their book is complemented by Arthur Fontaine's *French Industry during the War*, which explores the adaptations of the home front to the pressures of war, although his focus is oriented towards commercial businesses rather than those producing armaments and is potentially influenced by his involvement in Thomas's *Sous-Secrétariat* during the war.²⁷

The two most important works for this thesis are those of Godfrey and Porte.²⁸ They both cover the process of industrial mobilisation in considerable depth, providing detailed accounts of the actions of key individuals, such as Albert Thomas and Alexandre Millerand. However, they neglect the interests of industrialists and the army, focusing heavily on discussions at a governmental level rather than tying in developments to events at the front. This thesis will fill that gap, particularly as Godfrey's book draws heavily from his 1974 thesis and therefore warrants reassessment.

²⁵ S. N Broadberry and Mark Harrison, eds., *The Economics of World War I* (Cambridge: Cambridge University Press, 2005).

²⁶ Gaston Jèze, *The War Finance of France: The War Expenditure of France* (New Haven: Yale University Press, 1927).

²⁷ Fontaine, *French Industry*.

²⁸ John Godfrey, *Capitalism at War: Industrial Policy and Bureaucracy in France, 1914-1918* (Leamington Spa: Berg, 1987); Rémy Porte, *La mobilisation industrielle: "premier front" de la Grande Guerre?* (Saint-Cloud: 14-18 éditions, 2005).

Other works require brief discussion. Reboul provides an extremely critical account of the lack of pre-war preparation and the effects of armaments shortages at the front and, despite the title of the book, focuses heavily on the implications of poor output for the army rather than the means by which munitions were produced.²⁹ Fridenson and Hatry offer interesting case studies from the perspectives of an industrialist, Renault, seeking to adapt manufacturing to the war effort. They present some detail on the modernisation of the production process and the adoption of more advanced American methods, while Jeanneney offers a similar account of the leading metallurgist, François de Wendel.³⁰ Disappointingly, d'Angio's work on the Schneider establishment almost completely ignores the war.³¹

Finally, a considerable amount of research has been conducted into more specific aspects of the mobilisation process, particularly manpower. Once again, the Carnegie Foundation provides the starting point, with Nogaro and Wiel's book on overseas manpower, but Horne provides a more definitive overview.³² Nevertheless, his approach concentrates on the social issues affecting workers rather than the political and administrative ramifications of the expansion of the war industries.

While the current historiography recognises that the expansion in industrial production was impressive, it generally understates it and finds it very easy to focus on the negatives: the problems and complications that inevitably accompanied mobilisation. Without resorting to

²⁹ Frédéric Reboul, *Mobilisation industrielle : des fabrications de guerre en France de 1914 à 1918* (Paris: Berger-Levrault, 1925).

³⁰ Patrick Fridenson, *Histoire Des Usines Renault* (Paris: Editions du Seuil, 1972); Gilbert Hatry, *Renault, usine de guerre 1914-1918* (Paris: Éditions Lafourcade, 1978); Jean Noël Jeanneney, *François de Wendel en République: l'argent et le pouvoir, 1914-1940* (Paris: Seuil, 1976).

³¹ Agnes d' Angio, *Schneider et Cie et Les Travaux Publics (1895-1949)* (Paris: École des Chartes, 1995).

³² Bertrand Nogaro, *La main-d'œuvre étrangère & coloniale pendant la guerre* (Paris: Les Presses universitaires de France, 1926); John Horne, "Immigrant Workers in France during World War I," *French Historical Studies* 14, no. 1 (1985): 57–88; Horne, *Labour at War*, 1991.

exaggeration, this thesis seeks to emphasise the achievements of the French government, its ministers and the industrialists involved, while examining whether this success was accomplished because of, or in spite of, their efforts. There is a balance between the idea that the Ministry of War was moving closer towards a Platonic form of war management and structure and the need to explore the practicalities and the *ad hoc* nature of its development.

Definitions

Throughout the thesis, there is some language specific to the use of artillery that needs clarification.

As there is some overlap between the definition of English and French terms for artillery pieces, I have chosen to pursue a clear scheme to differentiate between the types. The term “gun” will not be used to describe generic “artillery pieces” but will refer to those with long barrels, primarily employed for counter-battery fire and firing at range. In theory, “howitzer” applies to pieces with barrels of intermediate length, with “mortar” reserved for pieces with very short barrels, however the French describe howitzers as “short-barrelled”, thus to avoid confusion mortars will be referred to simply by name, with any reference to short-barrelled artillery meaning howitzers.³³

Similarly, all guns with calibres below 95mm are classified as field guns, those with greater deemed heavy artillery. Finally, the term “quick-firing” or “rapid-firing” will describe any

³³ The following definitions mirror those adopted by Bruce Gudmundsson for his thesis. In precise figures, a gun possesses a barrel more than twenty calibres long, a mortar less than ten calibres long, and a howitzer in-between, with a calibre being a measure of the diameter of the bore of an artillery piece. Therefore a weapon with a bore of ten centimetres would be a gun if its barrel was more than two metres long.

piece equipped with a mechanism to absorb recoil such that the carriage remains still and therefore the piece can be fired without re-sighting. “Matériel” will occasionally be used to refer to artillery, and should be distinguished from “materiel”, which covers all forms of industrially-produced weaponry. The terms “munitions” and “shells” will be used interchangeably for artillery projectiles, with “ammunition” and “bullets” reserved for infantry projectiles.

Key themes

The thesis explores three key areas. First, it examines the impact of poor supply on tactics and operations at the front, and the efforts of the French high command to cope with restricted capabilities. Ultimately, the French army’s offensive capacity was restricted until late 1917, and the generals were forced to adapt to make the most of the resources available to them. This was a strong stimulus to tactical development.

Second, it explores developments at the Ministry of War, from the *ad hoc* and scrambled decision-making of the first two years of the war to an increasingly structured and planned approach that emerged by 1918 under the guidance of Ministers of Armament Albert Thomas and Louis Loucheur. Compromises were made on all sides in order to balance the interests of the army and the home front, while numerous problems emerged from unforeseen areas that repeatedly threatened the ability of the government to keep the army in the field.

Third, it examines the role of industrialists and the changing relationship between the state and industry throughout the war. In 1914, the factory owners possessed all the power as the Ministry of War relied heavily on them to keep France fighting. As the war progressed,

the government slowly wrestled back control through an increasingly interventionist approach that clashed starkly with pre-war liberalism.

Balancing the pursuit of quality, quantity and speed of delivery was an ever-present theme. In the first two years of the war when supplies of munitions and artillery pieces were scarce, the high command sought merely quantity rather than quality in order to keep the guns at the front lines firing. Therefore they sourced old-fashioned artillery pieces from within France that were unsuited for the requirements of trench warfare but were the only pieces available. As the munitions crises slowly eased by 1916, they began to turn their attention to quality and the production of pieces and munitions that correlated more closely with the tactical needs of the army. However, it would take considerable time to fulfil the production programmes and the initial quantities of the pieces produced would be low. By the last year of the war, industrial production was in a much stronger position, with large-scale production of pieces and munitions deemed to be the most effective for use at the front lines. These could now be supplied quickly and in large quantities to wherever the operational plans of the high command dictated.

By and large, it was not the administrative structures that limited production. Despite organisational inefficiencies, the system appeared to operate well. The problems stemmed from the practical issues of supply, particularly of manpower and raw materials, and it was in attempting to tackle these that bureaucracy and administrative confusion hindered the performance of industry.

From a tactical perspective, the first two years of the war were a period of waiting for sufficient supply to achieve success. The period between 1916 and the Nivelle offensive was a period characterised by a belief that the newly-arriving supply of heavy artillery and

munitions would suffice if it were thrown at the enemy. The second half of 1917 was a period of refinement, with Pétain taking the pressure off infantry and relying heavily on the power of the artillery, while 1918 saw the emergence of increasing sophistication in the use of combined infantry and artillery tactics. This is not to say that at some levels of the army development was so clear-cut, but rather that these trends pervaded in the overall doctrinal approach of the high command.

Ultimately, each of these areas ties into explaining how France arrived by 1918 at the extraordinary position where its armaments industry was out-producing Britain while supplying the American army, facilitating the unconstrained implementation of operations and tactics at the front.

Structure

In order to explore the development of French industry and artillery development over the course of the war, a chronological approach appears sensible, and it is first necessary to explore the pre-war foundations from which the changes emerged. Chapter 1 therefore examines the evolution of French military doctrine since the Franco-Prussian War of 1870-1. The debates over the subsequent forty years heavily influenced not just the tactical and strategic approach in 1914 but also the state of the artillery, as the structure of the army was entirely dependent on the methods it would seek to employ. The thesis focuses particularly on the discussions over whether to persist with the 75mm field gun or to adopt heavy artillery, which were fundamental to the army's lack of preparation for a modern, materiel-heavy conflict in 1914.

The chapter then explores the effect that the doctrinal decisions had on industry, as the belief that the war would be brief, and the faith in Plan XVII, meant that there was no expectation of industrial mobilisation on a large scale, with the French army expecting to rely on minimal output from the state arsenals. This section also comprises a broader analysis of the state of French industry, with an examination of its reliance on imports of raw materials, and its relative decline in comparison to Britain and France in the decades preceding war. Many of the problems that France faced between 1914 and 1918 stemmed from the lack of preparation in the years before the war and the flawed plans that were drawn up by the high command.

Chapter 2 explores the initial reaction to the early engagements of the war as it became increasingly clear that the army was not equipped for the style of war faced in 1914. The munitions and matériel problems first became apparent at the front lines. The chapter examines the vast levels of consumption by the artillery, the recognition of the insufficiency of reserves by the high command, and the initial attempts to limit consumption by restricting and ultimately rationing the firing of munitions. The initial developments in artillery tactics are particularly important here, with emergence of the need to prioritise accuracy of fire and specification of targets in order to maximise the effect of each individual shell fired.

Chapter 3 shifts to the response of the Ministry of War and industry. Following the initial concerns raised by the army, the Ministry of War sought to respond quickly and to increase production by turning to private industry for help. The demands from the front rose far quicker than industry was able to increase output, and Alexandre Millerand, the Minister of War, created the *Sous-Secrétariat d'Etat de l'Artillerie et des Munitions* with Albert Thomas in command to take control of the management of industrial armaments production.

The *ad hoc* responses of the Ministry of War worked in the short-term, as the army was able to continue fighting and never ran out of munitions, but it was a policy of putting out fires as they sprang up rather than trying to predict where they would occur and seeking to avoid starting them in the first place. While the actions were logical at the time considering the pressures and exigencies, they resulted in a number of protracted problems that plagued production throughout the war.

These problems are the subject of Chapters 4, 5 and 6, which explore the long-term issues that hindered the expansion of the artillery and transcend the chronological structure of the thesis. They examine efforts to resolve the shortages of manpower and raw materials, before discussing the increasing role of the state in managing industrial production, focusing on improvements in quality and manufacturing methods.

The manpower and raw materials issues were highly problematic throughout the entire war. The relative inferiority of French heavy industry, exacerbated by the territorial losses of the initial months of the war, resulted in a strong dependence on imports to supplement slowly developing domestic production. The supply of raw materials was a constant problem for industrialists, discussed on almost a weekly basis with the Ministry of War, while Alexandre Millerand and Albert Thomas were at the centre of a tug of war between armaments manufacturers and the French high command over manpower, as the army needed men to fight in the trenches while the factories lacked sufficient to produce the means to fight. These two problems in particular were a clear result of the lack of foresight and effective pre-war planning that left France in a perilous position for much of the war.

The quality of both munitions and artillery pieces was pertinent from the early months of the war, as the hastily produced shells frequently exploded while still in the barrel, causing casualties and destroying pieces that the army could scarcely afford to lose. The efforts of the Ministry of War, the high command and the industrialists to tackle the problem are a good example of the cooperation and communication between the three groups to find a solution for the overall benefit of the army.

Chapter 7 examines the second major period of the war: the shift towards large-scale attritional warfare in 1916 with the huge matériel-intensive battles on the Somme and at Verdun. The year illustrates the symbiotic relationship between industry and the front lines, as by this point of the war industry was able to provide the army with increasing quantities of munitions and artillery pieces, offering increasing flexibility of action. Doctrine still developed slowly, with the army persisting with an approach based on achieving 'total destruction' of the enemy through the use of large numbers of shells. However, over the course of the year, more sophisticated approaches emerged with the increasing use of neutralisation and interdiction fire, alongside the rolling barrage.

In 1916, the high command was finally able to think about the development of artillery pieces that were most suitable for the tactical requirements of the army, as the munitions situation was no longer critical and industrialists could turn their attention to other areas. This led to the creation of new production programmes for heavy industry that would finally redress the inferiority in comparison to the German artillery that had been prevalent since the start of the war.

The final chapter explores the last two years of the war, in which the actions and decisions of the first three years started to bear fruit. However, the period was also one of transition,

both at the front, with the replacement of Joffre by Nivelle and subsequently Pétain, and the appointment of Foch as Supreme Commander of the Allied Armies, and in the interior, with Louis Loucheur gradually taking over the management of armaments production. The impending arrival of the American army added a new dimension to discussions surrounding the allocation of materiel and the prioritising of men over firepower.

Chapter 1 – Pre-War Prevarications

Before examining how France reacted to the events of the First World War, it is necessary to assess its position before August 1914. This requires an exploration of French military doctrine at the time, the materiel resources available, and France's economic and industrial strength. It is necessary to look at doctrine first, as pre-war debates influenced the high command's attempts to strengthen the army and consequently affected the organisation of industry. These initial discussions had a significant long-term influence on the position in which France found itself in August 1914 and on the army's ability to fight in the early battles of the war.

French doctrine comprised three key and interrelated characteristics: the spirit of the offensive, a belief that a future war would be short, and a reliance on infantry and light artillery rather than heavy artillery. However, its development began with the high command's response to the last European war that France had fought: the Franco-Prussian War of 1870-71. Following defeat, French military doctrine underwent a number of revisions to ensure that France would not be so vulnerable again. New infantry manoeuvre regulations appeared every ten years between 1875 and 1914. However, the high command lacked sufficient knowledge of technical advances in materiel and thus continued to rely on out-dated weaponry. Indeed, the word "artillery" barely featured in the field service regulations of 1913 or the infantry regulations of 1914. The generals failed to assess the state of modern military developments, with many officers believing that warfare could only be learnt by practice and not through study.³⁴

³⁴ Goya, "Le Processus d'Evolution," 66, 100, 103–108.

The development of French military doctrine has undergone a significant reassessment in recent years, with Dimitry Quéloz arguing that there was considerable dispute at the *École Militaire* between two differing schools: one following Lieutenant-Colonel de Grandmaison, a proponent of *élan*, and the other surrounding the likes of Pétain and Foch, who stressed the importance of firepower. As both schools struggled to impose themselves on the other, continued debates delayed the formation of a clear, unified approach. It was de Grandmaison who appeared to succeed and he authored the regulations on the conduct of large units and the field service regulations. These two texts spelt out above all that ‘we accept no other approach than the offensive’.³⁵

The French have been unjustly criticised for their excessive faith in *élan* in modern warfare. Although the underlying concept was the importance of morale in the face of firepower, the doctrine with which France went to war was more complex and flexible.³⁶ The French high command recognised that spirit alone was not sufficient to defeat organised defences and that a clear tactical approach was needed. House in particular highlights the wider tactical approach of the French army with the preponderance of bravery making just one part of this.³⁷

The French offensive comprised four key parts: manoeuvre to avoid a simple frontal attack, a loose infantry line advancing in bounds, superiority of firepower to demoralise the enemy and restrict reinforcements, and ‘the morale exaltation which allows the attacker to succeed.’³⁸ Foch, in his *De la conduite de la guerre*, written in 1903, felt that the way to bring a modern war to an end was through a decisive battle, in which the traditional French

³⁵ Ibid., 108.

³⁶ Ibid., 129. There was a recognition of both the “*bataille par actions successives*” and the “*bataille par actions simultanées*”

³⁷ Jonathan M. House, “The Decisive Attack: A New Look at French Infantry Tactics on the Eve of World War I”, *Military Affairs*, 40 (1976), 167.

³⁸ House, ‘The Decisive Attack,’ 165.

spirit of the “Nation in Arms” would prove critical.³⁹ A report to the Minister of War in October 1913 laid out the principles of French thinking: ‘Battles are, above all, struggles of morale. Defeat is inevitable as soon as one loses hope of victory. Success comes, therefore, not to the force that has suffered the least losses but to the force whose will is the strongest.’⁴⁰ Still, the army’s method would prove inadequate and unsuited to the combat that emerged in 1914.

The French army’s faith in the ‘spirit of the offensive’ tied into their expectations for future war. Even in 1913, the consensus remained that it would be a war of mobility, as the size of the armies on either side would make a long conflict impossible.⁴¹ Norman Angell believed that ‘the delicate interdependence of international finance’ would deter nations from fighting, while Jan Bloch’s treatise *Is War Now Impossible?* written in 1899, described in detail the financial implications of a large-scale war that made the idea of such a conflict untenable.⁴² The expense of maintaining a modern army would cost the five major powers forty million pounds per day, which none of them would be able to sustain for any length of time. The result, from an economic perspective, would be an increasing difficulty to float loans in a tumbling market and massive inflation, which would either deter armies from going to war in the first place or ensure that, if war were to break out, it would not last long.⁴³ While Bloch predicated his theory on Britain not entering the war, his argument remained convincing.

³⁹ Ferdinand Foch, *De la conduite de la guerre: la manœuvre pour la bataille* (Paris: Berger-Levrault, 1904).

⁴⁰ Décret du 28 octobre 1913 cited in Goya, “Le Processus d’Evolution,” 131.

⁴¹ Robert M. Ripperger, “The Development of the French Artillery for the Offensive, 1890-1914”, *The Journal of Military History*, 59 (1995), 603.

⁴² Cited in Roger Chickering and Stig Förster, eds., *Great War, Total War: Combat and Mobilization on the Western Front, 1914-1918* (Cambridge: Cambridge University Press, 2000), 409; Jan Bloch, *Is War Now Impossible? An Abridgment of “The War of the Future”*. (London, 1899).

⁴³ Bloch, *Is War Now Impossible?*, xlv–xlvi.

Alfred von Schlieffen echoed Bloch, arguing from a military perspective that, with universal conscription, impregnable fortresses and increasingly modernised weaponry, the threat of the high costs and enormous casualties was a deterrent that rendered both sides much more willing to maintain peace, hence the need for a plan to secure victory quickly if Germany was to go to war.⁴⁴ Indeed, the German army's service regulations of 1 January 1910 stated that, 'today the character of war is defined by the longing for a quick and major decision.... The cost of the state of war...as well as the responsiveness of military organisation... mean that war would finish quickly.'⁴⁵

In reality, the international capital and money markets proved capable of taking the strain of warfare for much longer than expected, and, despite the unprecedented costs, ideological and political motivations made surrendering for economic reasons an unviable option until total collapse ensued (as in Russia and ultimately Germany).⁴⁶ While there has been significant historiographical debate on the extent to which the 'short war myth' truly existed, there is considerable evidence in the French mobilisation plan and their preparations for war that strongly suggests that the high command expected a brief conflict.⁴⁷ This was borne out particularly in the structure of the army by 1914, especially with regard to artillery and the resources in place to keep it supplied. Decisions formed according to this expectation had serious consequences for France's management of the war.

⁴⁴ Alfred Schlieffen, *Alfred von Schlieffen's Military Writings* (London: Frank Cass, 2003).

⁴⁵ "Grundzüge des höheren Truppenführung," cited in Horne, *A Companion to the First World War*, 7.

⁴⁶ Chickering and Förster, *Great War, Total War*, 409.

⁴⁷ Cosson, *Préparer La Grande Guerre*, 182; France. Armée. Service historique, *Les Armées françaises dans la Grande Guerre* (Paris: Imprimerie Nationale, 1922), 11, 18-29; Stig Förster, "German Military Leadership and Images of Future Warfare, 1871-1914," in Manfred F. Boemeke, Roger Chickering, and Stig Förster (eds.), *Anticipating Total War: The German and American Experiences, 1871-1914* (Cambridge University Press, 1999); Stig Förster, "Der Deutsche Generalstab Und Die Illusion Des Kurzen Krieges, 1871-1914. Metakritik Eines Mythos", *Militaergeschichtliche Zeitschrift*, 54 (1995), 61-96; Strachan, *The First World War*, 1005-14.

From the government's perspective, the expectation of a short war meant that there was no agreement on an administrative structure in time of war, the continuation of the parliamentary system, or the conduct of the various ministries. According to Renouvin, 'the programme reduced itself to this: to encourage, under the control of the Government, the initiative of the military departments, which would provide for the needs of the army and for the maintenance of order, while at the same time taking responsibility for military operations.'⁴⁸

The accepted plan was that, according to laws passed in 1849 and 1878, Parliament would abdicate power temporarily and the government and military would take control following the declaration of a state of siege. The commander-in-chief would be exempt from civilian interference in strategy. While this structure might have sufficed for a conflict of a few months, once it became clear that the war would drag on beyond 1914, it posed many complications for the governing of the country, for the supervision and control of the military, and especially for the mobilisation of domestic industry. In reality, the delegation of authority was even starker as the government withdrew from Paris to Bordeaux in the face of the German advance, resulting in a general state of disarray and confusion.⁴⁹

From a military perspective, the French army decided to persist with its reliance on infantry and on speed of manoeuvre in what they foresaw as a mobile war. They were reluctant to learn the lessons of the Russo-Japanese war of 1904-5 and see that modern weaponry such as the machine gun and artillery forced soldiers on both sides to build trenches in order to provide cover. Materiel and industrial power came to dominate the battlefield. Artillery, no

⁴⁸ Pierre Renouvin, *The Forms of War Government in France*, (Oxford University Press, 1927), 17.

⁴⁹ King, *Generals & Politicians; Conflict Between France's High Command, Parliament, and Government, 1914-1918*, 18.

longer the clumsy, inaccurate and unwieldy weapon of the Crimean War, had the destructive capacity to reduce warfare to a static, siege-style conflict.

'The doctrine of the *'offensive à tout prix'* significantly contributed to the insufficiency of French heavy artillery.' (Duroselle)⁵⁰

In 1914, the French army had three generations of artillery at its disposal. The first, the de Bange model guns, produced between 1878 and 1882, comprised 80mm and 90mm field guns as well as 120mm and 155mm long and short-barrelled siege guns. These were generally very robust and accurate but with a limited range (around 9,000 metres for the 155mm long) and very slow firing. Having been used in fortifications, they lacked the necessary platforms both for mobility and for firing on the curved or plunging trajectory that was crucial in trench warfare. At the start of the war, there were still around 3,500 de Bange field guns in the arsenals and forts as well as 2,800 120mm and 155mm guns. However, they were not an integral part of the army's artillery for front line operations.

The most recent generation of artillery comprised heavy field guns, such as the 155mm Rimmel howitzer, but these did not appear in great number at the start of the war due to the prevarications over the expansion of the French artillery. There were only five heavy artillery regiments in August 1914, comprising 308 pieces.

The standard artillery piece was the 75mm field gun, which made up sixty-one of the seventy-seven artillery regiments, divided among twenty army corps regiments of four groups (twelve batteries) and forty-one division regiments of three groups (nine

⁵⁰ Jean-Baptiste Duroselle, *La Grande guerre des Français, 1914-1918: l'incompréhensible* (Paris: Perrin, 2003), 169. Stevenson, Porch, and others have covered the debate over heavy artillery in considerable depth. This section will therefore only cover the main points briefly.

batteries).⁵¹ Developments in metallurgy in the 1880s and 1890s, along with advances in explosives, had enabled the production of the 1897 model 75mm field gun, which had a pneumatic platform, was lighter and more mobile, and could fire around fifteen shells per minute at a range of almost 6,000 metres.⁵² It slowly replaced the de Bange model field guns and France had around four thousand when war broke out in 1914.

By contrast, the German army relied heavily on howitzers, partly due to their recognition of the superiority of the French 75mm over its own 77mm model. It had eighteen 105mm howitzers per division (with a range of 6,000 metres) and sixteen 150mm per corps (with a range of 7,500 metres), supplemented by high calibre mortars. These were particularly effective in counter-battery fire against French artillery during the First World War.⁵³

Quéloz argues that the German army, starting from a position of initial inferiority, recognised the need to examine the artillery question, adopted new materiel, and developed fresh doctrine for its employment. The French, however, did not address these questions and, once the debate was ultimately opened in 1908, had to come to hasty conclusions on a number of issues: the use of long or short materiel, the use at corps or army level, how heavy artillery should interact with field artillery, the use of shrapnel or explosive shells, and the logistics of supply.⁵⁴

⁵¹ Goya, "Le Processus d'Evolution," 192.

⁵² The introduction of 'powder B' significantly increased the initial firing speed.

⁵³ Goya, "Le Processus d'Evolution," 198.

⁵⁴ Dimitry Quéloz, *De la manoeuvre napoléonienne à l'offensive à outrance: la tactique générale de l'armée française, 1871-1914*, (Paris: Économica, 2009), 252.

'The great weakness of the French artillery in 1914 was its lack of heavy artillery' (General Challéat)⁵⁵

One of the most significant hindrances to French military effectiveness on the front lines in the first three years of the First World War was a lack of heavy artillery, which placed the army in a significantly weaker position to Germany. Long-winded pre-war debates continually delayed the establishment of a coherent policy towards artillery in general, leaving it out-gunned and out-ranged. The neglect of heavy artillery began as a result of the French high command's doctrine for the offensive, which focused on mobility and emphasised the role of the infantry. The army relied on the 75mm field gun, which was deemed most suitable for such needs. The little heavy artillery that the French army did have was to be used for siege purposes and would be held in the rear for when it was required. The army did not plan on using it on the battlefield.⁵⁶

However, the rapid development in technology prompted military thinkers to reassess the usefulness of heavy artillery in a modern war, as its improved mobility and speed of fire challenged the perceptions of the *soixantequinzeboutistes* ('seventy-five is the limit-ists') over its usefulness on the battlefield. Nevertheless, even as the high command began to recognise the merits of higher calibres, debates continued over *which* pieces to adopt and how much an armaments programme should cost. Thus the modernisation of the French artillery was continually delayed to the extent that by the outbreak of the war. Although the principal figures were convinced of the need for heavy artillery by 1914, they came to this realisation too late and therefore had not begun to address the underlying problems of

⁵⁵ Challéat (général), cited in Jean-Baptiste Duroselle, *La Grande guerre des Français, 1914-1918: l'incompréhensible* (Paris: Perrin, 2003), 169.

⁵⁶ Robert M. Ripperger, "The Development of the French Artillery for the Offensive, 1890-1914", *The Journal of Military History*, 59 (1995), 609.

how it would be incorporated into the overall structure and doctrine of the army, which remained almost entirely dependent on the 75mm field gun.

At the turn of the twentieth century, the general staff felt that they were in an apparently strong position as they could rely on their modern quick-firing 1897-model 75mm field gun, which was the envy of armies across Europe. Its hydraulic recoil system, which facilitated its high rate of fire, meant the gun did not have to be re-sighted after each shot. It was light, mobile, and its low trajectory was ideal for firing on advancing lines of infantry, but the superiority of the 75mm proved to be a burden.⁵⁷ The high command believed that it was entirely capable of fulfilling the 'supporting' role.⁵⁸ The dominant attitude was demonstrated in 1909 when a representative of the general staff on the Chamber of Deputies' Budget Commission stated: 'You talk to us of heavy artillery. Thank God, we have none. The strength of the French Army is in the lightness of its guns.'⁵⁹

Generals paid scant consideration to the coordination between infantry and the artillery. In the fifty-six pages of the *Instruction ministérielle sur la préparation de l'Artillerie au tir de guerre* issued in 1906, the word *infanterie* was never mentioned.⁶⁰ Artillerymen viewed their role as eliminating enemy infantry rather than clearing obstacles or strongpoints to aid the soldiers' advance. They focused their fire on targets that were easy to hit as opposed to those that were tactically important to the overall offensive. The report from artillery inspector Percin on manoeuvres in Picardy in 1910 noted that, 'out of 59 attacks that required artillery support, there were only 23 in which the firing objective of the

⁵⁷ Anthony Clayton, *Paths of Glory: The French Army 1914-18*, (London: Cassell, 2005), 33.

⁵⁸ *Ibid.*, 33; Général Maitre, "Des idées sur l'emploi de l'artillerie pendant la guerre", *Revue Militaire Française*, 11 (1924), 206.

⁵⁹ cited in Alistair Horne, *The Price of Glory: Verdun 1916*, (London: Penguin, 1993), 12.

⁶⁰ Ripperger, "The Development of the French Artillery for the Offensive, 1890-1914", 603.

artillery was the objective for the infantry attack. In the 36 other cases, the artillery fired on objectives that the infantry was not attacking and sometimes even on friendly troops.⁶¹

As the events of 1914 demonstrated, the doctrinal and material requirements of modern warfare had developed considerably. In static combat the 75mm's range was a clear limitation, its flat trajectory meant that it struggled to hit targets sited on reverse slopes, and its shells were not powerful enough to cause sufficient destruction to fortifications or trenches.⁶²

Why did the French army not draw more on the lessons of the conflicts that punctuated the period between the Franco-Prussian war of 1870-71 and the outbreak of the First World War? Krumeich claims that the French learnt a lot from the Russo-Japanese War of 1904-5 and were particularly impressed by the performance of advancing infantry assault groups against field artillery and machine guns, which seemingly supported the army's faith in morale and *élan*. The Balkan Wars demonstrated the supremacy of modern firepower, yet the French thinkers felt that this reaffirmed their faith in the all-out offensive in order to prevent a static or siege war from emerging and the high casualties that would ensue. While their observations were largely accurate, Krumeich posits that they were made to support their pre-existing doctrinal beliefs rather than prompting a modification to their approach and mind-set.⁶³

Quéloz supports this to some extent, arguing that those charged with studying the conflicts undoubtedly perceived the events through the lens of their own bias and inclinations. Furthermore, their conclusions were too varied and contradictory to allow generals to draw

⁶¹ Goya, "Le Processus d'Evolution," 196.

⁶² The new 1913 model 75mm improved the range of the 1897 model from six kilometres to nine.

⁶³ Krumeich in Horne, *A Companion to the First World War*, 8–9.

reliable lessons.⁶⁴ Military observers recognised that heavy artillery was particularly destructive in trench warfare but lacked the mobility to advance with the infantry. However, this reinforced their belief in the importance of manoeuvre and ensuring that a static battle did not occur, rather than prompting a reassessment of their overall approach.⁶⁵ Still, Goya contends that, considering the orientation of German artillery, the French army should have pursued the traditional approach of imitating the enemy 'as a precaution, as had been seen with the machinegun.'⁶⁶

Structural obduracy hindered the introduction of change. The incompatibility of the de Grandmaison school and the 'firepower' school played a part in stalling progress, while a number of independent institutions, such as the *Comité technique de l'artillerie*, the *Inspecteur permanent du tir de l'artillerie de campagne*, and the *Écoles militaires*, issued contradictory notes and directives on the subject of modern artillery.⁶⁷

The decline of the *Comité d'artillerie* resulted in the loss of experienced, technically-minded individuals who increasingly went from the army into private industry, attracted by the high salaries and career stability. Flaminus Raiberti, a deputy on the *Commission du Budget*, suggested that the government could have mitigated this loss by utilising private industry for armaments production, but instead industrialists were treated with suspicion, and the government continued to rely on state arsenals.⁶⁸ If it had granted peacetime armaments contracts, the Ministry could have ensured that machinery was in place and that factories

⁶⁴ Joseph C. Arnold, "French Tactical Doctrine 1870-1914", 65.

⁶⁵ Cosson, *Préparer La Grande Guerre*, 273–4.

⁶⁶ Goya, "Le Processus d'Evolution," 199.

⁶⁷ Quéloz, *De la manoeuvre napoléonienne à l'offensive à outrance*, 283.

⁶⁸ SHAT 10 N 4, Rapport de Raiberti, 2 December 1916.

were prepared to fulfil the needs of the army should war break out. The Ministry of War could have relied on the initiative of industrialists to drive developments in artillery.⁶⁹

Similar to military thinking on increased infantry recruitment and overall artillery expansion, opinions on heavy artillery were clarified and argued more strenuously as diplomatic tensions increased, but despite a number of different proposals, progress still took time and debates rarely resulted in definitive changes. A key problem was not just convincing others of the need for heavy artillery, but also deciding what calibre or model to adopt. Having recognised the need for artillery reform, the military still had to secure the necessary credits and financial backing from Parliament, which opened up new debates, delays and complications. The army did not seek the funds from government until late in the day, due to the time taken for a decision on heavy artillery.⁷⁰ Ultimately, it was very difficult to enact meaningful progress in either production or doctrine before war broke out. It is unclear whether the move towards higher calibre pieces was the result of a perceived need to react to Germany's strength in this area, the increased mobility that was offered by mechanised transport, or rather a reasoned doctrinal shift in their approach to the use of heavy artillery. The evidence appears to point to the former.⁷¹

Throughout the ten years preceding the outbreak of war, numerous proposals were suggested and discussed with limited results. The general staff adopted a rapid-firing 155mm piece designed by Colonel Emile Rimailho in 1904, but the army's reliance on the 75mm field gun was strengthened further in 1909 with the adoption of a cadres bill proposed by Piquart, expanding the number of field artillery batteries from 508 to 670.⁷² A

⁶⁹ Ibid.

⁷⁰ Ripperger, "The Development of the French Artillery for the Offensive, 1890-1914," 599.

⁷¹ Stevenson, *Armaments and the Coming of War*, 217.

⁷² Gudmundsson, "Learning from the Front," 264; Stevenson, *Armaments and the Coming of War*, 176.

light field howitzer was adopted in July 1911 following a meeting of the *Conseil supérieur de la guerre* in which the Ministry of War recognised the French army's inferiority in heavy artillery.⁷³

Nevertheless, despite progress, the merits of the 105mm, the 120mm, the 135mm and the 155mm, along with the option of the *plaquette Malandrin* were continually weighed against each other without ever arriving at a concrete resolution. It is here that 'the administrative anarchy of the ministry, the lack of power and authority of the high command, [and] the indecision of the general staff proved decisive.'⁷⁴

In February 1912, the state workshops of Puteaux offered two artillery prototypes, and a month later the Schneider group proposed a 105mm howitzer, constructed for Bulgaria, and a long-barrelled gun (106.7mm) constructed for Russia. The Schneider pieces met the specifications and the Lamothe commission asked for them to be tested in manoeuvres and for the 105mm to be tested by the *Commission d'études pratiques de tir d'artillerie de campagne de Mailly*. These two pieces were deemed satisfactory, with the 106.7mm adopted in the form of a 105L and studies begun for a 135mm and a long-range 155L.⁷⁵

In February 1913, support for heavy artillery was growing. The report of General Herr, returning from the war in the Balkans, and the declarations of General Lamothe stressed the importance of heavy artillery in the conflict and persuaded many of those who remained unconvinced to recognise the pressing need for an increase in production of larger calibre guns.⁷⁶ Joffre, supported by General Mengin and the Minister of War, Alexandre Millerand, ordered two hundred 105mm pieces immediately. However,

⁷³ Stevenson, *Armaments and the Coming of War*, 217.

⁷⁴ Porch, *The March to the Marne*, 237; Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, ii, 66–7.

⁷⁵ Goya, "Le Processus d'Evolution," 203.

⁷⁶ Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, ii, 68.

administrative delays and the lack of flexibility from Schneider meant that there were only a few models available by August 1914.⁷⁷

The heightened diplomatic tension across Europe following the Balkan Wars provided new impetus to military preparations in both France and Germany. The latter became increasingly concerned about its numerical disadvantage to France and Russia, and passed a bill containing a significant materiel investment, but also expanding its army by 136,000 to 890,000 men. It seemed Germany was preparing for war and expected it within the next eighteen months. The War Ministry recognised that this bill would heighten international tension, but reckoned that, with war already on the horizon, Germany could not enter it at such a numerical disadvantage to its enemies.⁷⁸

The German bill did indeed provoke an immediate response from France, with a bill appearing before the Chamber of Deputies on 6 March calling for the extension of service in the army from two to three years. It was ultimately passed as the *Loi des trois ans* on 7 August 1913 and would increase the peacetime strength of the army from 545,000 to 690,000 by early 1914 and to 730,000 by 1916. France's demographic stagnation in the latter half of the nineteenth century meant the government had already been obliged to call up a significantly higher proportion of its male population in order to match Germany's strength, and this measure would once again put it on the front foot. Following the army law of 1905, France called up 80 percent of each conscript class in comparison to Germany's 54 percent. There had been some discussion in 1912 over the extension of military service, but it had been rather perfunctory and failed to garner much support or momentum. Only the news from Germany in early 1913 prompted a rapid reassessment of

⁷⁷ Goya, "Le Processus d'Evolution," 203.

⁷⁸ Stevenson, *Armaments and the Coming of War*, 294–6.

France's manpower policy.⁷⁹ The adoption of the *Loi des trois ans* demonstrates the renewed vigour and urgency with which the French Ministry of War and general staff addressed their military planning and preparations, something that had been lacking in 1912.⁸⁰

Crucially, however, the French law did not contain accommodations for materiel expansion, which would ultimately be dealt with separately, whereas the German manpower bill treated the two issues together.

Armaments discussions became more urgent in the wake of the Balkan crisis, but continued prevarication over the level of expenditure delayed decisions on artillery expansion. Joffre sought to profit from the increased political focus on the military by presenting new demands in April 1913, seeking 504.5 million francs, of which 364 million francs would be spent on the artillery.⁸¹ While the Minister of Finance believed that this was exorbitant, the general staff pressed for more. A single bill was finally drawn up to cover the cost of the *Loi des trois ans*, the new cadres law, and Joffre's materiel plan, but was only passed on 15 July 1914. It totalled 1,142 million francs, of which 404.3 was for the expansion of the artillery. This represented an enormous increase compared to the equipment expenditure for the previous five years (1908-1913), which was just 269.6 million, and can be seen not just as recognition of the flaws and materiel deficiencies in the French army but also as a sign of increasing fears about impending war.⁸²

⁷⁹ Ibid., 96, 302–3.

⁸⁰ Gerd Krumeich, *Armaments and Politics in France on the Eve of the First World War: The Introduction of Three-Year Conscription, 1913-1914* (Leamington Spa: Berg Publishers, 1984), 44.

⁸¹ Stevenson, *Armaments and the Coming of War*, 312.

⁸² Ibid., 313.

It is important to note that while the high command saw the importance of increased artillery, and particularly heavy artillery, before the outbreak of war, it was too late to implement changes. Stevenson and Porch both blame the weaknesses of the French political system, which slowed the decision-making process, allowing it to drag on repeatedly. Still, the reluctance of the high command, the government, and Parliament to conduct a large-scale modification of the army's structure, and therefore its doctrine, is understandable considering the time and money that were required to implement it. The pace of technological change and the development of modern heavy artillery was too fast for the unwieldy structures that controlled the direction of the army.⁸³

Plan XVII

The *Loi des trois ans* was critical to French strategic planning for a seemingly imminent war with Germany. Under Plan XVI, the French high command had been concerned about the possible involvement of Italy on the German side and therefore sought merely to resist the German advance at the frontier. However, by 1912 it seemed Italy would remain neutral, freeing troops to bolster the northern armies and offering numerical parity with Germany. Plan XVII shifted to the strategic offensive and outlined a flexible deployment of troops depending on the developing situation. As it was believed that the war would be brief and the first engagements crucial to gaining the upper hand, Joffre wished to commit his reserves at once to ensure that French territory was not invaded. The numerical superiority granted by the *Loi des trois ans* was therefore vitally important.⁸⁴ One seeming oversight, however, was that Joffre made no attempt and granted no consideration to protecting the industrial heartland in the north-east of France, in particular the Briey area. Given that he

⁸³ Ibid.; Porch, *The March to the Marne*, 245.

⁸⁴ Stevenson, *Armaments and the Coming of War*, 306–7.

appeared sure of a short war, he presumably did not view the economic importance of the northern territory as critical, as he did not expect it to have a bearing on its outcome.⁸⁵

Plan XVII demonstrates French expectations of a short, mobile war. It made no mention of industrial mobilisation, with the army expected to survive on the munitions and materiel stockpiled before the war and a very modest contribution from the state arsenals, for which no increase to the 50,000 strong workforce was deemed necessary.⁸⁶ During the first forty days of war, 800,000 75mm shells (554,000 shrapnel and 246,000 explosive) would be produced, as well as 10,000 155mm shells, primarily by making up completed shells from pre-made parts held in reserve stocks.⁸⁷

The arsenals would produce 13,600 75mm shells per day from the sixtieth day of mobilisation, but no production of munitions was planned for the other calibres, and the army was expected to survive on pre-war stocks of explosives. Thus the French high command revealed both the style and the length of the war they anticipated, their emphasis on shrapnel shells providing evidence of an expectation for open and mobile warfare.

The perennial delays in agreeing Plan XVII, particularly in setting the targets for matériel and munitions, left the French army unprepared in 1914. At the opening of hostilities, the reserves from which the *Service de l'Artillerie* was meant to constitute its supply of replacement shells were significantly depleted, having been used to bolster the pre-mobilisation stocks. As a result, France and its industry were already on the back foot when

⁸⁵ Ferguson, *The Pity of War*, 96.

⁸⁶ Patrick Fridenson, ed., *The French Home Front, 1914-1918* (Providence: Berg, 1992), 58.

⁸⁷ Godfrey, *Capitalism at War*, 44.

the war started.⁸⁸ The details laid out in Plan XVII clearly show that the French were not preparing for a vast consumption of munitions or a long war.⁸⁹

The *Sous-Secrétariat d'Etat de l'Artillerie et des Munitions* conceded in 1916 that in drawing up Plan XVII, the general staff did not believe that it would need to continue to produce new arms and munitions during the course of the campaign; still less that it would have to increase its numbers of matériel. The French high command had felt that the army could survive by simply producing munitions to keep the artillery supplied from day to day. Its forecasts 'of munitions consumption were imprecise, even contradictory.'⁹⁰ It also revealed that a few months before the war, during army group exercises in the north of France, the theories and outlines for munitions consumption differed starkly from one army corps to another, even in largely comparable tactical situations. The bases on which they evaluated munitions consumption came from interpreting results from the most recent wars, in particular the campaign in Manchuria, but these interpretations also varied wildly, suggesting a lack of clear analysis that further clouded attempts to develop a defined, unified approach. Once again the lack of accurate information available to the French high command severely hampered its ability to make reasoned decisions.

Financing the bill was particularly problematic. The *Loi des trois ans* alone, without taking into account re-equipment, was of a similar cost to the German bill, but the French fiscal situation was relatively weak and the government was struggling to agree on a new income tax. Heated debates resulted in the fall of Barthou's ministry and were only resolved just before the war, when a huge loan was agreed in June 1914 assigning 600 million francs to

⁸⁸ Archives Nationales, Paris (hereafter AN) 94 AP 84, Résumé des mesures prises par le Service de l'Artillerie depuis l'ouverture des hostilités, 11 December 1914, 4.

⁸⁹ Service Historique de l'Armée de Terre, Vincennes, Paris (hereafter SHAT), 6 N 16, Réponse au Rapport Gervais sur les Munitions, 2 April 1915, 2.

⁹⁰ AN 94 AP 84, Résumé des travaux depuis le début de la guerre, 1916.

rearmament. This was followed on 2 July by the Senate voting for the introduction of a progressive income tax, a radical step in the French fiscal system. Stevenson highlights the effect that this issue had on the entirety of France's preparations for a future war. The financial issue brought down the government that had introduced the *Loi des trois ans*, while 'the effect of ministerial instability and the military leadership's chopping and changing was to decouple manpower from weaponry and delay the passage of the military credit until two weeks after the Sarajevo assassinations.'⁹¹

Financial considerations perennially constrained the French army in the run up to the war. A key reason why the Chamber Budget Commission chose to adopt the *plaquette Malandrin* rather than develop a new light field howitzer despite protests from Joffre was that it would save around eight million francs.⁹²

Stocks of 75mm munitions reached 1,390 shells per gun by 1914, but this was considerably short of the 3,000 that it was estimated might be needed based on observations from the Balkan Wars. An agreement was struck in 1912 between the *Administration de la Guerre* and certain private establishments to secure the daily production of 3,000 shells (1,500 from Le Creusot, 1,000 from Saint-Chamond, and 1,000 from Montbard). These would supplement the shells produced in the state establishments to make up the 13,600 75mm shells deemed necessary for the requirements of the war. This agreement was extended in 1913, but the *Département de la Guerre* deemed the agreed price of 16 francs per shell too expensive and took its own measures to assure production from the Ateliers de Construction of Bourges, Puteaux, Rennes, Tarbes and Lyon not just for peace time but also

⁹¹ Stevenson, *Armaments and the Coming of War*, 313–4.

⁹² Joffre claims in his *Memoirs* that he protested this decision, although he is writing with the benefit of hindsight, which casts doubts on the veracity of his claims.

for the first days of mobilisation.⁹³ General Mangin explained in March 1913 that, ‘private industry is expensive. It can only be used from the sixtieth day of mobilisation.’ Financial considerations therefore came before military expediency and restricted the development and expansion of the army’s artillery and munitions. With hindsight, this appears a serious mistake, yet it was understandable if the *Département de la Guerre* did not view war as imminent. The number of 13,600 came from the general staff and was the limit that could be provided considering the limitations that the output of powder placed on production. At this stage, the threat of war was clearly not a strong motivating factor and financial issues took precedence over supply.

Shortly before mobilisation, on 18 July, the *Service de l’Artillerie*, and subsequently on 1 August the general staff pushed for an increase in the stocks of powder in order to produce more munitions. With the apparent rapid approach of war, the general staff changed its tone, declaring that, ‘the production of 75mm cartridges for mobilisation should be increased as much as possible by calling on not just the state factories but also on those of private industry.’ The recourse to private industry, and the increased costs that such an approach would entail, highlights the severity of the situation and implies the French general staff was beginning to doubt the level of its preparations. This was a stark shift from the tone of discussions in 1912 and 1913.

While France recognised the inadequacy of its materiel position, financial considerations continued to restrict the implementation of changes that would have significantly strengthened its military position at the outbreak of war. Ultimately, the government took a significant gamble on the security of the nation and lost.⁹⁴

⁹³ SHAT 6 N 16, Réponse au Rapport Gervais sur les Munitions, 22 April 1915, 2.

⁹⁴ Stevenson, *Armaments and the Coming of War*, 314.

Joffre blamed the 'perfectionism and incompetence of the Ministry of War.' It appeared particularly reluctant to commit firmly to a decision, frequently hesitating, delaying, and conducting trials. For instance, despite the general staff ordering 220 Schneider heavy howitzers in April 1913, the Ministry cut the order to just thirty-six. This order was followed in June 1914 by another for 120 modern gun carriages to adapt the 155mm de Bange fortress guns, which would have enabled each of the twenty batteries of the *4eme Régiment d'Artillerie Lourde* to be given an additional six 155m guns, but it was not due for completion until the end of 1917 and was therefore also too late.⁹⁵ At the start of the war, France still did not possess an adequate light field howitzer, its long-range heavy guns were only just starting to appear, and it had to rely on adapted, out-dated models for its heavy howitzers. The lack of a clear heavy artillery doctrine also played a key part in the failure to act quickly and decisively on the armaments question. Although by 1913-4 France was making an active effort to modernise its materiel and strengthen its military position, Stevenson posits that it was this very reorganisation that pushed Germany closer to war in 1914, as the German general staff recognised the French army's potential that might be realised if it was granted the time to complete the long-term plans that it was beginning to enact.⁹⁶

July 1914 Assessment

By July 1914, while debates over the various merits of heavy artillery persisted, progress had been slow and immensely frustrating for those seeking to institute change. Messimy, the Minister of War at the outbreak of war, blamed the ministerial instability of the pre-war years, which repeatedly hindered the implementation of a coherent armaments programme. Between 1 January 1912 and 1 July 1914, there were seven different war

⁹⁵ Gudmundsson, "Learning from the Front," 276.

⁹⁶ Stevenson, *Armaments and the Coming of War*, 315.

ministers, each with differing agendas.⁹⁷ He also castigated the pacifist ideology that pervaded government at the start of the twentieth century, with the country taken in by the 'chimera of idealism and of universal pacification', prompting a reluctance to commit too heavily to military expenditure. This idealism had been jolted after the Tangiers incident by the driving force of Clemenceau in 1906 and 1907, and the image was finally shattered after Agadir, but the harsh awakening had come too late.⁹⁸

The debate in the Senate on 13 and 14 July was heated as ministers and deputies discussed the severity of France's military situation and how it had reached such a position. Ministers were well aware of how unprepared France was for an impending conflict. Messimy wanted to make the public to be aware of the insufficiency of French armament. It is possible that he did not perceive how imminent war was, or he would not otherwise have made the severity of the situation public. He claimed, 'It is a question of money!', to which the immediate response from Ernest Monis, the former Prime Minister, was 'it is not a question of money when the security of the country is in jeopardy.' Messimy detailed how, on 13 July, he had asked a general why he had never asked for more credits for machinery and materiel over the course of the preceding ten years. The general's response was 'I asked for them, I demanded them, but my profession as a soldier is to obey, and I could not vehemently argue against the formal order which I received to reduce the allocation to the *3e section* of the army by 50, 60 or 80 percent.' The general's individual initiative had been suppressed by the military structure of resolutely following orders. Messimy revealed that these orders emanated from the *Département des Finances*, who over a number of years had reduced the budget of the *3e section* by three-quarters. Messimy lambasted

⁹⁷ Terrail, *Au sein des commissions*, 108.

⁹⁸ Speech by Messimy to the Senate, 14 July 1914, cited in *ibid.*

Parliament and its members for 'persistently ignoring the enormity of the effort of our neighbours as it has ignored the need to industrialise our war materiel.'⁹⁹

Louis-Lucien Klotz, the President of the *Commission du Budget*, defended Parliament against the reproaches of the Minister of War. He claimed that the *Commission* had been trying to increase armaments spending for a number of years. On 13 June 1904, it submitted a draft bill to the Chamber of Deputies containing a proposal for an extraordinary credit of 11,805,900 francs to improve the defensive organisation of France during the fiscal year. This included 500,000 francs for improving field artillery, along with three million francs for the construction of army machinery and materiel, referring to the Remailho rapid-fire artillery piece. He argued that it was on the initiative of the *Commission du Budget* that Parliament had included credits for military aviation and for rapid-fire heavy artillery. The Chamber had not lost sight of the issue of heavy artillery, with numerous reports submitted over the previous ten years for inclusion in the military budget. Klotz argued that the renovation of the army to match Germany's would require new budgetary sacrifices but Parliament had never refused to grant credits when it recognised clear needs for national defence.

Senator Charles Humbert, a deputy on the *Commission de l'Armée* and a vocal critic of the government's military preparations, turned the blame back on the government and its failure to grasp the overall situation, pointing to the purchase of twelve million tractors in 1913. The *Commission de l'Armée* had enquired of the general staff whether the supplies for oil and petrol had been secured for these tractors and also for all the cars and trucks that would be required at the front in case of a war. While the general staff had declined to comment (this information was greeted with derisive laughter in the Chamber), it was clear

⁹⁹ Ibid., 122–3, 161.

upon investigation that no accommodation had been made either in the army groups or in defensive emplacements.¹⁰⁰

The French President, Raymond Poincaré, despite the potential unreliability of his memoirs, claims that he recognised the army's inferiority in both field and heavy guns and tells of Adolphe Messimy, the Minister of War, coming to the *Conseil des Ministres* and attempting to put on a brave face. Messimy tried to say that he was 'wholly confident' before 'he stopped, buried his head in his hands and began to sob out loud.' Poincaré realised that France would have to rely on 'national courage' and prayed that this would suffice against Germany's 'great military workshop.'¹⁰¹

There were clearly deep underlying structural issues that resulted in the poor state of France's artillery at the start of the war. There was a stubborn doctrinal reliance on the 75mm field gun that pervaded military thinking and prompted complacency towards heavy artillery. The merits of higher calibre guns were appreciated too late and governmental sluggishness and reluctance meant that, when changes were sought, they took too long to be implemented. Attempts from 1911 onwards to increase the number of heavy artillery batteries were not effective by the outbreak of war in 1914, whereas Germany had been preparing and strengthening its artillery from the turn of the century. The planned expansion to artillery was not scheduled for completion until 1917 and 1918. France saw that its army was significantly inferior to Germany but needed time to introduce changes. This counters Stefan Schmidt and Sean McMeekin's argument that the French army was pushing for war in 1914, attempting to appear strong to secure Russian support. Considering the state of the artillery, the attempts to secure its expansion, and the efforts

¹⁰⁰ Ibid., 131–2, 165.

¹⁰¹ Raymond Poincaré, *The Memoirs of Raymond Poincaré* (London: Heinemann, 1926), iii, 2.

to pass the *Loi des trois ans*, entering into a materiel-intensive war with Germany made little sense.¹⁰²

Once fighting broke out, much of France's ability to cope would depend on the state of its industry, including both armaments manufacturers and commercial firms, particularly those based in metallurgy.

Industry pre-1914

Plan XVII foresaw a short, mobile war that required only minimal industrial production to keep the army supplied with munitions and materiel. As a result, there would be no great need to call upon industry to fulfil a more onerous role than that to which it was accustomed before the war. The high command would rely on the state arsenals, principally Bourges, Puteaux and Tarbes, for the provision of artillery and munitions.¹⁰³ Once it became clear that the war would not be over quickly, industry came to the fore as the primary factor that would dictate success or failure.¹⁰⁴ France would succeed or fall depending on the strength of its domestic economic response.

Although the French army was supplied by the state arsenals, private enterprises, such as Schneider, Saint-Chamond, and Firminy, were engaged in the manufacture of arms for export abroad, in particular to Russia and Romania. However, relations between these firms and the Ministry of War were strained, with private industry viewed as too expensive for

¹⁰² Stefan Schmidt, *Frankreichs Aussenpolitik in der Julikrise 1914: ein Beitrag zur Geschichte des Ausbruchs des Ersten Weltkrieges* (München: Oldenbourg, 2009); Sean McMeekin, *July 1914: Countdown to War* (London: Icon Books, 2014).

¹⁰³ Duroselle, *La Grande guerre des Français, 1914-1918*, 174.

¹⁰⁴ Broadberry and Harrison, *The Economics of World War I*; Anthony P Adamthwaite, *Grandeur and Misery: France's Bid for Power in Europe 1914-1940* (London: Arnold, 1995).

state contracts.¹⁰⁵ Schneider in particular had seen rapid expansion in the latter half of the nineteenth century thanks to the driving force of Eugene Schneider, who profited from the opportunity to provide armaments abroad that became possible following the removal of the law forbidding such action in 1885. Its artillery had proved so effective since the turn of the twentieth century that Schneider was rapidly expanding its factories in the years preceding the war in order to meet the growing demand from foreign powers, particularly following its 'incontestable superiority in the Balkans'.¹⁰⁶ Armaments production had become Schneider's principal output by 1914, and ultimately proved critical to France's ability to remain in the war in the early months of the conflict.¹⁰⁷

By contrast, in Germany, munitions were made by both state and private industry, with the government fixing the quantity that these two groups would provide in wartime in January of each year. It frequently verified that the quantities of materials were with the manufactures or in stock and that the means of production, the personnel, and the machinery were in place.¹⁰⁸

The Ministry of War also neglected the French metallurgy industry along with private armaments firms. Both Charles Charguéraud, *Directeur des Mines* at the *Ministère des Travaux Publics* from 1905 to 1910, and his successor Paul Weiss, declared that they had devoted little thought to how a war might affect the industries in north-eastern France, with the latter claiming that the general staff had felt that 'the production of the... region was unnecessary' for the wartime armaments programme as existing stocks would be sufficient. François de Wendel affirmed this, telling a post-war commission that '[he did]

¹⁰⁵ Gerd Hardach, "Industrial Mobilization in 1914-1918: Production, Planning and Ideology," in Patrick Fridenson (ed.), *The French Home Front, 1914-1918* (Providence: Berg, 1992), 59.

¹⁰⁶ Schneider, 187AQ015-01, General Assembly, 23 November 1907; *ibid.*, 187AQ016-03, General Assembly, 30 November 1911.

¹⁰⁷ Hatry, *Renault, usine de guerre 1914-1918*, 15.

¹⁰⁸ Terrail, *Au sein des commissions*, 173.

not believe that the idea came to anyone that the loss of blast furnaces in the east was going to present a real difficulty for France.¹⁰⁹ Such underestimation proved extremely costly and meant that industry spent the first three years of the war recovering from the lack of pre-war preparation. Before explaining the response and subsequent success of French industry during the war, however, it is necessary to assess the platform from which French industry was starting.

State of industry

The historiography of French economic development in the latter half of the nineteenth century is somewhat convoluted and one must bear in mind distinctions between metallurgy, armaments industries, the financial and capital markets, and the automobile industry when exploring success, progress, and growth. François Caron sees the structure of industrial France around the turn of the twentieth century as being incredibly dispersed and varied, with a plethora of small independent artisan companies, often working in quite specialised areas. There was a clear distinction between these elements and the larger, more traditional, industrial heavyweights in the mining, textile, and metallurgical industry.¹¹⁰ After 1900, collaboration between smaller industrialists and larger companies produced more concentrated and coordinated cooperation.¹¹¹ Pre-1960 Anglo-Saxon historiography has charged the nineteenth century French entrepreneur with lacking dynamism, innovation, and entrepreneurial spirit, concerned more with personal independence and family security than modernisation and innovation. However, more recently Rondo Cameron has highlighted the role of French industrialists in technical advances and their dispersion accompanying the exports of capital. Furthermore, increasing

¹⁰⁹ Jeanneney, *François de Wendel en République*, 77.

¹¹⁰ Caron, *An Economic History of Modern France*.

¹¹¹ Barjot, Chaline, and Encrevé, *La France Au XIXe Siecle, 1814-1914*, 384.

emphasis is placed on the role of the *techniciens* between 1880-1914 in driving industry forward, taking a more scientific and analytical approach to practices, while fostering the rise of 'machinism' exemplified in the *Société des ingénieurs civils de France*.¹¹²

Barjot identifies five periods of innovation and development from the second half of the eighteenth century to 1914. As elsewhere, the early advances came in textiles, while the key progress in steelwork was made between 1874 and 1877, with electricity developing considerably between 1905 and 1913. In general there was a steady increase in the reliance on new techniques and the incorporation of machinery into production. Barjot also stresses the role of the engineer, with innovations aiming to save both energy and manpower, elements that France increasingly lacked, beginning to appear towards the end of the nineteenth century. The large French schools (*Polytechnique et les école d'applications, Mines et Ponts et Chaussées, Centrale, Arts et Métiers*) began producing engineers of high technical expertise, diffusing a more entrepreneurial and productive spirit into French society.¹¹³

Kemp is quick to stress the progress made during the twenty years before the First World War. France was 'an old industrial country with an inherited structure which was resistant to change and blocked fuller adaptation to the technical and organisational conditions of the twentieth century.' Although he uses the word "retardation", he stresses that growth was occurring but was below that achieved elsewhere.¹¹⁴ French industry was extremely geographically diverse, with significant regional differences in prosperity and modernity. The south and west remained relatively stagnant, while the north and east became the

¹¹² Ibid.

¹¹³ Ibid., 403–4.

¹¹⁴ Kemp, *Economic Forces in French History*, 222.

focal points for heavy industry and economic development.¹¹⁵ When German officers assessed French industry during their occupation of northern France in 1916, in comparison to their own firms, they found it to be significantly behind Germany in terms of scale, expertise, financial methods, extent of vertical integration and concentration. They put this down to the emphasis on family firms and the 'rentier mentality' of the French businessmen.¹¹⁶

The expansion of metallurgy is of greatest importance to this study, as it would prove critical to supplying the armaments industries with the raw materials required for a modern war based around artillery and munitions. The steel industry was one of the most rapid expanders under the Second Empire, benefiting from massive investment, new techniques and geographical redistribution towards the north of France and the Lorraine region. Between 1810 and 1914, the contribution of industry to the total of French production, aside from food, public works and construction, increased from a quarter to a half, while the iron and steel industry represented 40.3 percent of the basic industry sector, as both demonstrated rapid growth in this period.¹¹⁷ A number of new companies sprang up, taking advantage of the increasing availability of electricity and adopting a specialised approach to steel production and manufacture. The key advances were the introduction of the Bessemer convertor in 1856, the Martin furnace in 1864 and the Gilchrist-Thomas process for the dephosphoration of iron in 1880. These all helped France to start bridging the technological and industrial gap with Britain that had widened considerably in the nineteenth century. France in 1870 was in the position that Britain had been in 1835.¹¹⁸

¹¹⁵ Kemp, *The French Economy, 1913-39*, 9.

¹¹⁶ *Ibid.*, 16.

¹¹⁷ Godfrey, *Capitalism at War*, 11.

¹¹⁸ Barjot, Chaline, and Encrevé, *La France Au XIXe Siecle, 1814-1914*, 386, 403-4.

The extent of French metallurgy expansion is demonstrated by the fact that between 1890 and 1913, while German steel production increased by a factor of 2.62, USA 2.32, and Britain 1.52, France outstripped them all with its production increasing by a factor of 3.1. Whilst this was only possible due to the level of stagnation earlier in the nineteenth century, it reveals the dynamism that characterised the area in the years before the outbreak of war. Godfrey highlights two reasons for this development: the utilisation of raw materials and the entrepreneurship of industrialists. The Thomas method of steelmaking enabled France to exploit its large supplies of phosphoric iron ore, a resource that had previously been untapped. In 1913, of the 21.918 million tons of iron ore produced in the country, 20.059 million tons were phosphoric. Greater collaboration between steel industrialists, particularly between the de Wendel and Schneider families enabled an increasingly rapid expansion, capitalising on the new methods of production to maximise their output. Furthermore, as modernisation and expansion continued, and companies grew, they were increasingly administered by technocrats and engineers who had risen through the ranks rather than by the old family dynasties characterised as being conservative and out-dated.¹¹⁹

Even if the French economy was not as comparatively strong as that of Britain and Germany, one of its key strengths was that it was 'largely a quality market, rather than one geared to mass-produced goods.' There was a high level of technical proficiency that pervaded the armaments industry in particular, especially the private enterprise of Schneider-Creusot, whose light and medium artillery were its primary export. The automobile industry was also producing high quality products based on strong traditions of

¹¹⁹ Godfrey, *Capitalism at War*, 13–5.

technical excellence that would serve the state well once war erupted and enabled a swifter adaptation than might otherwise have occurred.¹²⁰

The *Comité des Forges* played a vital role in the development of the metallurgical industry. The *Comité* was a trade association founded in 1864 with two purposes: to maintain the balance and structure of the industry and to defend the interests of industrialists in the larger economic context. It controlled prices to ensure that competition remained reasonable, and ultimately it represented three-quarters of the iron and steel producers in France. It expanded further under the direction of Robert Pinot and came to incorporate a wider variety of enterprises, including railways, munitions producers and the Union of Metallurgical and Mining Industries, totalling 238 members by 1914. It opposed pressure from Alexandre Millerand for social reform and improved workers' rights in order to protect the liberty and freedom of action of the manufacturers. In particular, the *Comité* established a standard classification for metallurgical products produced by members of the union in order to facilitate the coordination of production and pricing, which would prove particularly convenient once the *Comité* began working with the government during the war.¹²¹ Politically, it was strongly nationalist and conservative, even though many of its members had close ties with firms in neighbouring countries, including Germany.¹²²

The *Comité des Forges* was symptomatic of the overall structure of French heavy industry. Godfrey claims that the ironmasters 'had a technical capacity and a genius for organisation which allowed them to recover' from the territorial losses in the early months of the war and to employ them to the fullest. The structures of the *Comité des Forges* and the *Comptoir de Longwy* facilitated the adaptation to the requirements of wartime, particularly

¹²⁰ Millett and Murray, *Military Effectiveness*, 1988, 196.

¹²¹ Godfrey, *Capitalism at War*, 16–18.

¹²² Kemp, *Economic Forces in French History*, 254.

with regard to the financing of new installations. The former was pivotal in the negotiations between industrialists and the state and was one of the key reasons behind the financial gains that industrialists made from the war.¹²³

While France's industrial development over the latter half of the nineteenth century is impressive, it must be assessed in relation to the other major powers, which were undergoing a similar period of sustained growth as part of the Second Industrial Revolution, for it is their relative strengths in 1914 that would prove critical to how they coped with the stresses and strains of supplying their armies in a modern, industrial war. France lagged behind its rivals in industrialisation. Having been one of the two major industrial powers in 1850 alongside Britain, by 1900 France had been overtaken by Germany in coal, iron and steel production, producing just 41 million tons of coal in comparison to Germany's 279, Britain's 292, and the United States' 474.¹²⁴

Too much emphasis has been placed on the idea of France being technologically advanced, which has been used to justify the relative inferiority of French industry as a whole and to explain the success of the recovery during the war. The automobile industry in particular is highlighted as an area of particular development, yet it was mainly the Renault firm that led the way by experimenting with Taylorism while others failed to recognise the potential. Even here, the adoption of modern practices was relatively piecemeal.¹²⁵

One area that has been particularly overlooked is that of private industry. Schneider-Creusot and Saint-Chamond provided materiel to Serbia and to Russia in the years leading

¹²³ John F. Godfrey, "Bureaucracy, Industry and Politics in France during the First World War : A Study of Some Interrelationships" (Thesis DPhil, University of Oxford, 1974), 20. The Comptoir de Longwy was a similar commercial organisation facilitating the sale of iron in north-east France.

¹²⁴ Adamthwaite, *Grandeur and Misery*, 3.

¹²⁵ Fridenson, *Histoire Des Usines Renault*, 71–75.

up to the war. Their methods of production remained somewhat basic in 1914. They had not yet adopted the mass production system that had contributed to the rise of the likes of Ford in the United States. The factory had a few stock components but largely relied on making pieces to order, with the use of skilled technicians often working by hand. As a result, large orders could only be met by a long series of small production batches. Hence the lead-time for the production of the first set of 105mm guns was twenty-five months and the production of 155mm gun carriages was to take forty-two months.¹²⁶ Such production methods were symptomatic of French industry as a whole, and even across Europe.

While there were some critics of the lack of military preparation before the war, it is also necessary to explore whether there was concern about the ability of industry to meet the potential military demands should war break out. Were the directors and management blind to the increasing diplomatic tension in Europe and the likelihood of a future conflict? If so, was there any attempt to prepare to capitalise on this, by increasing production or modernising their infrastructure to cope with the possibility of increased demand? The Schneider archives reveal little discussion about the possibility of a forthcoming conflict or whether the factory should seek to improve its manufacturing methods in the face of increased demand.¹²⁷

Similarly, although the French high command gradually realised the need for more artillery, it neglected to concern itself with or improve the industrial capabilities of the armaments manufacturers. In a report to the Minister of War from the then *Sous-Secrétaire d'Etat à la Guerre* on 30 March 1907, Henry Chéron noted that whatever plans were drawn up to increase the state of their armaments,

¹²⁶ Gudmundsson, "Learning from the Front," 289.

¹²⁷ Schneider, 187AQ015-01.

We have at the current time neither the necessary stocks, nor the manufacturing capacity necessary, nor the supplies in raw materials, nor even, at the very least, agreements in place to obtain them if mobilisation occurs.... It is absolutely unbelievable that our means of production and our stocks of powder and explosives have not been arranged a long time ago and that all this has not been made the object of a specific, structured programme in which all our production and consumption needs are coordinated and nothing is left unforeseen or to chance.

The situation in 1907, critical then, was unchanged in 1914.¹²⁸ Ultimately there was little concern for the state of industry, exemplified by the stipulation in the mobilisation plan that all men would be called up from private industry, with only a relatively small number remaining in the state arsenals to produce the required munitions.

Overall, the lack of unity among the high command and the reluctance to accept the merits of heavy artillery, coupled with the expectation of a mobile war had two key effects: First, France went to war heavily reliant on the 75mm field gun, lacking in heavy artillery and without supplies of sufficient munitions. Second, there was no incentive to explore the preparation of industry. In terms of doctrine, armaments and industrial capacity, France was wholly unprepared for the material demands of the First World War and the decisions made between 1900 and 1914 would have far-reaching consequences over the subsequent four years. Ultimately, the majority of the problems faced by the army and the Ministry of War during the war stemmed from this lack of foresight and preparation.

¹²⁸ 6 N 16, Réponse au Rapport Gervais sur les Munitions, 22 April 1915, 22.

Chapter 2 – 1914 – Reaction

When war broke out in 1914, pre-war speculation ended and the scale of modern warfare became clear to belligerents on both sides. The fallout from the decisions made in the pre-war years was felt in numerous ways. The artillery suffered munitions crises that hindered the ability of the army to fight effectively, French industry struggled to meet the ever-increasing demands of the front lines, manpower and material shortages plagued the home front, and hasty attempts to increase output resulted in a stark drop in the quality. The initial actions of Alexandre Millerand, the Minister of War, suggest that the war granted him the opportunity to take measures that he had struggled to introduce in peacetime, and although his actions created almost as many problems as they solved, they succeeded in keeping the army in the field. Furthermore, many of the changes implemented took significant time to bear fruit, with results only starting to appear from 1916 onwards.

Early Lessons

The materiel requirements of a modern war and the prominence of artillery were demonstrated from the outset. It was responsible for 67 percent of casualties on the Western Front, in comparison to 15 percent in the Franco-Prussian war of 1870-71 and just 11 percent in the Russo-Japanese war of 1904-5.¹²⁹ The general staff quickly highlighted its importance. For General Foch, a battle was no longer 'an infantry attack to be prepared by the artillery; it [was] an artillery preparation to be exploited by the infantry.'¹³⁰ Colonel

¹²⁹ Pedroncini, *Pétain, général en chef*, 41; Cosson, *Préparer La Grande Guerre*, 124, 160. Cosson suggests that possible reasons for the low proportion of casualties caused by artillery in the Russo-Japanese war were the inexperience and lack of technical expertise of the artillerymen on both sides and the continued preference for manoeuvre over tactical defense.

¹³⁰ Maxime Weygand, *Mémoires* (Paris, 1950), 298.

Carence agreed, writing in October 1915, 'the artillery first; then the infantry! Everything should be subordinated to the artillery in the preparation and execution of attacks.'¹³¹

Nevertheless, the general staff's pre-war prevarications over artillery in the build-up to the war left the army with vastly insufficient reserves of both artillery and materiel. One of the major flaws of Plan XVII, the expected reliance on pre-war stocks of munitions with a modest contribution of 13,600 75mm shells per day from state industry, was swiftly laid bare.¹³²

Shell Consumption

The consequences were grave. During the 'Race to the Sea' between 28 September and 14 October, the French army fired 651,928 shells, at a rate of nearly 40,000 per day.¹³³

Munitions stocks fell with alarming speed, with over half of the pre-existing stocks of 75mm munitions expended by the end of the Battle of the Marne.¹³⁴ Colonel Pellé placed much of the blame on young officers, who lacked sufficient experience and had been far too profligate, having replaced senior officers who had been killed in the first weeks of the war.¹³⁵ The situation was so severe that army commanders were explicitly told to conceal the precise figures from their subordinates, as the war effort could be jeopardised if the enemy discovered the army's weakness.¹³⁶

¹³¹ Marius Daille, *Histoire de la guerre mondiale. II. Joffre et la guerre d'usure, 1915-1916*, (Paris, 1936), 394.

¹³² SHAT 6 N 16, Rapport de C. Humbert, 24 March 1915, 4.

¹³³ Service Historique de l'Armée de Terre, *Les Armées françaises dans la Grande Guerre* (hereafter AFGG), 14, 555.

¹³⁴ Robert A Doughty, *Pyrrhic Victory: French Strategy and Operations in the Great War* (Cambridge, Mass: Belknap, 2005), 116.

¹³⁵ Poincaré, *The Memoirs of Raymond Poincaré*, iii, 188.

¹³⁶ AFGG, 14, 394.

By 20 September 1914, shell supplies had deteriorated to such a level that Joffre was forced to tell Alexandre Millerand, the Minister of War, that if production did not increase considerably, 'we will no longer have the means to... continue the war from 1 November.'¹³⁷ He asked for at least 50,000 shells per day, but at the time of writing, output was just 12,000.¹³⁸

Industry was not able to react quickly enough to meet the demands of the front lines, thus the army would have to find ways to conserve shells. The shortages were so severe that Joffre even demanded that the training shells used in artillery schools and any munitions available to the French army in Morocco, North Africa, and its other colonies be sent to the front as soon as possible.¹³⁹

As early as September, tension grew between the French high command and the Ministry of War. Joffre was angry at the failure of industry to provide adequate munitions while Millerand was not sufficiently informed of the extent to which consumption was exceeding supply.¹⁴⁰

The Effect of Munitions Shortages on Tactics

The army had to sacrifice its short-term military effectiveness to ensure the long-term ability to continue to fight. Joffre first restricted artillery fire, commanding on 22 September that guns 'should never be fired without clearly defined targets or on large areas' and later ordered that shells should be expended parsimoniously outside offensives.¹⁴¹ In some

¹³⁷ AFGG, 21–19, 11. Joffre to Millerand, 20 September 1914.

¹³⁸ Ibid.

¹³⁹ Ibid., 211–39, Joffre to Millerand, 28 September 1914.

¹⁴⁰ Poincaré, *The Memoirs of Raymond Poincaré*, iii, 190.

¹⁴¹ AFGG, 41, 393; SHAT 16 N 696, Note pour les Armées, no. 1.647, 5 February 1915.

cases, the use of artillery was forgone altogether. On 26 September, Joffre instructed the commander of the Second Army that when faced by fortified defences, they should seek to advance through manoeuvre rather than by artillery, a tactic that went completely against all the lessons learnt from the war thus far.¹⁴²

By the 27 September, the munitions crisis was so severe that the commander-in-chief imposed strict rationing, limiting the supplies of the army to just three hundred 75mm shells per gun, with any surplus being held back to build up a reserve under his exclusive disposal. Armies would not receive any more munitions until 20 October unless they were assigned a particular mission. The supplies of the Sixth Army were reduced to just a hundred shells per gun, and of these, ten were practice shells of little practical use.¹⁴³ Until further notice, commanders were to persist in stopping enemy attacks on their section of front and reinforce their defences in order to make them impenetrable.¹⁴⁴ Although saving munitions, the artillery's ability to fulfil its role of as an offensive weapon was severely limited.¹⁴⁵ From the very start of the war, therefore, shell supply limitations placed significant constraints on the artillery's fighting potential, threatening the entire French army's survival.

The high command's extensive efforts to preserve the maximum number of shells possible by clamping down on what they deemed to be excessive consumption demonstrate the gravity of the crisis. To monitor the amount of shells being fired, each army had to telegram the *Directeur de l'Arrière* every evening to inform him of the number of shells it had consumed that day. Numerous notes were issued to individual corps drawing their attention to where they had exceeded their allocations and ordering them to reduce their

¹⁴² AFGG, 211–31, 22, Joffre to Second Army, 26 September 1914.

¹⁴³ Reboul, *Mobilisation industrielle*, 8.

¹⁴⁴ AFGG, 14, 394, Note, 27 September 1914.

¹⁴⁵ *Ibid.*, 14, 395.

consumption immediately. Joffre threatened that, if consumption was not curtailed, it could seriously contribute to losing the war.¹⁴⁶ The sheer number of these notes illustrates the importance that the commander-in-chief placed on this matter. Consequently, at times during 1914 an army corps might fire just four 75mm shells per day.¹⁴⁷ Artillery commanders of the Sixty-Ninth Reserve Infantry Division were ordered to restrict fire to 'well-defined targets' while also only registering 75mm guns by individual piece rather than by firing all four pieces at once, thus lengthening preparatory bombardments and removing all chance of surprise.¹⁴⁸ Nevertheless, the measures could not accommodate the practicalities of the front lines. Even in October, certain batteries fired more than a thousand shells per gun in one day to combat enemy activity.¹⁴⁹

The high consumption of the early months affected specific types of shells more than others. French expectations of a war of movement meant that of the 4.8 million 75mm shells available in August 1914, 58 percent were shrapnel, which were much more effective against exposed infantry, with just 42 percent explosive shells, which were suited to destroying defensive fortifications.¹⁵⁰ This left the army exposed in early battles because artillery commanders continually neglected shrapnel, leading to the exhaustion of supplies of explosive shells.¹⁵¹

Such was the state of the French munitions stocks that Joffre was forced to promote the use of shrapnel, despite its unsuitability for trench warfare, lest a situation arise where the stocks of explosive shells were exhausted completely.¹⁵² He issued a number of directives

¹⁴⁶ Ibid., 14–2114, 395, Joffre to Romigny (Fifth Army), 5 October 1914.

¹⁴⁷ Reboul, *Mobilisation industrielle*, 17.

¹⁴⁸ Gudmundsson, "Learning from the Front," 182.

¹⁴⁹ Reboul, *Mobilisation industrielle*, 16.

¹⁵⁰ Ripperger, "The Development of the French Artillery for the Offensive, 1890-1914," 603.

¹⁵¹ Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, ii, 24.

¹⁵² AFGG, 21, 9, Note pour les armées, 14 September 1914.

that amount to a small propaganda campaign in favour of shrapnel, strenuously highlighting its positive effects against infantry and uncovered defences. He implied that there was not a significant difference in quality between explosive and shrapnel shells in day-to-day trench warfare operations, despite evidence from the front lines to the contrary.¹⁵³

The shell crisis also impinged on tactical effectiveness by influencing which artillery pieces were used, with the availability of shells taking precedence over the individual tactical merits of the different calibres. Joffre pressed artillery officers to use the 95mm and 58mm guns, rather than the 75mm, for which the army was rapidly running out of shells. Before the war, the army had sought to strengthen the artillery by converting old, out-dated pieces from forts and coastal defences. As the munitions situation deteriorated, Joffre was forced to requisition any available models for which there were sufficient munitions, thus providing the army with 85mm, 120mm, 155mm and 220mm pieces. On 22 September 1914, he demanded the replacement of 75mm batteries with 95mm batteries wherever possible and three weeks later ordered the Sixth Army to use as many 90mm and 85mm batteries as it could, in order to conserve 75mm within the restrictions imposed on 27 September.¹⁵⁴ Despite their technical flaws, they would fill a gap at the front until the production of both shells and modern artillery pieces could reach an acceptable level.¹⁵⁵

Joffre realised that saving munitions cost human lives and lamented the fact that, had more munitions been available, 'important results could have been achieved.' Prolonging the

¹⁵³ *Ibid.*, 211–13, 9, Télégramme chiffré, Général Commandant en Chef à général commandant armée, Villers Cotterets (6e armée), no. 6213, 19 September 1914; *ibid.*, 211–14, 10, Note: Général Commandant en Chef à armée: Epinal; Verdun; Dommartin-sur-Yèvre; Romigny; Villers-Cotterets; Chalons; Clermont. (1st, 3rd, 4th, 5th 6th, 9th, 2nd respectively), no. 6235, 19 September 1914.

¹⁵⁴ *AFGG*, 211–25, 45, Letter to Millerand, 22 September 1914; *ibid.*, 14–3099, Joffre to Villers-Cotterets (Sixth Army).

¹⁵⁵ *AFGG*, 14, 395, Note aux armées, 27 September 1914.

situation would lead to increased losses and 'would have a serious influence on the outcome of the war', and a certain level of firing was clearly necessary to maintain the French army's position at the front.¹⁵⁶ He received a large number of pleas from commanders claiming that, although they were attempting to save munitions, they needed to respond to the actions of the enemy.¹⁵⁷ He was therefore faced with a precarious balancing act, since, if munitions supplies were exhausted, then the army could no longer fight, but 'although consumption was frightening, it was, unfortunately, unavoidable' in order to hold back the German advance.¹⁵⁸

Use of out-dated materiel

In order to bolster the artillery at the front lines, Joffre sought to create batteries from out-dated models requisitioned from forts in the interior and the navy to cover for the lack of munitions and pieces possessed at the start of the war. Between 5 October and 24 October 1914, eighty-eight batteries of six 90mm de Bange field guns were formed, along with thirty-nine 95mm Lahitolle batteries, three batteries of 120mm heavy de Bange guns, eighteen batteries of 155mm light siege howitzers, and six batteries of 220mm de Bange medium siege howitzers. Initially, many of these were assigned to reserve divisions, but they would rise in prominence as the shortages worsened.¹⁵⁹ In total, France had approximately 11,000 de Bange model pieces, ranging from 80mm through to 270mm, and stocks of 4.7 million shells. Lieutenant-Colonel Aublet declared after the war: 'we can say

¹⁵⁶ Ibid., 211–65, 45, Télégramme chiffré, Général Commandant en Chef à Guerre (cabinet), no. 2813, 13 October 1914.

¹⁵⁷ SHAT 16 N 696, Note: Le Général de Division Dubail, Commandant la 1ère Armée, à M. le Général Commandant en Chef, no. 221/5, 2 December 1914; SHAT 18 N 293, Le Général de Division de Villaret, Commandant la 7e Armée, à Monsieur le Général Commandant la GAE, no. 2909, 5 February 1916.

¹⁵⁸ Émile Herbillon, *Souvenirs d'un officier de liaison pendant la guerre mondiale* (Paris: Tallandier, 1930), 41.

¹⁵⁹ Gudmundsson, "Learning from the Front," 183–4.

that it was these pieces which saved France, by allowing us to hold on until production could improve sufficiently.¹⁶⁰

The scrambling to meet the demands of the front lines was inevitably erratic and *ad hoc*. Initially, the general staff sought to establish a “floating” artillery headquarters coordinating the constantly changing batteries and artillery groups, rather than a fixed structure of heavy artillery at the disposal of army commanders. For instance, on 4 October 1914, just three of the twelve batteries allocated to the Second Heavy Artillery Regiment had actually been mobilised with that regiment, with six assigned to other heavy artillery regiments, and three created at the front from obsolete field guns. Furthermore, as of 22 October 1914, the Third Heavy Artillery Regiment ‘had lost its two original groups of Baquet howitzers, formed several batteries of 120mm de Bange heavy guns, and acquired batteries equipped with 155mm de Bange heavy guns. Less than a month later, it had lost its heavy guns but gained at least one battery armed with Filloux howitzers.’¹⁶¹

While the shortage of 75mm munitions posed a severe threat to the ability of the army to continue fighting, the lack of heavy munitions constrained its offensive potential, leaving the army struggling to match the more numerous and more powerful German guns. Pre-war indecision left the army in August 1914 with just three hundred modern heavy artillery pieces to match Germany’s two thousand. The emphasis on field guns also meant that there were minimal stocks of heavy artillery munitions. Joffre’s attempts to push for the increased use of larger calibres in order to preserve 75mm munitions exacerbated these shortages.¹⁶² Ultimately, the 95mm gun, which was slow firing and lacked the firepower of the larger, more modern pieces, was prioritised in the early months simply because it still

¹⁶⁰ Lieutenant-colonel M. Aublet, “L’artillerie française de 1914 à 1918”, *Revue Militaire Française*, 97 (1929), 240.

¹⁶¹ Gudmundsson, “Learning from the Front,” 285.

¹⁶² Goya, “Le Processus d’Evolution Tactique de l’Armée Française de 1871 à 1918,” 300.

possessed sufficient shells, not because of its tactical effectiveness.¹⁶³ Although this clearly hampered the short-term fighting capabilities of the artillery, it was deemed necessary in the long-term for the overall war effort, as larger calibre shells could be preserved for when they were most needed, and the artillery would not run out of shells completely.

The high command also promoted the 58mm trench gun, particularly towards the end of 1915 when the number of heavy artillery pieces in the French army was still minimal. It took a similar approach with the 95mm and 58mm guns to the prioritising of shrapnel shells over explosive shells. The directives issued heavily emphasised their merits, claiming that they were suitable for almost all tasks, and should not be neglected in favour of higher calibre options. The 58mm was described as offering a 'large advantage', particularly effective due to its range of six hundred metres. It was also useful for inflicting losses on enemy soldiers trying to repair their trenches. Similarly, the 95mm was trumpeted as being able to meet the needs of heavy batteries in the day-to-day engagements of artillery.¹⁶⁴

Nevertheless, despite these attempts, the 58mm and 95mm guns would always represent a poor substitute for the 75mm field gun and for higher calibre guns such as the 120mm and 155mm. Thus, the lack of shells for both field and heavy artillery significantly constrained the army at the front.

The tactical consequences of using slow-firing, old-fashioned materiel were extremely detrimental to the attacking capabilities of the French army, adding to the problems of using unsuitable types of shell. Given a rate of fire around four times slower than modern

¹⁶³ SHAT 18 N 293, Note pour les Commandants de Groupes d'Armées, 15 November 1914, no. 8261.

¹⁶⁴ Ibid. Note pour le Commandant du Group d'Armée de l'Est, no. 626, 2 November 1915; *ibid.* Note pour les Commandants de Groupes d'Armées, no. 7474, 14 December 1915; *ibid.* Le Général de Division Dubail, Commandant le GAE au Général Commandant le 7e armée, no. 7096, 4 February 1916.

guns, commanders had a choice between surprise, without the support of artillery, or well-prepared attacks, which had to last several days in order to ensure a sufficient level of destruction. It was only in 1918 that the French army had the flexibility offered by modern materiel to use the same kind of sophisticated and audacious approach employed by the German army since 1915. The French had to rely on extremely methodical and centralised tactics that lacked the serendipity and subtlety of their German counterparts.¹⁶⁵

The sourcing of older models of artillery was entrusted to General Louis Baquet, *Directeur de l'Artillerie* at the Ministry of War, who prioritised certain pieces that were deemed superior in the front lines and expedited their transfer to the army. For instance, in September and October 1914, he pushed the 120mm de Bange model, sending two complete batteries to the front each week, before transitioning to favour the 155mm de Bange gun, which was subsequently deemed more suitable for static warfare. Nevertheless, although there existed some guidance and direction, the emphasis remained on finding artillery pieces wherever possible, and the extent to which Baquet's wishes penetrated to the local level is debateable.¹⁶⁶

The coordination of the artillery was haphazard in the early months of the war due to a lack of clear structure and delineation between the high command and the War Ministry. Artillery requests from army commanders arrived on the desk of General Joffre, who passed them on to the Minister of War, but the commander-in-chief's priorities fluctuated. On 10 September 1914, he prioritised requests for heavy guns, before three days later stressing the need for larger, more powerful coastal artillery for use against German fortifications. Nine days after this, concerns were raised about the attrition of the fragile recoil mechanisms possessed by Baquet and Rimmel howitzers, prompting a request for

¹⁶⁵ Goya, "Le Processus d'Évolution Tactique de l'Armée Française de 1871 à 1918," 300.

¹⁶⁶ Gudmundsson, "Learning from the Front," 286.

220mm siege howitzers, Filloux howitzers and Lahitolle guns, while also ordering as many 120mm de Bange heavy guns as possible for counter-battery fire. The Ministry of War accommodated most of these requests but it does not appear that Joffre had a clear grasp on the requirements of his armies and the use of artillery in the field. Either that, or he was simply trying to provide as many options and as many pieces of whatever type to the front to accommodate both the shortage in matériel and the deteriorating munitions situation. Ultimately, his army commanders were reluctant to take up the option of the Filloux and medium siege howitzers, declaring that they had little use for further howitzers and needed to prioritise heavy guns to combat the German heavy artillery. Most of the newly created howitzer batteries were therefore set aside in the reserve with heavy batteries transferred to the front instead.¹⁶⁷

The general shortage of heavy artillery had an interesting effect. Despite howitzers being more typically suited to trench warfare due to their high angle of fire, the overwhelming lack of heavy guns capable of matching those possessed by the German army and the need to provide counter-battery fire meant that, from August 1914 to the end of May 1915, the high command created roughly four and a half batteries of heavy guns for each howitzer battery formed, resulting in a decline in the ratio of howitzers at the front lines. This is a further example of the prioritisation of expediency and short-term needs over the longer-term tactical effectiveness of the army.

¹⁶⁷ Ibid., 288.

Table 1 Proportion of guns and howitzers in heavy artillery units, August 1914-May 1915

	August 1914	December 1914	May 1915
Howitzers	192	288	392
Heavy guns	120	729	1,020
Total Heavy pieces	312	1,017	1,332
Howitzers	62%	28%	29%

Source: Gudmundsson, "Learning from the Front", 292. The figures for guns and howitzers at the front are from Baquet, 122-3, and seem to reflect cumulative deliveries rather than an actual census, i.e. the figures do not seem to take into account pieces lost at the front.

The first orders for modern heavy howitzers were made in early spring 1915 and only began to be delivered to the front in May 1916. It took almost two years for France to amass a comparable number of pieces to those possessed by Germany in August 1914, and French artillery continued to employ significant numbers of out-dated heavy guns well into the last year of the war.¹⁶⁸

The second munitions crisis, prompted by poor quality shells exploding in the barrel upon firing (discussed in Chapter 6), accentuated the inferiority of French materiel compared to their German counterparts. By 15 May 1915, the artillery had lost a total of 1,700 75mm guns, and this number had doubled by 1 January 1916. Of these, 1,000 had been lost to counter-battery fire, 600 had exploded, 750 were out of action due to attrition and overuse, and a further 400 had been taken by the enemy or destroyed.

A decree passed on 5 August 1915 eased the situation somewhat by removing the autonomy of fortifications, particularly those in coastal regions, allowing the high command to recover four thousand heavy guns (mostly of the de Bange model). Still, these remained slow firing and cumbersome, and were far from ideal for the task required.¹⁶⁹

¹⁶⁸ Ibid., 294.

¹⁶⁹ Reboul, *Mobilisation industrielle*, 36.

Mounting and Maintaining Offensives

The shortage of munitions and materiel of all types persistently hampered the French army for the first two years of the war. Although the French army was limited in its offensive capabilities, the nature of trench warfare actually favoured it in its attempts to cope with the munitions crisis. The construction of stout defences allowed the front line to be held with fewer soldiers but also fewer munitions than were required for continuous attacks. The high command therefore attempted to preserve munitions to build up reserves for large offensives.¹⁷⁰ The key problem was, if it launched an attack, the reserves of munitions were such that they could 'neither repeat this effort, nor exploit it.'¹⁷¹

For instance, in the offensives launched at Flanders in autumn 1914, 'poor shell production led to the ending of the battle due to lack of munitions.'¹⁷² However, strategic necessity dictated that Joffre could not forego all attacks and he ordered four more offensives for the Sixth Army between 1 and 15 November. Inevitably, he was only able to provide a pitiful allocation of munitions, and the efforts resulted in failure.¹⁷³ This continued into 1915, with General Foch attributing the failure of the attacks on 9 May to insufficient shells, meaning the French artillery was overwhelmed by the more numerous and more rapidly firing German artillery: 'In the face of the enemy's increasingly numerous rapid-firing heavy artillery, abundantly supplied in munitions that it can fire without worry, we can offer up only a slow-firing heavy artillery that is scarcely equivalent in number and is restricted in the number of shells it can fire.'¹⁷⁴ Even in September 1915 the French stocks of munitions were still too low for anything but a limited offensive. Foch could not foresee achieving

¹⁷⁰ AFGG, 14, 394, Telegram to the armies, 24 September 1914.

¹⁷¹ Ibid., 211–127, 149, Note no. 3669, 16 November 1914.

¹⁷² Jean-Claude Mauffré, *Un Aspect de La Mobilisation Industrielle Au Cours de La Première Guerre Mondiale: La Fabrication Des Obus En France* (Paris: U.E.R., 1970), 19.

¹⁷³ Ibid.

¹⁷⁴ Daille, *Histoire de la guerre mondiale*, 126; Koeltz, *La Guerre de 1914-1918*, 233.

success without large quantities of munitions, and the attack in Champagne was a failure and called off after four days.¹⁷⁵

The French official history of the war claimed that ‘the inevitable consequence of the rationing of munitions was the halting of all offensive operations,’ with the armies ‘restricted to a purely passive approach.’ It makes clear that ‘the stabilisation [of the Western Front] was the result of the lack of munitions.’¹⁷⁶ While in theory a lack of munitions did not necessarily mean that attacks could not be launched or be successful, when taken in the context of the relative inexperience of French generals in the tactical requirements of trench warfare, it is easy to see how the French high command reached the conclusion that large quantities of munitions were required for success on the battlefield. Later, once lessons had been learned from both successful and failed offensives from both sides, more creative attacks were tried, such as offensives without a preparatory bombardment, but such thinking was improbable so early in the war.

The general staff particularly felt the shell shortages at an operational level. Following the emergence of static warfare, the initial strategy of the French army was to achieve a *percée* or ‘breakthrough’. However, with a limited supply of shells, Joffre ‘did not anticipate breaking through German lines until he acquired sufficient heavy artillery and ammunition.’¹⁷⁷ General Gamelin was similarly frustrated, lamenting the fact that the army ‘did not have the munitions or the heavy artillery necessary to undertake operations’ for a breakthrough on even a small sector of front.¹⁷⁸

¹⁷⁵ AFGG, 34–3056, 212, Foch to Joffre, 6 November 1915; Griffiths, *Marshal Pétain*, 15.

¹⁷⁶ AFGG, 21, 13.

¹⁷⁷ Doughty, *Pyrrhic Victory*, 2005, 112.

¹⁷⁸ Maurice Gustave Gamelin, *Manoeuvre et victoire de la Marne* (Paris: Grasset, 1954), 308.

During the course of operations, stocks were exhausted and there was a delay while they were replenished once again, with the front lines restricted to holding their positions with minimal resources.¹⁷⁹ The report, issued after the Flanders offensive on 29 November 1914, stated that the army should not mount an attack unless it possessed four to five hundred shells per piece and production reached 50,000 shells per day. Until then, 'it should content itself with small operations, such as those at Ypres and in the Vosges region.'¹⁸⁰ Thus, the state of shell supply continually hampered the ability of the high command to launch attacks, resulting in a protracted strategy that offered little hope of success in the short-term, despite the persistent hopes of the generals that the next offensive would return the war to one of manoeuvre.¹⁸¹ This approach slowed down the ability of the high command to learn lessons from experiences at the front lines. The longer the gap between offensives, the fewer attempts were made to experiment with different tactics, with the result that it inevitably took more time before adequate information could be gathered on which methods proved effective. If the army learnt through trial and error, restricting the number of trials limited its capacity to improve.

The stop-start nature of offensives characterised French strategy for almost the entirety of the war, with freedom to act only emerging from mid-1917 onwards. Even then, as will be seen, the army called for larger and larger quantities of shells that still took considerable time to amass. As a result, the length of time between operations did not change significantly, but the scale and intensity of attacks increased dramatically.¹⁸² Even in September 1916, Colonel Mouchon declared that, for future attacks, the French should wait until all the means necessary for an attack were in place, particularly stressing the

¹⁷⁹ AFGG, 14, 394, Note, 27 September 1914.

¹⁸⁰ Ibid., 211–227, 294, Note sur les conditions d'un mouvement d'offensive générale, 29 November 1914.

¹⁸¹ Ibid., 33–2935, 1214, Le Général Commandant en Chef au général Foch, no. 8034, 14 October 1915; Griffiths, *Marshal Pétain*, 1970, 10.

¹⁸² AFGG, 512–196, 330, Commander of the Fifth Army to GAC, 13 May 1917.

need for 'the constant and unlimited influx of munitions.'¹⁸³ Furthermore, Joffre recognised that, although density of artillery fire was crucial to tactical success, the number of artillery pieces that could be put into battle was constrained by the number of shells available, not least because the stocks of 155mm and 75mm shells had been significantly reduced by the battles of September 1915.¹⁸⁴ This was a key consideration in deciding the date of the Somme offensive, as the high command believed that industrial output would be sufficient to supply all the necessary artillery only by June 1916.¹⁸⁵

Overall, the lack of preparation for the war, the underestimation of the materiel requirements and the consequent shortage of munitions had a serious effect on the military effectiveness of the army throughout 1914 and 1915. The army struggled to maintain an active presence at the front that could cope with the requirements of day-to-day combat, while its offensive capabilities were shackled, as the artillery did not possess sufficient munitions to mount attacks. Even when the army did launch operations, they were often cut short or hampered by the shortage of shells.

Tactical improvements

One positive that emerged from the shell crisis of the early months of the war was that artillery officers increasingly focused on tactics, particularly on accuracy, as they recognised that the paucity of shells required maximising the effect of each shot that was fired. Artillery fire at the start of the war was often wasteful and generally unregulated partly due to a lack of training and unfamiliarity with the requirements of the war. Joffre lamented the tendency of the artillery to exhaust supplies on 'undefined objectives.' The artillery

¹⁸³ SHAT 18 N 272, Colonel Mouchon, De l'Offensive, September 1916.

¹⁸⁴ AFGG, 4, 73.

¹⁸⁵ Ibid., 4, 74, GQG Note du 3e Bureau pour la D.A., 19 January 1916.

recognised the merits of continual fire, harassing the German soldiers and wearing down their morale, but the army could not afford to expend their daily stocks of shells for no concrete gain. The artillery corps' misplaced belief that they had to use up their daily allocation meant that the army struggled to conserve and accumulate shells for future offensives.¹⁸⁶

The high command therefore issued a number of directives, often accompanying those detailing the munitions restrictions, calling for improved regulation of artillery fire. The clearest example was a note issued to all armies on 22 September 1914 prohibiting 'bombardments without a defined goal' or that failed 'to facilitate the progression of the infantry.'¹⁸⁷ Joffre reiterated this order two days later in a telegram specifying that, to ensure accuracy, the artillery should only fire on observable targets.¹⁸⁸ This was difficult in the First World War because the range of heavy artillery had extended the depth of the battlefield to such an extent that batteries were often located a number of kilometres behind the front lines, while reverse slope positions further hindered the ability to pinpoint a target. The artillery responded by placing observers with the infantry in order to observe fire, while later in the war, as the aviation industry expanded, control of the skies played a key role in improving targeting, but precise measurements remained a challenge. The need to conserve munitions influenced tactics in a positive manner, as fewer shells were wasted and accuracy was improved.¹⁸⁹

Maximising the effectiveness of artillery fire became a key theme in the first two years of the war when the munitions crisis was at its most severe. With supplies of shells further reduced following the Champagne offensive during the winter of 1914-15, Joffre called for

¹⁸⁶ SHAT 16 N 696, Note pour les Armées, no. 1.647, 5 February 1915.

¹⁸⁷ AFGG, 14, 393, Note aux armées, 22 September 1914.

¹⁸⁸ Ibid., 14, 393, Télégramme chiffré aux armées, no. 6999, 24 September 1914.

¹⁸⁹ Porch, *The March to the Marne*, 234.

artillerymen to save munitions through strict discipline of fire, concentrating on key points on the front such as communication trenches, machinegun posts and dugouts.¹⁹⁰ These orders were issued explicitly 'to avoid wasting munitions.'¹⁹¹ Throughout the war, the high command continued to clamp down on poor use of artillery to ensure accuracy of fire so that shells were not needlessly wasted.¹⁹² By focusing artillery fire on key objectives, as well as ensuring that accuracy was improved by firing on observable targets, the effectiveness of the artillery was significantly increased. It is unlikely that this would have happened so swiftly had it not been for the catalyst of the munitions crisis.

Ultimately, all efforts at the front lines to limit consumption were stopgaps until industry could match demand. However, this would take considerable time, even if the problems were recognised early. Millerand quickly realised that 'no provisions had been made for what was now required' and that the army 'had never believed that such consumption of munitions would ever have been possible or necessary.'¹⁹³ France would require a rapid mobilisation of industry in order to meet the demands of the front line. If it did not mobilise quickly enough, Germany might be able to overwhelm the army with matériel. Before turning to the mobilisation and development of industry, however, it is necessary to explore the lessons learnt from the early months of the war that influenced the direction and focus on the industrial effort.

¹⁹⁰ AFGG, 3, 613.

¹⁹¹ Edmond Dubail, *Quatre années de commandement, 1914-1918* (Paris: Fournier, 1920), 139.

¹⁹² SHAT 18 N 293, Le Général Commandant en Chef au Général Commandant le G.A.E., no. 9505, 15 January 1916.

¹⁹³ Herbillon, *Souvenirs*, 56.

Tactical Realisations

After the initial shock of the early battles of the war, a rapid rethink of the tactical approach and the materiel needs of the army was needed. The major developments occurred in the confirmation of the need for heavy artillery and recognition of the merits of certain shells. Over time, the role of artillery in battle evolved and became more sophisticated, with differing types of gun performing more distinct roles.¹⁹⁴

As seen in the previous chapter, a growing body of military thinkers was already pressing the merits of heavy artillery in the years before the outbreak of war, but they had struggled to make headway against the *soixantequinzeboutistes* and Parliament. The strength and destructive power of the German heavy guns, which outranged the French field guns and therefore established dominance on the battlefield, laid the evidence bare for all to see. While the army was able to survive with the stopgap solution of using out-dated models recruited from the interior, it desperately needed modern heavy artillery if it was to be effective on the front lines.

Philippe Pétain, a vocal pre-war advocate of heavy artillery, was vindicated by the early lessons. In his view, 'the battle of Champagne shows us the difficulty, if not the impossibility of carrying in one rush the successive enemy positions in the present state of armaments.'¹⁹⁵ He declared, 'the *sine qua non* of an attack is the possession of a heavy artillery of all calibres in the largest numbers possible.'¹⁹⁶ Similarly, General Weygand believed, 'the supply of heavy artillery dominates the outcome of our attacks.'¹⁹⁷ Finally, General Herr argued that the events of 1915 showed that, 'to succeed, we must deploy a

¹⁹⁴ This will be discussed in greater depth in Chapter 7.

¹⁹⁵ Quoted in Laure, 49; Griffiths, *Marshal Pétain*, 15.

¹⁹⁶ Pedroncini, *Pétain*, 88.

¹⁹⁷ Weygand, *Mémoires*, 296.

large artillery comprising matériel suitable for all the tasks foreseen, it must be well supplied with munitions, and the shells should be used carefully, according to a well-thought out plan and not according to the whim of the moment.¹⁹⁸

It was not simply the firepower of heavier calibres or the difference in trajectory of howitzers that made them superior. A study conducted in 1916 in America clearly showed that howitzers were also far more accurate than field guns for firing on fixed positions as in trench warfare. Over a range of three thousand metres, an average of two and a half field gun shells was required to achieve a similar probability of hit as one howitzer shell.¹⁹⁹

On 14 September 1914, therefore, Joffre demanded an increase in heavy artillery. In particular, he requested the organisation of siege artillery capable of firing at a range of at least twelve thousand metres, along with the creation of a sizeable ALGP (*Artillerie Lourde à Grande Puissance*), which were very large calibre, long-range artillery, similar to that used by the German army in the destruction of the forts at Metz. Both would take considerable time to produce, and the latter in particular required lengthy testing before orders could be made. It was only on 25 January 1915 that 24 190mm guns were ordered after trials had proven satisfactory.

Production was painfully slow. While the Ministry of War was keen to push the production of heavy artillery, industry was orientated towards the production of 75mm field guns and particularly 75mm munitions. The paucity of munitions for heavy artillery meant that there was little merit in producing larger artillery pieces if the shells were not available to supply

¹⁹⁸ Frédéric Georges Herr, *L'artillerie: ce qu'elle a été, ce qu'elle est, ce qu'elle doit être* (Paris: Berger-Levrault, 1923), 40. Weygand and Herr's accounts were both written after the war and therefore are potentially biased in favour of demonstrating their own foresight. However, they are both critically written with a very objective approach.

¹⁹⁹ Bruce I. Gudmundsson, *On Artillery* (Westport, Conn: Praeger, 1993), 30.

them. It was only once 75mm field gun production was up to speed that the Ministry of War began to think about the production of heavier models. Until then, quantity was prioritised over quality.²⁰⁰

The production of larger calibres began in spring 1915 but was limited to areas in which factories had experience, such as that of 105mm guns, 155mm LTR and 280mm mortars.²⁰¹ Joffre continued to push for increased heavy artillery. In May 1915, he demanded pieces with a range that could continue to support the advancing infantry without having to move forward. In July, the French army possessed 4,646 light artillery pieces (3,049 75mm and 1,597 90mm) and 3,538 heavy artillery pieces, of which only 2,033 long-range 105mm, 120mm and 155mm pieces were deemed adequate. Joffre wanted as many 120mm and 155mm pieces as 75mm guns. Joffre also stressed once more the need for ALGP, of which France possessed just one 305mm and twelve 190mm guns, mounted on railway platforms in July 1915.²⁰² Finally, in August 1915 after further failures in attacks during the summer, Joffre requested the production of more than five hundred heavy artillery batteries.²⁰³

With regard to munitions, the high command initially struggled to assess the needs of the army accurately as demonstrated by the ever-changing requests. On 17 September 1914, it requested that production of 75mm shells rise to 40,000 a day, but this was subsequently increased to 80,000 and then 100,000 just weeks later, as the scale of warfare overwhelmed the French.²⁰⁴

²⁰⁰ Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, ii, 15–16.

²⁰¹ Reboul, *Mobilisation industrielle*, 45–46.

²⁰² Doughty, *Pyrrhic Victory*, 175.

²⁰³ Carls, *Louis Loucheur*, 15.

²⁰⁴ Reboul, *Mobilisation industrielle*, 18.

The type of shells was important. It was apparent that shrapnel was ineffective for the destruction of defences and that the army should prioritise high explosive shells. According to General Baquet, it was not just their destructive capacity but also ‘the effect on morale produced by the detonation of German explosive shells that had discredited the shrapnel shells... the explosion was less terrifying. Shrapnel was classed as “dead weight”.’²⁰⁵ Thus, on 17 August, the general staff decided to focus production only on explosive 75mm shells.²⁰⁶ By December 1914, industry was producing seven times more explosive shells than shrapnel shells, but even with the low level of demand, it would take until October 1915 for industry to be able to match the army’s shrapnel needs.²⁰⁷

The Ministry of War’s Response

The matériel requirements of the war were clear to all, but having begun to appreciate where these matériel deficiencies and requirements lay, Joffre saw that the army would have to work in close contact with the home front to fulfil its needs: ‘The high command quickly understood that the military offensive was inseparable from the economic offensive, and that to achieve the greatest output possible from the latter, it was necessary that the high command was involved in it.’²⁰⁸ The responsibility for production therefore passed to the Ministry of War, which acted as an intermediary between the army and industry, tasked with the coordination of the mobilisation effort. It would need to draw on all the resources of the nation to match the demands of the army at the front lines and provide it with the means to defeat the German army.

²⁰⁵ Baquet, *Souvenirs*, 69.

²⁰⁶ AN 94 AP 84, Résumé des mesures prises par le Service de l’Artillerie depuis l’ouverture des hostilités, 11 December 1914, 9.

²⁰⁷ Reboul, *Mobilisation industrielle*, 27.

²⁰⁸ SHAT 7 N 883, Organisation des services de renseignements et d’études pour la guerre économique au ministère de la Guerre”, 1 May 1918.

The lack of pre-war preparation meant that the Ministry of War encountered severe problems when it sought to do this.²⁰⁹ Hasty attempts to increase output resulted in a deterioration of quality that had disastrous consequences once shells arrived at the front. Furthermore, the reliance on private industry meant financial interests and capitalist considerations complicated negotiations, as industrialists sought to maximise their profits in spite of the needs of the nation. The response of the Ministry of War in the first two years of the war was *ad hoc* and rushed, as it sought to improve output by whatever means. It underwent a number of administrative and organisational changes in order to adapt to the requirements of mobilising industry for war production, while seeking to manage private industry and respond to the problems and difficulties that arose throughout the war.

The initial decisions fell to the bureaucrats at the Ministry of Commerce and the Ministry of War. The Ministries were run along similar lines, divided into departments (*directions* or *services*), which were subsequently split into *bureaux*. In 1913, the Ministry of War contained 174 people, including the general staff of the army and military inspectors, although only ten had direct involvement in industrial issues. There were five men in the artillery and military equipment section who oversaw the arsenals, forges, foundries, workshops and general production, as well as a permanent inspector of artillery production and an inspector of artillery experiments and trials.²¹⁰ The vast burden of industrial management fell on this rather small number of men. Their pre-war functions were poor preparation for the tasks that they would face from August onwards. Furthermore, the civil service did not attract the finest intellectual minds of the country and those that did enter ministerial offices tended to avoid the Ministries of Commerce and War. Indeed, it is

²⁰⁹ Hardach, "La mobilisation industrielle", 82; Fontaine, *French Industry*, 282.

²¹⁰ This was roughly a quarter of the size of the German general staff on the eve of war. Godfrey, *Capitalism at War*, 6; Arden Bucholz, *Moltke, Schlieffen, and Prussian War Planning* (New York; Oxford: Berg, 1991).

difficult to explore these individuals in too much depth, as they would only represent a fraction of the wartime bureaucrats, due to the rapid expansion at the ministries to cope with demand.²¹¹

Mobilisation

Although all nations were caught off guard by the industrial requirements of fighting in the First World War, French industry was in a particular state of disarray.²¹² Not only was it unprepared for production on the scale required, but it also suffered significant territorial losses following the German invasion of ten of the eighty-seven *départements* of France. The government lost not just the productive capacity of the regions, but also its taxable income while the occupied territory was one of the most productive areas of France for both industry and agriculture. It was responsible for 20 percent of 1913 wheat production, 25 percent of oats, 12 percent of potatoes, and 50 percent of sugar beet. The population of the areas invaded was estimated to be 3,733,666 in 1906, which was approximately 9.6 percent of the total population of France. Of these, 990,110 were engaged in industry, and therefore France lost 14 percent of its total industrial population of 7,058,580. In terms of area, approximately 32,000 square kilometres, or around 6 percent of the total French territory, was occupied by Germany, although the area affected by the war can be judged to be around 8 or 9 percent.²¹³

Most important, however, was the loss of industrial production: 80 percent of steel, 43 percent of electricity, 55 percent of coal and 90 percent of iron ore which translated to an industrial loss of 64 percent of its cast iron output, 62 percent of its steel output, and half of

²¹¹ Godfrey, *Capitalism at War*, 8.

²¹² Adams, *Arms and the Wizard*, 2.

²¹³ Fontaine, *French Industry*, 4.

its coal output.²¹⁴ As a result, France imported more than a quarter of its iron and a third of its coal from 1916 until the end of the war.²¹⁵ This immediately put industry at a disadvantage, struggling to meet the factories' demands for raw materials. The most serious effect of these losses was on the availability of iron and steel, which were vital for the production of shell casings. Iron production in January 1915 was at just 25 percent of pre-war levels, at around 1,100,000 tons.²¹⁶ However, by 1917, coal production had recovered to 71 percent of pre-war levels and steel production to 42 percent.²¹⁷

Stages of mobilisation

Reboul identifies three distinct phases of industrial mobilisation during the First World War. First, the period from the outbreak of war until spring 1915 was characterised by widespread dispersion in the division of work. The emphasis was simply on finding industrialists and factories to help the war effort, whatever the cost: 'we did not worry about cost prices or about deadlines. During this period, 25,000 factories from various backgrounds worked for national defence.'²¹⁸ From spring 1915 to the end of 1916, there was a reduction in the number of smaller factories and workshops and an increase in the machinery and capacities of those capable of high levels of output. As a result, the number of factories employed fell from 25,000 to around 20,000. Finally, the period from 1917 until the end of the war saw the emergence of large factories specialising in one area or product, resulting in a further reduction in the number of factories employed in the war effort, with the figure falling to around 15,000.²¹⁹

²¹⁴ Jèze, *The War Finance of France*, 189.

²¹⁵ Hautcoeur, "Was the Great War a Watershed?," 172–3.

²¹⁶ Mauffré, *La Mobilisation Industrielle*, 45.

²¹⁷ Ferguson, *The Pity of War*, 250.

²¹⁸ Reboul, *Mobilisation industrielle*, 158.

²¹⁹ *Ibid.*, 158–9; Munitions Ministry of, *History of the Ministry of Munitions*. Vol. 1/3, 104, Moir Report, April 1915.

Porte similarly outlines three stages of development but characterises them slightly differently. He sees the first period until spring 1915 as a time of hesitations, discussions, disputes and improvisation. During the subsequent two years, experience and understanding grew, fuelled by creative initiative, empiricism and analysis, while from 1917 onwards the creation of the hegemonic Ministry of Armaments allowed for increased planning and the rationalisation of resources. As a result, the measures and changes introduced over the previous two years began to bear fruit but only by summer 1918.²²⁰

In reality, one can view the first two years of the war as a scramble to improve output figures as rapidly as possible despite long lead times as factories converted to war production. With the state arsenals limited in their capacities, and few private industrialists specialising in armaments manufacture, the Ministry of War called upon smaller industrialists and those with any experience in metallurgy. However, it estimated that it would take between six and eighteen months for these firms to install and set up the required machinery and production processes before output could attain the desired levels.²²¹ Although the army was aware of the difficulties involved, the high command was still surprised and disappointed at the time taken for the rear to supply the armies.²²²

President Poincaré's response to the German invasion of Belgium was to declare a state of siege on 2 August 1914. The Chamber of Deputies and the Senate ratified this on 4 August, thus legalising the total mobilisation of the army and ceding control of the direction of the war to the government and the army, with Parliament adjourned indefinitely. Without Parliament, the government and the Ministry of War operated through executive decree,

²²⁰ Rémy Porte, "Mobilisation industrielle et guerre totale: 1916, année charnière", *Revue historique des armées*, 242 (2006), 6.

²²¹ Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, ii, 29–30.

²²² Reboul, *Mobilisation industrielle*, 54.

free of supervision or criticism. 'The powers of the French government to December 1914 were theoretically limitless.' The state of siege triggered two laws (9 August 1849 and 3 April 1878) allowing the suspension of individual liberties, the requisitioning of arms, munitions and other forms of private property, and the censorship of publications, although at this time there was no law permitting requisition for civilian needs. However, the expectation that the war would be brief meant that many areas, such as the extent to which ministers could act without recourse to Parliament and how the home front economy should be managed with respect to both war production and civilian production, were left unresolved.²²³

Although the idea of a short war appears to have had a large influence on pre-war planning, the governmental response once the conflict broke out suggests that those in power were very aware of the potential requirements. On 2 August 1914, the Ministry of War amended the law of 1877 covering the requisitioning of industrial establishments by the military to define the process in which it could be applied in far greater detail. Although Millerand and subsequently Albert Thomas sought to avoid recourse to such an approach, this action implies that the government was considering its necessity.²²⁴

Politics and Ideology

Although the response to the requirements of war was *ad hoc*, many have tried to impose an ideology on the process, and there are some underlying trends. The state's approach to managing the economy was rooted in adherence to French Revolutionary legislation and Napoleonic Codes, and the belief that it was the state's legal obligation to maintain a free market economy. Colbertism, the doctrine of state intervention in the economy so that the

²²³ Godfrey, *Capitalism at War*, 44.

²²⁴ *Ibid.*, 45–6.

wealth of France served the nation, was not widely followed. The government failed to appreciate that 'capitalism in war was not the same... as capitalism in peace.'²²⁵

The ideological foundations of the French nation complicated the mobilisation process, as numerous interest groups had to be accommodated and considered with every action taken. Legislation on state intervention in industry, including the taxation of war profits and management of manpower, was particularly difficult to achieve and was only agreed upon in 1917. Despite the *union sacrée*, France was politically fragile throughout the war and was already on its third ministry by 1916. It was difficult for one man to establish strong control until Clemenceau did so in 1918, and political parties fought to exert their influence on proceedings. Furthermore, there was tension between the Ministry of War and the French high command, as politicians blamed the generals for the lack of success on the battlefield, while Joffre sought to take on the politicians rather than focus on events at the front.²²⁶

In the initial phases of the war, the state remained reluctant to intervene greatly in the economy, with Alexandre Millerand and subsequently Albert Thomas shying away from requisitions. 'That the state was drawn more and more deeply into economic matters was imposed by necessity and accepted with some reluctance.'²²⁷ Thomas recognised that, 'in the haste of our daily activities, we do not have time to stop and reflect as much as we would like about the basic philosophy behind our actions.'²²⁸ As the pressures of war grew, the government had to take increasing steps to centralise control of resources and to manage the economy, but Kemp argues that while 'this was the sheer logic of modern

²²⁵ Kemp, *Economic Forces in French History*, 33.

²²⁶ Philpott, *Bloody Victory*, 138–9.

²²⁷ Kemp, *Economic Forces in French History*, 34.

²²⁸ Cited in A. Hennebicque, "Albert Thomas and the War Industries" in Fridenson (ed.), *The French Home Front, 1914-1918*, 89.

warfare... it was certainly not envisaged or planned beforehand, nor was it much reflected upon at the time.²²⁹

Turning to Private Industry

Adolphe Messimy, Minister of War at the start of the war, recognised the need to resort to private industry to bolster production almost immediately, as the state-owned arsenals were unable to match demand. The state employed 38,000 workers in armaments production, with 12,500 employed privately. However, before the war, state arsenals were producing relatively little and even rented out factory space to private industry, which sold armaments abroad. As a result, they lagged behind in terms of quality and modernisation, while even their administration and record keeping were haphazard and at best inconsistent. It was this out-dated structure that the Ministry of War had to rely upon to produce the vast levels of output required by the army.²³⁰

Messimy made the decision to turn to the private sector on 1 August 1914, before the armies had even met on the battlefield.²³¹ Mobilisation had barely begun by this point, and therefore Messimy's response indicates that the shortfalls in the supply of the army and the need to rely on industry were immediately apparent. The speed of his action demonstrates not only the known inadequacies of French state arsenals but also that the peacetime arguments against such action, such as financial cost, were no longer deemed important.²³²

The first priority was to formulate a better overview of the situation. One of Messimy's first acts was a decree of 6 August 1914 creating a commission charged to gather information

²²⁹ Kemp, *Economic Forces in French History*, 34.

²³⁰ Godfrey, *Capitalism at War*, 2.

²³¹ AFGG, 211, 3. Note pour la direction de l'artillerie, 1 August 1914.

²³² Millett and Murray, *Military Effectiveness*, 195.

concerning the available industrial resources both inside and outside France.²³³ The lack of information that the government possessed about the state of its nation's industry further illustrates the lack of preparation for an extensive war production effort.

Role of the *Comité des Forges*

As the government was inexperienced in organising industry on such a large scale, it turned to the *Comité des Forges*, the metallurgy union, to aid with the management of industrialists and to bring structure to the mobilisation effort. Led by Robert Pinot, who saw the opportunity to strengthen the union's position within the industry, 'the *Comité des Forges* acted as a monopoly in the state's name.'²³⁴ Pinot stressed that it was at the disposition of all industrialists to act as an intermediary with the Ministry of War, and to pursue the realisation of their demands.²³⁵

The *Comité des Forges* was founded in 1864 with two purposes: to maintain order among the metallurgical manufacturers and to defend the interests of industrialists, either against consumers or against the state. At first, it represented a simple means for distributing information, keeping prices uniform and products of a similar standard. By 1884, it represented three-quarters of France's iron and steel producers. The *Comité* expanded dramatically under the leadership of Robert Pinot in the years before the war, incorporating mining, railways, ship building and munitions industries, and it worked hard to oppose social legislation, pushed by Alexandre Millerand, such as a minimum wage, limitations on working hours, guidelines on safety restrictions and the establishment of workers' representative groups. In summer 1914, the *Comité des Forges* counted 238 members,

²³³ Emmanuelle Braud, "Le renseignement économique militaire en France à partir de 1916", *Revue historique des armées*, 242 (2006), 7.

²³⁴ Kuisel, *Capitalism and the State*, 35.

²³⁵ SHAT 10 N 29, Réunion des Industriels fabricant de gros obus en fonte aciérée, 25 June 1915.

although this was by no means all of the metallurgists of France. Indeed, it saw the war as an opportunity to squeeze out the smaller, independent producers. Godfrey argues that the *Comité des Forges*, and the high level of organisation and structure that it entailed, was one of the major strengths of French industry on the eve of the war and was vital to its recovery during the war. The dislocation caused by the war did threaten the balance of power by creating and reviving geographical rivalries. However, it was clear that the industrialists held the upper hand when dealing with the state and would manipulate this position for financial gain as much as possible.²³⁶

On 23 August 1914, the *Comité des Forges* was given freedom to organise its members' productive capacities, to distribute and coordinate contracts, to allocate manpower and to explore avenues for further expansion. Its primary role in the early months of the war was to coordinate the import of raw materials until the domestic coal and steel industries could recover to a sufficient level. Industrialists who had lost factories to the invasion were encouraged to relocate and start up production within central France. Renault recalled the cooperation and coordination facilitated by the *Comité* in a post-war speech to the *Chambre syndicale des constructeurs d'automobiles*: 'Do you remember our first meetings with the *Comité des Forges*? How we felt like we were together, united! Our factories seemed to have become one. There were no more secrets, no divisions between our firms.'²³⁷ Pinot remembered the *Comité's* performance through particularly rose-tinted glasses, writing after the war, 'whatever the *Comité des Forges* was called upon to do, it did with all the heart, all the zeal, all the intelligences that its directors and its associates could

²³⁶ Godfrey, *Capitalism at War*, 18–9.

²³⁷ Speech by L. Renault, 1919, cited in Fridenson, *Histoire Des Usines Renault*, 92.

muster. The only condition that it made, from the first day, was that it would accept no reward. The only honour that it asked for was the privilege to serve voluntarily.²³⁸

In reality, however, the *Comité des Forges* benefited in a number of ways. Pinot sought to use the war to his members' advantage by assigning contracts to as many factories as possible to ensure that they maintained at least some of their workforce. The *Comité des Forges* expanded rapidly, particularly in terms of its administrative structure, and thus made itself essential to the government.

Unlike the organisation in Britain France continued to view private armaments manufacturers almost as competitors. Albert Thomas, the *Sous-Secrétariat d'Etat de l'Artillerie et des Munitions*, was wary of the power of the *Comité des Forges* and sought to maintain the Ministry of War's own links with industrialists. He produced the *Bulletin des usines de guerre*, which provided information on armaments policy, production methods, and labour relations to industrialists without having to go through the intermediary of the *Comité*. He feared becoming 'entirely subordinate to the *Comité des Forges*.... It is quite capable of forwarding only that information which conforms to its own views.'²³⁹

The Ministry of War had taken the expedient option. Due to the level of inexperience of government bureaucrats in industry and economic mobilisation, turning to the *Comité des Forges* in the early weeks of the war made sense to recruit those who were experienced, and as a structure for the management of the metallurgical industry was already in place. Later in the war, the Ministry of War sought to reassert its own control over production, but 'the *Comité des Forges* had become so firmly entrenched as an integral part of the

²³⁸ Robert Pinot, *Le Comité Des Forges de France Au Service de La Nation* (Paris: Armand Colin, 1919), vii.

²³⁹ Memorandum to Industrialists, cited in Hardach, "Industrial Mobilization in 1914-1918: Production, Planning and Ideology."

machinery for supplying... arms... that it could not be uprooted without causing serious disruption to the war effort.' '[It] became a private consortium, free of state interference, a metals trust controlled by industrialists but financed by the state through loans and advances.'²⁴⁰

While the Ministry of War may have foreseen the subsequent problems that would arise further down the line, the priority was to get industry up and running as quickly as possible. Therefore it is difficult to blame its decision, although perhaps, with hindsight, a greater level of control over the situation could have been established early on in order to maintain government involvement.

The lack of an administrative structure to deal with the pressures of mobilisation was a feature of the first two years of the war. When an order arrived from the French high command for the delivery of matériel, 'a veritable system of converging industrial systems was set in motion, of which each constituent element was critical.'²⁴¹ Even the construction of a single shell entailed numerous complications. The raw materials had to be sourced, refined and transported to the manufacturers. These in turn required constituent parts from sub-contractors, powder and explosives, and the necessary machines to produce the shell casings, before these were subsequently filled and finished. This all required coordination, management, supervision and regulation. Consequently, the industrial effort became a mélange of boards, committees and commissions, with 291 in existence by the end of the war, in order to cover and coordinate all aspects of the mobilisation and production process.

²⁴⁰ Godfrey, *Capitalism at War*, 49–50, 221.

²⁴¹ Porte, *La mobilisation industrielle*, 83.

The main reason for the complicated structure was that the majority of the new offices and commissions for the management of industrial production had to be created from scratch and it was difficult in 1914 to foresee the direction and the multitude of requirements necessary to ensure the smooth running of the system. As a result, further complications arose as committees, sub-commissions and branches of offices developed, were transformed, changed their names and were amalgamated and split up on a frequent basis: 'the successive strata weighed down the overall structure.'²⁴²

The proliferation of committees and the ever-expanding levels of bureaucracy have been viewed as symptomatic of 'the inefficient and expensive way of making war' adopted by the French, but this must be viewed in context. Given the overwhelming nature of the First World War, it was inevitable that mobilisation would not run smoothly.²⁴³ Moreover, the French administrative structure would be the envy of the British. By April 1915, around half of 75mm shells were being produced by firms new to munitions work, the workforce was strictly regulated, strikes were rare and absenteeism even rarer.²⁴⁴ Compared to Britain, France mobilised its industry much sooner and more effectively, motivated by the need to defend its country.²⁴⁵

Before the wholesale recruitment of private industry, key industrialists met with the Ministry of War to explore the possibility of aiding the industrial effort. For instance, Louis Renault met Messimy on 14 August 1914, 'to see if it was possible to produce forged shells in the Parisian factories.' When he arrived, Renault found Messimy pacing back and forth,

²⁴² Ibid.

²⁴³ Millett and Murray, (eds.), *Military Effectiveness* (Boston: Unwin Hyman, 1988), 197.

²⁴⁴ Elizabeth Greenhalgh, "Errors and Omissions in Franco-British Co-Operation over Munitions Production, 1914-1918", *War in History*, 14 (2007), 188.

²⁴⁵ Ibid., 215; Hardach, "La Mobilisation Industrielle", 103-4.

holding his head in his hands, saying, 'we need shells, we need shells.'²⁴⁶ On 21 August, Renault and other industrialists visited the state factories at Bourges and the Schneider works to explore how 75mm shells were being produced and on 1 September, the *Directeur de la Section Technique de l'Artillerie* began to provide those who would work on or study artillery production with all the information currently available on its processes. The initial forecasts were for around 25,000 75mm shells per day, almost double that which had been foreseen in the mobilisation plan. This was helped by the fact that the *Service des Poudres* abandoned the production that had been destined for the navy and was therefore able to assure the needs of the army.

The pivotal moment came on 20 September when Alexandre Millerand, who had replaced Messimy as Minister of War on 26 August, united the major French industrialists, along with bankers and representatives of the railway companies at a conference in Bordeaux, to discuss the reorganisation of shell production towards the target of producing a hundred thousand 75mm shells per day. All factories that were employed with metalwork in any way were recruited, enticed by large contracts from the government.²⁴⁷ He stated, 'under the fire of the enemy, we are mobilising private industry.'²⁴⁸ The task was daunting. German industry dwarfed that of France. France's largest metallurgical firm, Le Creusot, owned by Schneider et Cie, had a capital worth of 27 million francs in 1912 in comparison to the Krupp factories of Germany that were valued at 225 million francs.²⁴⁹ Still, by recruiting a wide variety of firms and factories that might be converted to war production, the Ministry of War pursued quantity over quality in the hope of redressing the balance.

²⁴⁶ AN 94 AP 237, Letter from Renault to Thomas, 31 December 1918, cited in Fridenson, *Histoire Des Usines Renault*, 89.

²⁴⁷ Hardach, "Industrial Mobilization," 59.

²⁴⁸ SHAT 6 N 16, Rapport fait à la Commission de l'Armée sur les Munitions, par A. Gervais, Sénateur, adopté par la Commission, 29 March 1915, 6-7.

²⁴⁹ Godfrey, *Capitalism at War*, 257.

Millerand created nine regional groups of industrialists to which shell orders would be distributed, presided over by an industrial director: Région Parisienne (Groupe Renault); Creusot; Saint-Chamond; Basse-Loire; Chemins de fer de l'Etat, Midi, P.O., PLM; Belfort; Indépendants de la Loire; Aciéries Firminy; Aciéries Saint-Etienne; Marine. To these initial groups were later added the group of Montluçon and the Groupe de l'Éclairage Électrique. The number of individual industrialists in each group varied and increased steadily until the end of January. The leading industrialist of each group was responsible for the distribution of steel, military contracts, and coordination of the output. He would also investigate the resources of the area and recruit sub-contractors and smaller factories to aid the production effort and ensure that the system was running as efficiently as possible.²⁵⁰

In addition, the *Service des Forges* gave direct orders to twenty-five industrialists who were not affiliated with a specific group, bringing the total to around six hundred private industrialists.²⁵¹ These industrialists immediately promised the provision of 30,000 75mm shells for the beginning of October, although this would ultimately prove to be very optimistic. Private industry only actually began to show some results from early November, with Millerand lamenting the length of the delays.²⁵²

This structure avoided subordinating the administration of industry to private cartels, as desired by the *Comité des Forges*. Although pre-war cartels were strengthened and private industrialists made large profits, this was deemed acceptable to secure the necessary production and was in stark contrast to the close connection between cartels and the state as emerged in Germany and the United States. Etienne Clémentel, the Minister of

²⁵⁰ Ibid., 48.

²⁵¹ The *Service des Forges* should not be confused with the *Comité des Forges*. The former was a government department overseeing metallurgy, whereas the latter was a union of industrialists.

²⁵² SHAT 6 N 16, Note: Commission de l'Armée, Réponse au Rapport Gervais sur les Munitions, 22 April 1915, 6.

Commerce, supported such an approach, believing that France was weakened by the lack of cartelisation. He hoped to promote an improved organisation of French capitalism to encourage more dynamic growth, and expansion into foreign markets.²⁵³

By December, the numbers of industrialists in each group were as follows:

Région Parisienne	245
Creusot	unknown
Saint-Chamond	150
Basse-Loire	5
Etat-Midi-PO	2
Groupe du PLM, Ateliers de Paris, Oullins, Arles	unknown
Groupe de Belfort	2
Groupe de la Loire	30
Groupe de la Marne	unknown.

By June 1915, there were 869 private industrialists working for the government, although this number only relates to those who received direct contracts from the government. These industrialists employed a large number of sub-contractors who had not been fully accounted for. A further 500 establishments worked on heavy equipment and materiel, and 65 on the production of automobiles, bringing a total of 1,434 private industrialists employed for the war effort. The total orders placed domestically were valued at 1,488,037,138fr.²⁵⁴ 457,905,993fr were for 75mm munitions contracts, 25,422,850fr for 155mm munitions, and 43,283,750fr for 105mm munitions.²⁵⁵

It was clearly necessary to turn to private industry to supplement the state arsenals in the early months of the war, and, without the rapid increase in output, the army would have been unable to continue fighting. The reaction of the Ministry of War was swift, and

²⁵³ Hautcoeur, "Was the Great War a Watershed?," 192.

²⁵⁴ AN 94 AP 84, Note pour le Cabinet du Ministre Chef du Cabinet sur les Etablissements travaillant pour la 3eme Direction, June 1915, 1.

²⁵⁵ Ibid., Commandes faites à l'industrie privée française, May 1915, 2.

grouping the industrialists eased the administrative burden and facilitated the creation of a network of factories working for the purpose of national defence.

Nevertheless, industrialists held a position of strength in negotiations with the Ministry of War, with which they rarely saw eye to eye. For the factory owners, financial considerations superseded all others, despite repeated appeals to their patriotism.

In the early months of the war, industrialists were particularly reluctant to introduce sweeping changes to their workshops and machinery to convert to armaments production. They still believed that the war might end in 1915 and therefore did not want to risk expensive outlays for production that might never be needed. It took large and favourable contracts from the government to convince them to put in place costly installations that were not suited to their ordinary production and were out of proportion with their traditional levels of output. They waited for large advances before they would begin construction. The Citroen factory, for example, was advanced six million francs in August 1914, approximately a quarter of its total contract.²⁵⁶ François de Wendel, a leading steel manufacturer declared 'the mercantilism of my colleagues disgusts me!'²⁵⁷ It was only by early 1915 that their concerns began to disappear as it became clear that the conflict was likely to continue for the foreseeable future.²⁵⁸ The provision of assistance to private industry was a further step towards increased intervention into the economy. Advances initially funded raw materials and wages, but swiftly came to cover purchases of machinery and the construction and expansion of factories, culminating in state efforts to fund new plants at Roanne and Paris.²⁵⁹

²⁵⁶ Mauffré, *La Mobilisation Industrielle*, 26.

²⁵⁷ Jeanneney, *François de Wendel en République*, 40.

²⁵⁸ Mauffré, *La Mobilisation Industrielle*, 23.

²⁵⁹ Kemp, *Economic Forces in French History*, 48.

The contracts made with industrialists were sizeable. Commentry-Fourchambault-Decazeville's first order was for more than 80,000 semi-steel shells at 12.50 francs per shell, and a subsequent order followed for 40,000 shells at 11.50 francs per shell. Citroen received a contract in January 1915 for more than one million 75mm shrapnel shells at 24 francs per shell to be 'manufactured in a factory yet to be built', and an advance of 1.2 million francs to aid with set-up costs and up to 4.8 million francs for new machinery.²⁶⁰

Following the Bordeaux Conference, munitions production increased at a reasonable rate. By the end of November 1914, production of 75mm shells had reached 22,000 shells per day, and rose to 33,000 in December, and 42,000 in January 1915.²⁶¹ Output continued to increase to 96,000 by November 1915 and passed 100,000 in February 1916.²⁶² Although production was always some way off achieving the high targets demanded by Joffre, by setting the bar high Joffre was able to motivate both the Minister of War and the munitions industry to make all efforts possible to increase production. By summer 1916, output began to exceed consumption, and from then on, 'anxiety could be banished, the difficult period was over.'²⁶³

The expansion of the production of munitions, and the instigation of the production of materiel would not run smoothly however, and there were multiple fits and starts. While the Ministry of War had been quick to respond to the costly omissions in Plan XVII, it had only just begun to address the problems that the lack of pre-war preparation would throw up. This will be addressed in the next chapter, which explores the expansion of production in the first two years of the war and the persistent attempts to fill the gaping chasm between demand and supply in order to keep the army fighting at the front lines.

²⁶⁰ Hardach, "Industrial Mobilization," 59–60.

²⁶¹ *AFGG*, 21, 69.

²⁶² *Ibid.*, 3, 614.

²⁶³ *Ibid.*, 42, 413.

Chapter 3 – Response – Industry to the rescue

Despite quickly recognising the need to work with private industry, the Ministry of War faced a pressing problem: initially, those who were able to produce munitions were also the only ones capable of manufacturing artillery. What should they prioritise: artillery or shells? If the Ministry of War focused its attention on munitions output, the army would continue to lack matériel, particularly high calibre guns and howitzers. However, if resources were devoted to materiel production, the army would not have any shells to fire. Either way, the army would be left dissatisfied, while those on the home front struggled to accommodate seemingly incompatible demands, putting a considerable strain on the relationship between the front lines and the Ministry of War.²⁶⁴ Ultimately, the army and Millerand deemed that the shortage of shells was most pressing, and older models of artillery were recalled in order to fill the deficit temporarily. Nevertheless, the Ministry of War came under intense criticism from the *Commission de l'Armée* over its handling of mobilisation, and the two bodies repeatedly clashed throughout the war.

Munitions Production

Production was slow to get up to speed due to the complicated nature of munitions manufacturing, which made it difficult for those without experience to adapt quickly. Quality was vital for the precise art of ballistics. Shells produced by the arsenals were formed in one piece and entailed a comprehensive and detailed manufacturing process.²⁶⁵

²⁶⁴ Porte, *La mobilisation industrielle*, 69.

²⁶⁵ Marie La Hire, "La femme française, son activité pendant la guerre", cited in Hatry, *Renault, usine de guerre 1914-1918*, 42.

The method employed by those unused to munitions production was simpler but more prone to faults and imperfections. It consisted of taking a bar of metal of equal length to that of the shell, and drilling the interior to the required diameter of a forged shell. The difficulty lay in forming the warhead shape. As no tool was capable of doing this, the factories were forced to resort to a shell constructed in two parts, with the point of the shell attached.²⁶⁶

The process for manufacturing even a simple shell involved numerous considerations: French shells were relatively advanced. Their sophistication owed a great deal to the work conducted by General Herment before the war. In 1909, he foresaw the difficulties of producing steel shells in wartime and also viewed the supply of explosives for iron shells, which did not exceed 5 to 6 percent, as insufficient. He therefore studied the use of cast iron and set up the process for its production. Without his fortunate initiative, the artillery would have suffered terribly in its supply of munitions due to the insufficiency of steel and steel imports, and would have had to rely solely on poor quality, minimally effective shells.²⁶⁷

The constituent materials of shells were of great importance, but often quality was sacrificed for quantity. The merits of various possible shells were studied intensely in the early months of the war at the *Commission d'expérience de Bourges*. They found that the most effective shells were steel shells charged with a very explosive powder, along with a high ratio of powder to the weight of metal. Cast iron shells were noticeably inferior, although the difference obtained by using a less powerful explosive, reduced the gap between the two models. The least effective shells were made from iron, as the destructive capacity of these shells was vastly inferior to the steel and cast iron models. The iron shell's

²⁶⁶ Notice sur les usines Renault, 1918, cited in *ibid*.

²⁶⁷ Herr, *L'artillerie*, 213–4.

thick walls meant that only a minimal quantity of explosive could be used, often three to four times less than that used in steel shells. Furthermore, on explosion, it fragmented into a smaller number of large splinters that rapidly lost their speed and were largely ineffective.²⁶⁸ Nevertheless, in spite of its inferiority to the steel shell, the cast iron shell was viewed as a good substitute and had two advantages that made up for its faults: it was considerably cheaper and much simpler to produce in war time.²⁶⁹ Still, early orders for munitions were commonly for iron shells, as they were easiest to manufacture. Despite the merits of cast iron shells, they only began to arrive in large quantities in the second half of 1916.²⁷⁰

The army's request to push only explosive shells at the expense of shrapnel immediately destabilised the production process. While in the long-term, explosive shells were quicker and easier to produce, stopping the production of shrapnel shells and immediately modifying machinery for the almost exclusive production of explosive shells resulted in a momentary reduction of production totals. Studies and tests were carried out with extreme urgency to explore an explosive shell that was drilled cold from the bar rather than pressed, and constructed in two parts, which would facilitate the production of explosive shells by those who did not possess the machinery to forge shells.²⁷¹

The main problem involved in the efforts to mobilise French industry for war production was the sacrifice of quality. The Ministry of War deemed this risk worthwhile, especially when uncertainty remained about how long the war would last, but it proved incredibly costly, with serious consequences for the artillery at the front lines. General Baquet, the

²⁶⁸ Reboul, *Mobilisation industrielle*, 53.

²⁶⁹ Herr, *L'artillerie*, 213.

²⁷⁰ Reboul, *Mobilisation industrielle*, 54.

²⁷¹ AN 94 AP 84, Résumé des mesures prises par le Service de l'Artillerie depuis l'ouverture des hostilités, 11 December 1914, 9–10.

Directeur de l'Artillerie, claimed that until May 1915 and even beyond that, 'intensive production never attained the quality that was achieved in peacetime and was indispensable for the reliability of fire. This perfection was impossible to obtain straight away from production that was improvised extremely hastily.'²⁷²

The majority of private industrialists were not set up for armaments manufacture, and it would therefore take a considerable amount of time to convert to the most effective method of production. For instance, when Louis Renault was called upon to produce munitions, he was initially asked if he could make forged shells but deemed it impossible to make shells other than by drilling. Ultimately an order was handed down from Alexandre Millerand on 19 September for drilled shells in two parts.²⁷³ Thus, early on, despite the recognition that quality was going to be compromised, Millerand made the decision to prioritise quantity of output.

Similarly, in December 1914, Joffre asked for 3,000 155mm steel shells. Due to the availability of steel, General Baquet declared that this could only be supplied at the expense of 80,000 75mm shells and that the 155mm shells would take six months to be produced. Despite the tactical benefits of the more effective 155mm shells, the extreme shortages at the front lines forced the Ministry of War to choose the 75mm shells that were required to keep the guns at the front firing. Quantity was therefore prioritised over tactical effectiveness.²⁷⁴

²⁷² Baquet, *Souvenirs*, 84.

²⁷³ Hatry, *Renault, usine de guerre 1914-1918*, 26.

²⁷⁴ Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, ii, 29. It should be noted that while heavy artillery shells were more suited to fighting at the front, the 75mm shells still possessed considerable merits in open combat, and in defence. Furthermore, considering the orientation of the French army towards the field gun, it was logical to keep them supplied with sufficient munitions rather than producing munitions for materiel that was not readily available.

The period from the Bordeaux Conference in mid-September until the end of February 1915 marks the first period of cooperation with private industry. While the mobilisation process was swift, it ran into a multitude of administrative complications. The *Commission de l'Armée* summed up the response: 'they came up with this improvised structure, which, in the confusion, was revealed to be completely insufficient compared to a system that might have been conceived and prepared to function from the first day of mobilisation.'²⁷⁵

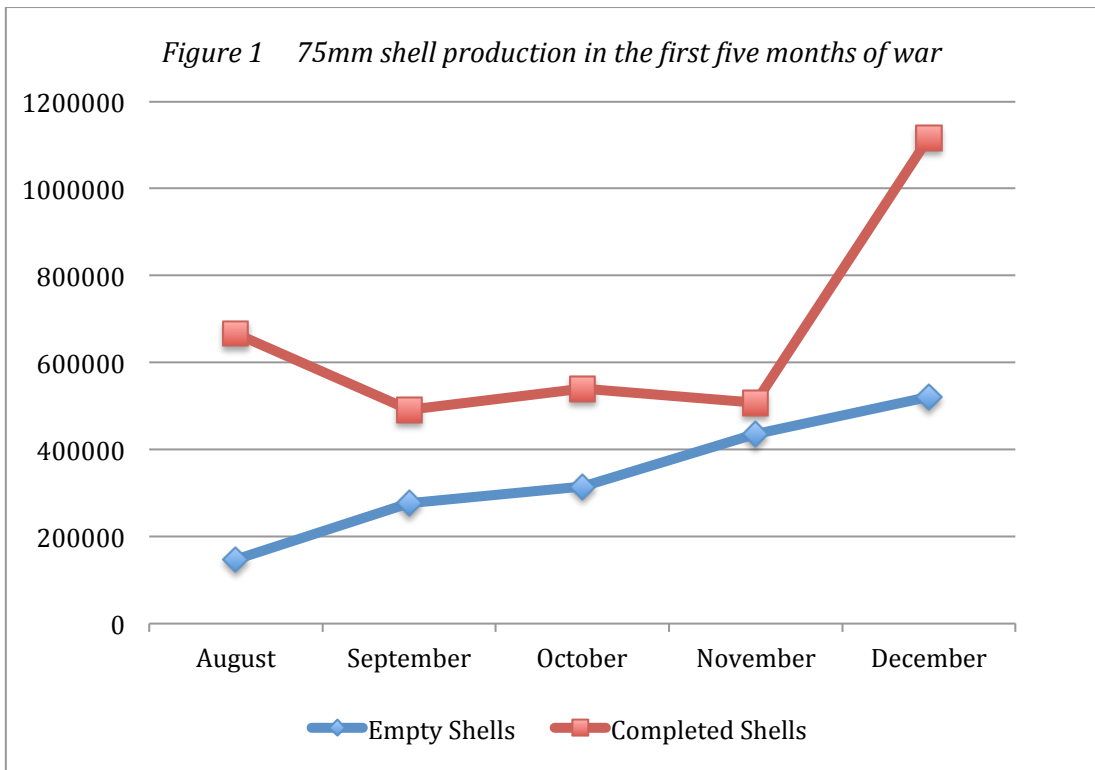
Nevertheless, once underway, production rose relatively quickly. In October, the production of empty 75mm shells was 12,044 per day. It rose to 26,921 in November, 50,272 in December, 60,883 in January and 72,223 in February. However, these figures should be viewed alongside the total number of completed shells produced and ready to be fired, as detailed in the following table for the first five months of the war.

Table 2 75mm shell production in the first five months of war

	Empty Shells	Completed Shells
August	147,000	667,000
September	277,000	491,000
October	315,000	540,500
November	435,000	508,000
December	521,000	1,117,000

Source: SHAT 6 N 16, Rapport fait à la *Commission de l'Armée*, 29 March 1915.

²⁷⁵ SHAT 6 N 16, Rapport fait à la *Commission de l'Armée sur les Munitions*, par M. Gervais, 29 March 1915, 6-7.



The table highlights the struggles to secure raw materials, particularly explosives, in the scramble to increase production in the first four months of the war. The number of completed shells produced remained relatively constant in the first four months, as they were able to make shells from the stocks of constituent parts already available at the start of the war. It took until December for industry to manufacture sufficient new fuses, charging mechanisms, powder and explosives to begin increasing output. By December, the charging of shells began to increase dramatically. The production of empty shells by private industrialists also increased steadily, as at this point the supplies of steel and iron were sufficient to match the capabilities of the manufacturers. Even so, the monthly output of complete shells for December was only an average of 36,000 per day, and the average for the first five months as a whole was only 21,700 per day. This is vastly inferior to the 50,000 per day requested by General Joffre. For October, November and December, the army received less than 50 per cent of the shells requested.²⁷⁶

²⁷⁶ Ibid. Rapport fait à la Commission de l'Armée sur les Munitions, par M. Gervais, 29 March 1915, 8.

Everything rested on the ability to fill shells with powder and explosives. The damning report from M. Henry Bérenger, head of the sub-commission investigating the supply of powder, was that:

Nothing had been foreseen, either in the general mobilisation plan or in the practical arrangements of the Ministry of War, to face up to the needs revealed by the campaign in 1914-1915. Neither the quantities, the stocks, the raw materials, the means of production, the contracts abroad, the industrial manpower, nor the factories, nothing, in a word, was read or even prepared in view of a campaign of this type on the day that war was declared.

The stocks were so low that when General Joffre called for the production of 50,000 to 80,000 75mm shells per day, along with supplies of heavy shells, the government's response was that they could only deliver 13,600 per day and a negligible production of heavy shells. Bérenger's reports revealed the indecisions, the delays, and the bureaucratic lethargy that plagued the powder industry between August and December 1914. While the needs were revealed to be more than twenty times superior to the means available, the Ministry of War only decided in January 1915 to order the complete and intensive industrialisation of the production of powder and explosives in France.²⁷⁷

Output continued to increase in fits and starts as demonstrated by the following table.

Table 3 Expansion of shell production

	Completed 75mm shells per day
1-15 January 1915	38,979
16-31 January 1915	45,706
1-15 February 1915	44,930
16-28 February 1915	30,622
1-15 March	55,927

Source: SHAT 6 N 16, *Commission de l'Armée*, Rapport Doumer.

A further complication for the French Ministry of War was the obligation to provide allies with munitions. On 4 January 1915, France was producing 83,000 shells a day, of which

²⁷⁷ Ibid. *Commission de l'Armée*, Rapport Doumer, adopté 26 April 1915, 16-18.

2,000 were shipped to Serbia, 3,000 to Romania, 2,000 to Belgium and 12,000 to Russia.²⁷⁸

This was an additional drain on French munitions stocks that limited the resources sent to the front lines and added tension to the relationship between the high command and the Ministry of War, with the former reluctant to cede shells to other armies when there were such pressing shortages on the Western Front.

A second stage of production began in February 1915 and saw a move towards providing both the quantity *and* quality desired. All the shells produced in the period up until the end of February came from the first series of contracts signed in October 1914, which expired in February 1915. Due to the difficulties of securing the correct machinery for forged shells, the contracts had also accommodated drilled shells or shells produced in two parts. However, this had serious consequences for the quality of shell produced (which will be examined later), such that the contracts signed from February onwards were almost exclusively for single-body shells. Drilled shells were still produced in limited numbers, as the needs of the army were such that, at this point, the *Administration de la Guerre* could not completely suppress their production. As industry transitioned away from shells in two parts, the output of shells lagged a little. Production fell from 58,213 on 28 February to 28,800 on 15 March, with munitions at Le Creusot and Saint-Chamond particularly affected. Their output fell from 15,685 to 1,800 and 8,375 to 1,200 respectively. Nevertheless, average daily output recovered quickly by 24 March to 57,000 complete shells and a production of 72,000 empty shells.

Once the appropriate machinery had been put in place, the *Administration de la Guerre* was confident that output would rise swiftly. The *ad hoc* attempts to meet the French high command's demands in the early months of the war ceded to a recognition that a more

²⁷⁸ Doughty, *Pyrrhic Victory*, 116.

thoroughly thought out approach was required to ensure that the army was supplied in both the quality and quantity desired. Furthermore, the *Administration de la Guerre* believed that, 'the production of single body shells will allow, when it has been completely organised, an output superior to that obtained with shells in two parts.' Many firms, such as the *Éclairage Électrique*, were still far from achieving their maximum capacity, and the *Administration de la Guerre* estimated that output would exceed that of February and would reach 95,000 shells per day for explosive shells by the end of April 1915, while shrapnel shells would reach 23,000 shells per day during July.²⁷⁹

Unfortunately, this was all based on the forecasts from industrialists, which were rarely accurate, with output almost always inferior to the agreed targets. The *Administration de la Guerre* summed it up with the phrase, 'we do not have it yet, but we will', which was the response that repeatedly emanated from the factories. In order to secure large contracts and to keep favour with the Ministry of War, industrialists promised greater output than could be achieved. Inevitably, a number of obstacles and problems arose that slowed production. This infuriated both the Minister of War and General Joffre, who relied on accurate reports for the planning of future operations and offensives. These frequently had to be modified and reduced due to the lack of munitions appearing at the front.

Heavy Shells

The French Ministry of War was faced with a dilemma over whether to focus its limited resources on the production of 75mm munitions for which industry was relatively well-prepared and for which there was a reasonable number of batteries, or heavy munitions, which were more effective in trench warfare. Once again there was a choice between

²⁷⁹ SHAT 6 N 16, Rapport fait à la Commission de l'Armée sur les Munitions, par M. Gervais, 29 March 1915, 10.

quality and quantity, as it was futile for heavy calibre shells to be produced if the guns to fire them did not exist.

Auguste Gervais, a deputy at the *Commission de l'Armée* and former Minister of War, illustrated the difficulties facing the Ministry of War. During summer 1915, the high command had reduced its requests for 75mm munitions to 80,000 per day in order to focus efforts on larger calibres. However, lessons from recent battles demonstrated that, while large calibre shells were needed in large quantities to break through fortified positions, the character of the battle changed once the line was broken, and artillery commanders found that the 75mm field gun had a better effect due to its mobility and speed of fire. Thus a balance needed to be struck between the two.²⁸⁰

On 10 December 1914, Joffre insisted on the need to start production of 105mm steel shells, for which there was no current stock, and to transform the contracts for steel shells to cast iron shells to facilitate greater production.²⁸¹ Due to the size of heavy artillery shells, and their destructive capacity, Albert Thomas was insistent that they be constructed correctly through forging, with no half-measures to improve output, which had proved so disastrous for 75mm shells. The number of factories capable of producing them was therefore limited, and there was a considerable delay until machinery could be sourced and installed. Once in place, however, production rose quickly, although demand would always exceed supply.²⁸² Output of heavy munitions rose dramatically, from a paltry 200 expected in Plan XVII to 50,000 a day in 1917 for 155mm, and 30,000 a day for 220mm shells.²⁸³

²⁸⁰ Ibid., Rapport fait à la Commission de l'Armée sur la situation des projectiles dans le mois de Septembre, par A. Gervais, 3.

²⁸¹ Joffre, *Mémoires Du Maréchal Joffre (1910-1917)*, ii, 28.

²⁸² Reboul, *Mobilisation industrielle*, 52.

²⁸³ Fontaine, *French Industry*, 282.

Still, even in September 1915 there was a stark difference between the desires of the high command, the forecasts of the *Administration de la Guerre* and actual output of shells. According to the programme agreed in July 1915, the maximum demands of the high command were as follows:

Table 4 Shell requests of the French high command, July 1915

Calibre	Request	Forecast
95mm	10,000	4,700
105mm	4,800	4,320
120mm	10,000	5,540
155mm	12,000	4,570
220mm	3,000	510
270mm	1,000	79
280mm	180	22
293mm	370	15
370mm	-	25
Total	41,350	19,781
Total per month	1,240,000	583,430

Source: SHAT 6 N 16, Rapport de M. Gervais, 13.

Total production for September was 428,075, but it was difficult to ascertain the real needs of the army. Two elements were involved in this calculation: the number of pieces in service at the front and the necessary supplies for these pieces based on the information gained from recent battles. The number of pieces at the front was as follows:

Table 5 Number of pieces at the front

Calibre	Number
95mm	74
120L	1,528
120C	150
155L	661
155C	369
155CTR	102
220mm	162
270mm	50
280mm	2
370mm	4
58mm	1,060

Source: SHAT 6 N 16, Rapport de M. Gervais.

Gervais suggested that it was necessary to supply the 105mm and 155mm pieces with 1,500 and 1,000 shells per day respectively, which would represent at least doubling the maximum requests from the high command, for a daily production of more than 80,000 shells and a monthly supply of more than 2,500,000. For heavy artillery, Gervais compared the figures for heavy artillery in the following manner:

Table 6 Heavy artillery shell requests and production, September 1915

Monthly production for September	426,075
Forecast production for September	583,430
Request from the French high command	1,240,000
Actual needs	2,400,000

Source: SHAT 6 N 16, Rapport de M. Gervais.

The table illustrates the scale of the task still facing the Ministry of War in September 1915.²⁸⁴

While the Ministry of War sought to balance the focus of production effort between heavy and light munitions, Auguste Gervais pushed for increased output across the board. Progress had been made in field artillery shells. The army fired 802,980 75mm shells in August 1915, but output attained 2,231,539. This represented a saving of almost two-thirds of this amount, which was still deemed insufficient. The offensives of Artois and Champagne had to be cut short due to a lack of munitions for fear of exposing the rest of the army to a dangerous weakening of the supplies of 75mm shells. Gervais therefore wanted to continue to increase production, looking to double the number of shells being produced at the time.²⁸⁵

²⁸⁴ SHAT 6 N 16, Rapport fait à la Commission de l'Armée sur la situation des projectiles dans le mois de Septembre, par M. A. Gervais, 13.

²⁸⁵ Ibid. Rapport fait à la Commission de l'Armée sur la situation des projectiles dans le mois de Septembre, par A. Gervais, 9.

Artillery production - 75mm field gun

The production of shells was futile if the army did not possess the guns to fire them. Again, French industry was largely unprepared for materiel production, relying heavily on state establishments. In 1914, the arsenals were capable of manufacturing or repairing just five 75mm guns a day. However, by the second half of 1916, this had increased to thirty, rising to thirty-six in 1917, and further still in 1918.²⁸⁶ By 20 February 1916, the French army had 4,046 75mm field guns, along with 2,373 65mm to 90mm, meaning a total number of 6,419 light pieces.²⁸⁷

Until spring 1915, the Atelier de Bourges was the sole producer of 75mm barrels, having made 280 since mobilisation. However, production had progressed slowly. On 26 April 1915, Paul Doumer, the former President of the Chamber of Deputies and a member of the *Commission de l'Armée*, declared that the lack of artillery was 'the most troubling danger.' He felt that the French army needed 1,500 to 1,800 new 75mm field guns to meet the shortfall caused by faulty explosive shells, barrel wear, and destruction by enemy fire. The effort so far was deemed 'absolutely insufficient', with the Bourges workshop manufacturing just twenty-four per week, when a minimum of thirty-six was needed. This was not enough even to meet the number of guns put out of action each day. The other manufacturers, such as the Manufacture de Tulle, had already demonstrated that they were incapable of coming close to the targets set. The *Administration de la Guerre* seemed reluctant to use the resources that private industry offered. The outlook was bleak as the French field artillery continued to rely on out-dated models.²⁸⁸

²⁸⁶ Fontaine, *French Industry*, 282.

²⁸⁷ Doughty, *Pyrrhic Victory*, 255.

²⁸⁸ SHAT 6 N 16, Commission de l'Armée, Rapport Doumer, adopté 26 April 1915, 6.

The problem was eased slightly by the fact that the *Administration de la Guerre* suddenly discovered at the start of May 1915 that the Atelier de Tarbes was also able to produce barrels and would soon start to produce just over one per day. Millerand hoped that the total output from Bourges and Tarbes would soon reach 275 barrels per month, but this was still insufficient for the needs of the army and meant that the lack of shells was matched by a lack of guns.²⁸⁹

Even if the army lost no more pieces on the battlefield, it had to tackle two major causes of waste: the explosion of faulty shells and barrel wear. By Charles Humbert's calculations, they ideally needed 4,800 new guns to ensure that the army was not losing more guns than were produced, but this was unrealistic, and as a bare minimum he viewed 2,500 as strictly necessary. The Ministry of War declared that they expected to receive 1,327 new pieces between the end of May and the end of the year, with 112 coming from Le Creusot and 1,215 from state arsenals. Joffre had deemed this sufficient in a telegram sent on 26 April, declaring, 'if the explosives diminish in the near future, the delivery of 75mm guns foreseen for this second semester appear sufficient and will allow us to make up a large part of the deficit.' This view clashed with Humbert's assessment.²⁹⁰ Far from reassuring Humbert, the telegram troubled him. It provided confirmation from the highest military authority of the enormity of the deficit, as 1,327 pieces would only fill 'a large part' of the gap.

Humbert had a number of recommendations as to how to improve the output of both public and private establishments. First and above all, he deemed it indispensable to restrict and move away from the 'parasitic productions' of the large state manufacturers

²⁸⁹ Ibid., Rapport fait au nom de la Commission de l'Armée sur le canon de 75mm par Charles Humbert, 17 May 1915, 6.

²⁹⁰ Ibid., Rapport fait au nom de la Commission de l'Armée sur le canon de 75mm par Charles Humbert, 17 May 1915, 4-5.

that limited their ability to focus on the most important areas. The entire focus of industry should be on items crucial to the war effort and not those for miscellaneous peacetime needs. Furthermore, the Bourges foundry should be developed and expanded as much as possible with the construction of a new hangar of fifty metres by a hundred metres. In May 1915, Bourges did not have enough space to set up all of its machines. By expanding Bourges and ordering new machines, Humbert estimated that it would be possible to increase the production of tubes to sixteen per day by the end of September. At this point, the availability of personnel was deemed acceptable, while the Director of Bourges had created a school of specialists capable of training all the workers in techniques that were necessary. Similar measures were proposed for the Atelier de Tarbes and the Marine foundry at Ruelle, which aimed to raise production to twenty-five barrels per day, and seven hundred per month. Once those needed for repairs and restoration had been taken into account, this would leave a surplus of 300 to 350 barrels for the creation of new guns.

Humbert believed that, with intensive work, the state establishments could produce 1,800 to 2,000 pieces by April 1916, without factoring in further appeals to private industry. Following discussion with the Forges et Aciéries de la Marine and Le Creusot, he hoped that, if provided with all the manpower and facilities required, they would be able to produce a further fifty complete 75mm model 1912 batteries between October 1915 and May 1916, with Saint-Chamond also contributing fifty batteries in a similar timeframe. Along with the 312 pieces already ordered from Le Creusot, this would provide a further 712 modern 75mm guns, bringing the total close to the 2,500 pieces deemed necessary to meet the current deficit.²⁹¹

²⁹¹ Ibid., Rapport fait au nom de la Commission de l'Armée sur le canon de 75mm par Charles Humbert, 17 May 1915, 6.

Heavy guns

After starting the war with vastly inferior supplies of heavy artillery, the state struggled to increase production. The manufacturing of heavy artillery was more complex than that of 75mm field guns and could only be carried out by large private companies with sufficient technical expertise. Before the war, in the last minute scramble to increase artillery production, the state relied primarily on the Schneider artillery works at Le Creusot, ordering thirty-six 105mm guns, which started to arrive in the middle of September.²⁹² The factory was relatively modern and advanced by French standards but neglected American methods of mass production, preferring to have each piece made individually by highly skilled engineers. This approach meant large orders could only be completed in a series of relatively small batches, hence the long lead times of twenty-five months for the production of the first order of 105mm guns, thirty-six months for a small number of 280mm heavy siege howitzers, and forty-two months for manufacturing 155mm gun carriages.²⁹³ Although these estimates were made in peacetime, without the pressure of wartime necessity, the delays exemplify the limited mass production capabilities of industry at the time. Still, the private firm of Le Creusot was much better equipped than the state arsenal at Bourges, which received a similar order to Le Creusot for 105mm guns but had not produced a single gun by the outbreak of the war. Indeed, by December, the arsenal had performed so poorly and produced so little that the Ministry of War cancelled its order for complete guns, and restricted manufacturing at the arsenal to constituent components and barrels.²⁹⁴

²⁹² Doughty, *Pyrrhic Victory*, 118.

²⁹³ Gudmundsson, "Learning from the Front," 289.

²⁹⁴ *Ibid.*, 290.

Once the needs of the army in heavy artillery were made clear following the outbreak of the war, the Ministry of War adopted two policies:

- 1 – to organise new formations of heavy artillery utilising the best available materiel already existing within France, in forts and in use by the navy, improved and renovated as much as possible to facilitate use on the battlefield;
- 2 – to concentrate all the power of state and private industry on the intensive production of new models that had originally been broached in peacetime.

Drawing on existing out-dated artillery in the interior, by late November, France was able to equip each corps with a battery of heavy long-range pieces of various calibres between 105mm and 155mm, and each army group with additional heavy artillery to be assigned as 'reserve' artillery.²⁹⁵

On 21 April 1915, Millerand reacted to critics of the 'old pieces' from which the five regiments of heavy artillery were formed. He praised the mobility, accuracy, speed of fire, destructive and demoralising effect of the 155CTR, which highlighting that the 120L had been renovated through the adoption of a modern platform, rendering it much more mobile and of great use in battle. In his view, a continuous renovation process gave the siege and fortress artillery a power and mobility that satisfied all the requirements of battle. In this regard, therefore, 'France had not simply remained a spectator of the progress made in this area by other nations.'²⁹⁶

For the second part of this policy, the Ministry of War had the opportunity, granted by its liberation from its obligation to pre-war heavy gun orders, to focus its efforts on heavy

²⁹⁵ Doughty, *Pyrrhic Victory*, 118.

²⁹⁶ Ibid., Réponse du Ministre à L. Boudenoot, 31 March 1915, 3.

howitzers, which were deemed so potent in trench warfare. However, it made the decision to persist with heavy guns, which alone could match their modern German counterparts.

The focus on heavy guns began on 5 October, when Joffre requested the production of long-range 120mm and 155mm pieces, followed by further requests that were assimilated into the programme of 14 October that established the overall needs in heavy artillery. In March and April 1915, the Ministry of War granted three new orders to Schneider for long-range heavy guns. The first was for the 155mm gun carriages that had been suspended at the outbreak of the war; the second was for the 105mm guns that had been cancelled with Bourges, and the third was a new order for 105mm guns.²⁹⁷ Once again, the speed of Millerand's response to the heavy artillery issue raises the question of whether he was reflecting pre-war expectations. The need for high calibre guns had been hotly debated, but the catalyst and pressure of war allowed the Minister of War to push for the changes that had been met with reticence in peacetime. Nevertheless, Humbert lambasted the fact that, due to the 'capricious tyranny of the central technical departments, the deadline for delivery of this production had not even been discussed,' with output still tediously slow in March 1915.²⁹⁸

Despite progress in the production of 105mm guns, with a second order for 110 placed at Le Creusot and expected for delivery in January 1916, and a third already placed for a further 110 at a rate of 24 per month to follow it, Albert Thomas was reluctant to commit himself further. In a letter of 22 June 1915, he expressed the opinion that the third order was not quite as urgent, and he wanted to see if the war was likely to continue that long. Humbert strongly disagreed with this approach, saying that the hopes for an end to the war

²⁹⁷ Gudmundsson, "Learning from the Front," 291.

²⁹⁸ SHAT 6 N 16, Rapport fait au nom de la Commission de l'Armée sur le matériel d'artillerie lourde, par Charles Humbert, 24 March 1915, 7.

in the near future had evaporated at the start of the summer and that a delay in ordering could only have negative repercussions. He blamed Albert Thomas for being 'afraid of doing too much', for the costly interruptions earlier in the war, and for the hesitations about placing the second order for 105mm guns with private industry, which had resulted in a lengthy delay in the provision of the one piece of truly modern heavy artillery that the army possessed.²⁹⁹ To Humbert, history was repeating itself.³⁰⁰

The Minister of War defended the suspension of the order for 105mm guns at the start of the war, which had to be abandoned to devote resources to the productions foreseen in the mobilisation plan. Even if the Bourges establishment had been able to continue to devote personnel to the production of 105mm materiel, the first shipment would have been received in October 1914, three months behind the Schneider establishment, due to the time required for the study and setting up of machinery.³⁰¹

The response of Louis Boudenoot, of the *Commission de l'Armée*, was cutting. He was surprised that the Minister did not share the opinion of the *Commission de l'Armée*, as the results of the report were based on a study of all the documents provided by the Ministry, and it was certainly not a polemic. 'If the criticisms have been viewed as harsh, it is because they were based on facts, which kept all personal issues out of the debate, and we carefully abstained from all criticism that could appear to be directed against you [the Minister of War] or your predecessors. What has incriminated them is the defective methods; what we have bemoaned are the inadequate responses.'³⁰² This was a further example of the

²⁹⁹ Ibid., Rapport fait à la Commission de l'Armée sur l'état d'avancement des fabrications d'artillerie lourde, par Charles Humbert, 23 September 1915, 2.

³⁰⁰ Ibid., Rapport fait au nom de la Commission de l'Armée par Charles Humbert, sur le matériel d'artillerie lourde, 31 May 1915, 5.

³⁰¹ Ibid.; SHAT 6 N 16, Réponse du Ministre à L. Boudenoot, 31 March 1915, 3.

³⁰² Ibid., Réponse à lettre du Ministre en date du 31 Mars concernant l'artillerie lourde, 21 April 1915, 1.

tension that emerged between the Ministry of War and the *Commission de l'Armée*, with persistent criticism of past mistakes viewed as unhelpful by Millerand, Poincaré, and Thomas. Although they recognised that the mobilisation process had been far from smooth, production was beginning to progress, and they felt that it was more beneficial to look forward and continue improving the work of industry rather than dwelling on what might have been.

One person who was crucial to the continued recruitment and improvement of industry in France was General Camon, who, on 9 August 1915, received the task of overseeing the production of materiel and projectiles for heavy artillery, and subsequently the production of 75mm guns and munitions as well. Before the war, as a captain, he had spent seven years at the *Direction de l'Artillerie* at the Ministry of War, before spending four years as second in command at the *École Polytechnique*. Once war broke out, he commanded the artillery of the Fourteenth Army Corps in the Vosges and on the Somme. He went on to oversee the technical command of artillery fire for the Second Army and was therefore well versed in the finer elements of modern artillery use. His task focused particularly on accelerating the output of the 105L Schneider gun, the 155C Schneider and Saint-Chamond model howitzer, and the 155GPF Filloux system howitzer. He only had one assistant, Lieutenant Rouger, a civil engineer, and was not even allocated a car, travelling instead by rail.

Camon visited more than two hundred factories, observing their methods and familiarising himself with the production process. He made an impact on both industrialists and the *Sous-Secrétariat d'Etat*. Camon was able to advise where industrialists could make the necessary efforts to accelerate production. He prioritised the allocation of manpower, both specialists and unskilled workers, to establishments making the best use of the resources

available to them. He facilitated visits between factories so that foremen, workers and industrialists could see the most promising factories in action, and he was able to modify working practices accordingly in order to encourage manufacturers to produce more with the existing personnel. On returning from each of his visits to industrialists, he wrote a lengthy report on his findings, detailing the particular machines and the way production was organised, so that this could be distributed to factories for study and incorporation. His reports were frequently published in the *Bulletin des Usines de Guerre*. He wrote detailed studies on the production of cast iron shells which were distributed not only to French industrialists through the *Section Technique de l'Artillerie*, but also to the French missions in Russia and Romania.³⁰³

In his study of heavy artillery output, Camon identified three areas for improvement: the supply of forged parts, the difficulties of manufacturing, and manpower. For the first two in particular, solutions were found through industrialists supporting each other: combining resources of machinery and expertise to meet the shortfalls, as was seen with the link established between the Société Electromécanique du Bourget and the Groupe de l'Artillerie for the manufacture of 155 GPF. However, the greatest efforts were made with regard to manpower. By specifying the number of workers for the factories of Le Creusot, Saint-Chamond and their sub-contractors, Camon was able to estimate the increase of output that could be expected. For example, Camon believed that the factories of Saint-Chamond and Le Creusot could provide an additional 155C howitzer per month with a supplement of just forty-five workers, while additional manpower was needed as their operations expanded and new machinery was installed.

³⁰³ SHAT 10 N 1, Mission de General Camon, 4-5.

Reactions to mobilisation

As has been seen, the *Commission de l'Armée du Sénat* was highly critical of the mobilisation effort of the Ministry of War. It returned to work in December 1914 when the government recalled the Chamber of Deputies, and its role was to form as clear a view as possible of the military situation and to summarise the efforts of the government in providing the army with the means to fight in both materiel and manpower. Its twenty-seven members were asked, 'have we done all that can be done to allow the entire nation to contribute to the goal of increasing our military power to its maximum?'³⁰⁴ Its task was even more important given the lack of parliamentary control over the war effort during the first five months of the war. There were also a number of other parliamentary commissions, such as the *Commission du Budget*, who also oversaw the government's management of the war effort, but the *Commission de l'Armée du Sénat* was the most active, vocal and aggressive in its scrutiny.³⁰⁵

Millerand promised to withhold nothing from the *Commission*, and vast quantities of documents covering all aspects of the first months of mobilisation were delivered to General Pédoya, its president. The response of Pédoya's colleagues to his initial report was far from positive. Two ministers were so shocked that they begged him not to continue: 'it was as if he had lowered the floodgates on a sea of pessimism.'³⁰⁶

³⁰⁴ SHAT 6 N 16, Commission de l'Armée, Rapport Doumer, adopté 26 April 1915, 2.

³⁰⁵ Jean Marie Gustave Pédoya, *La Commission de l'Armée Pendant La Grande Guerre. Documents Inédits et Secrets*. (Paris, 1921).

³⁰⁶ Terrail, *Au sein des commissions*, 37.

Opinions on mobilisation – Criticism and Response

The first report of Auguste Gervais on the mobilisation process was not favourable: ‘serious mistakes of foresight and profound errors have been committed. We did not come up with a plan, a programme, a structure, or the necessary supplies for the construction, management, and functioning of the military machine during the war.’ He went on to state that, ‘the mobilisation plan for munitions was totally insufficient. It was under the fire of the enemy that we have tried to organise everything.’ His main criticism, therefore, was of the lack of pre-war foresight, rather than the measures that had been taken since the outbreak of the war. However he did not overlook the latter either. He felt that had the *Services de l’Intérieur* had a clearer view of their goal, it would have acted differently, avoiding the ‘furious passion and energy’, and taking a more rational approach. In March 1915, the task facing the Ministry of War was scarcely different from that which it had faced in August 1914. This assessment, while brutally honest, goes too far. It supposes that it was clear to all that the war would become one of trench warfare and that it would last a long time. At the outbreak of war, this was not obvious, and therefore the Ministry of War reacted to the situation in front of them. Gervais felt that in March 1915 there was still a considerable gap between the government’s perception of the battle and the actual requirements revealed by the fighting, and that the Ministry of War should base their views not on battles just completed but by attempting to perceive how the next battle might look. It had been too reactionary, rather than seeking to be a step ahead.³⁰⁷

On 15 July 1915, the *Sous-Commission de l’Armement* presented a further report to the *Commission de l’Armée* on the state of production, criticising the fact that some factories were still not reopened or working for the state. Those factories that remained closed were

³⁰⁷ Ibid.; SHAT 6 N 16, Rapport fait à la Commission de l’Armée sur les Munitions, par M. Gervais, 29 March 1915, 16.

primarily small, and the delay in reopening them was due to the fact that there was insufficient manpower to devote to these firms that often did not possess the machinery with which to tackle an order. It was sensible to prioritise the larger establishments, as they generally operated more efficiently and were able to put the manpower to better use than smaller, private establishments.

General Pédoya, who had left the army in 1909 to become a deputy, further attacked the on-going mobilisation effort in spring 1915, drawing attention to ‘the almost total absence of any foresight or critical thinking.’ He blamed the lack of organisational structure; the isolation and detachment of departments, which made the coordination of efforts impossible; the lack of individual initiative, crushed by the bureaucratic system; the false conception of hierarchical respect, which imposed on subordinates the almost mechanical execution that a work prescribed. Although he viewed the relationship between the Ministry of War and the *Commission de l’Armée* as positive, he felt that to move forward his investigations would only be fruitful if they led to changes in mentality, personnel and approach: a clear and swift vision of the reality of the situation; better planning, a more defined division between the department, a constant and loyal collaboration, and a clearer centralisation of individual responsibilities.³⁰⁸

The artillery situation became the key debate around which battle was waged. The first shots were fired with a report from the *Commission de l’Armée* issued on 17 March 1915 lambasting the state of French artillery. It pointed to the confused actions of the early months, which left its members baffled. The two individuals who bore the brunt of their wrath were General Baquet, who was appointed *Directeur de l’Artillerie* by Alexandre

³⁰⁸ SHAT 6 N 17, Lettre du Général Pédoya, Président de la Commission de l’Armée au Président du Conseil sur les travaux à envisager en vue de renforcer la puissance de nos armements, 23 June 1915, 1-4.

Millerand in December 1914, and General Sainte-Claire-Deville, who became ‘the scapegoat for all the negligence and mistakes’ of the pre-war period.

Baquet was appointed to oversee munitions and artillery production due to his experience as the inventor of the 120mm gun that bore his name and his involvement in the development of the 75mm field gun. He was an intellectual and scientifically minded soldier, specialising in the technical aspects of the battlefield, and he ‘often struggled to hide his impatience and disdain’ for those who sought to intervene in artillery affairs. Having always restricted himself to his work as a soldier, he was brusquely thrown into a political maelstrom.

Terrail blamed corrupt individuals, ‘wheeler-dealers’ who sought to take advantage of Baquet’s political naivety. ‘Fluttering about like flies around a festering wound, they had rushed from neutral countries and from all corners of France’ to secure contracts for products that often they did not even have. Brokers presented themselves brazenly in the name of foreign firms, even when lacking any mandate from them, ‘plucking the names of companies out of the telephone directory.’ Even if turned away, they frequently became intermediaries or middlemen who lined their pockets while France suffered. Baquet, however, remained largely unmoved, turning these “Thenardiers” away, who, in retaliation, sought to denounce his name in public.³⁰⁹

He was described by his detractors as ‘a munitions worker who wants to buy nothing when France lacks for everything, and when, to have everything, he only has to order; a soldier having all the flaws that come with the nature of his profession: the civil mistrust, the stubbornness of his routine, the formalist spirit; a general good only for service in the rear,

³⁰⁹ Terrail, *Au sein des commissions*, 356–7.

and who deserves to be written into the *Annuaire de Limoges*.' This atmosphere of malevolence pervaded when Baquet ran up against the *Commissions*.

The first controversy surrounded munitions production and the decision taken by General Sainte-Claire-Deville, *Inspecteur des Fabrications*, on the quality of explosive shells to be produced. With the need for haste, the general opted for lower quality shells that could be produced in greater quantity in a short period of time. If he had not taken this option, the batteries at the front lines would have quickly run out of shells. On the other hand, with lower quality shells came the risk of accidents.

However, the storm of war was not favourable to calm judgement. The accidents were a result of Sainte-Claire-Deville's need to conform to the demands of industrialists, who were incapable of producing higher quality shells at this time. As a result of his concession, the general was denounced as 'the destroyer of artillery' and a murderer.

In the wake of the shells crisis, the *Commission* turned to Baquet, questioning why the production of artillery was progressing so slowly.³¹⁰ Struck by the number of pieces lost in the early battles, on 31 October 1914 Baquet had ordered eighty 75mm batteries, with production to be split evenly between Le Creusot and Saint-Chamond. This was in addition to twelve batteries that had previously been ordered from Le Creusot and eight batteries currently in construction that were destined for Greece but would be requisitioned by the Ministry of War, thus providing one hundred new batteries. However, on 30 November Baquet changed his mind and the orders were cancelled, apparently causing considerable discontent among the industrialists who, although the agreements had been made without determining a price or a deadline for delivery, had already ordered and received supplies of

³¹⁰ Ibid., 358–60.

raw materials for the execution of the order. The Ministry of War ordered four 370mm mortars at Saint-Chamond and two at Le Creusot as compensation.

The Minister of War reported that the orders were retracted because the armaments industry was only capable of producing shells *or* artillery. Thus, the severity of the munitions crisis prompted the need to reassign resources, as the two companies had apparently indicated that it would be impossible to carry out the orders at the same time as making 75mm shells. Saint-Chamond and Le Creusot subsequently denied this.³¹¹

The backlash against Baquet was even more impassioned than that directed against Sainte-Claire-Deville. The *Commission de l'Armée*, and particularly Charles Humbert, attacked the handling of the affair, arguing that, when the field gun order was retracted, the shells crisis was being well managed. However, the response from Alexandre Millerand was firm. He criticised Humbert for perpetually saying that France was populated by unintelligent and antipatriotic people. The order for 75mm batteries had been suspended because the Aciéries de la Marine had stated that it was not able to provide the necessary steel to fulfil orders for both munitions and materiel. Furthermore, the order already made with Schneider-Creusot for twenty batteries had continued, and the batteries would begin to be delivered in April 1915 and completed in October. The industrialists had never complained to the Ministry of War about the suppression or reduction of orders, and if they had declared to the *Commission* that they would have been able to carry out a delivery of the order in three or four months, they were contradicting their earlier declarations. In summary, Millerand stressed that all orders that could be viably completed had been placed.

³¹¹ SHAT 6 N 16, Première rapport fait au nom de la Commission de l'Armée sur le canon de 75mm par Charles Humbert, 18 March 1915, 8.

Unfortunately, Baquet's response was more abrupt, with his main point summarised by the oft-misquoted statement: 'we have too many guns for the number of shells at our disposal.' French industry was already struggling to provide shells for the existing artillery, and therefore it was pointless to produce new pieces that they would not be able to supply.

The phrase that the *Commission* picked up was 'we have too many guns', which became the stick with which Baquet was beaten. To some extent, Baquet made the rod for his own back, as he shied away from responding to his critics, viewing civilians as lacking the technical knowledge to fully comprehend the situation.

Even eight months into the war, no new 75mm guns had been produced. The *Commission* summed up the bleak artillery situation, concluding:

- That of 4,712 pieces of 75mm making up the field artillery at the start of the war, 569 had been lost or destroyed;
- That, to replace the missing pieces at the front, it had been necessary, for lack of a general reserve, to make requisitions from the interior formations, notably from the depots;
- That the number of guns put out of service could only increase in the future, because of wear through intensive fire;
- That to meet all the needs of the army, France needed a monthly production of two hundred to three hundred barrels and the production of 1,500 to 1,800 entirely new vehicle drawn pieces;
- That the artillery workshops, providing at least one hundred barrels per month, were not even at the level to meet the needs for repairs and thus could not be used to construct supplementary materiel;
- That little real effort had been made to recruit private industry, and having ordered one hundred batteries, the *Services Techniques* had reduced this figure to twenty without fixing a date of delivery.

Baquet became the scapegoat for all the problems of French mobilisation and for failing to arm France. Eventually, he was driven out of office in June 1915, although he was rewarded by being raised to the grade of commander in the Legion d'Honneur, while Sainte-Claire-Deville was given a third star by decree from Poincaré.³¹²

³¹² Terrail, *Au sein des commissions*, 352–63.

The source of the staunchest criticism of the government was Charles Humbert. Humbert's correspondence often reveals an individual more interested in playing up his own importance and trying to preserve his own place in history than genuinely seeking to aid the war effort. For instance, his letter to Poincaré on 19 June 1915 began,

For many years I foresaw the tragedy proven today. I spent all the energy I had trying to raise the alarm, to demand the necessary effort for national preservation... Since 1905, not a week has passed that I have not tried to make my country hear the pressing warnings. I highlighted all the armaments efforts that Germany was making. I denounced our lack of concern, our inaction. I highlighted all the insufficiencies in our war materiel. I clamoured for all the improvements that the facts demonstrated to be indispensable. I pursued this in public, in parliamentary assemblies, and with the relevant administrations. I campaigned daily in the press, I published books, such as *Somme-nous défendus*, which has had a significant impact.... [After the Morocco crisis] The German armaments production intensified, but the French effort did not even begin to materialise. I spoke in front of the head of the general staff, the Minister of War, and the president of the Conseil... my worries exclusively motivated by reasons of national security.³¹³

Humbert blamed the lack of progress on 'ministerial instability, poor organisation of the administrative structure, a repugnance for responsibility, and the impossibility of any serious outside control.' Seemingly, it was necessary for a parliamentary commission to 'step in to demand the most urgently needed military reforms.'³¹⁴

Poincaré challenged Humbert's claims in a letter on 20 June 1915. There was a popular belief that Humbert's pre-war campaign was inspired by the manufacturers, seeking large contracts that might prove ruinous for the state. Poincaré said that Humbert had never raised his concerns throughout 1913 or in 1914. After Humbert's report in 1912, Poincaré had written to Humbert asking him to meet but had received no response. He chastised Humbert for being unaware of the actions Poincaré had taken and the efforts he had made to gather information and to tackle the situation, and for subsequently reproaching him in

³¹³ Letter from Humbert to Poincaré, 19 June 1915 in *ibid.*, 370.

³¹⁴ *Ibid.*, 168.

writing and in public for being deaf to his warnings. In particular, he suggested, 'if I did not know how patriotic you are, I could be made to believe that in writing all these letters, where your emotion takes such a literary form, you try, in these tragic hours, to preserve for yourself the compliments of history.'³¹⁵

Poincaré's tone became increasingly short. 'You want us to give the army as many guns and shells as possible. Bravo! You have friends in government. Ask them! They will tell you that since the start of the war... I have not ceased calling for the same things as you; they will tell you of the stubbornness with which I demanded more bullets, more light artillery, more heavy artillery, more shells.... If someone is failing in their task, denounce them straight away, honestly, brutally, from the podium. Weeding out the wrong-doers and the incapable individuals would not destroy the *union sacrée*.'³¹⁶ He questioned the merits of Humbert's repeated self-referential reports that ultimately did little to help the French cause.

Because of its remit, the *Commission de l'Armée* was always looking backwards, ascertaining what had gone wrong, criticising, and offering advice on what approach might have been taken. However, this was of little help to those seeking to improve the current situation. Repeated calls to answer questions on previous decisions were a consistent distraction that antagonised those in the Ministry of War. Poincaré described a report from Paul Doumer on 2 May 1915 as 'a veritable prosecution of Millerand and the management of the war.'³¹⁷ It rarely looked forward, failing to offer constructive advice on how to improve the military and industrial situation. It was a microcosm of the entire French war effort, which was consistently reactionary, rather than well planned and organised.

³¹⁵ Letter from Poincaré to Humbert, 20 June 1915, in *ibid.*, 379.

³¹⁶ *Ibid.*

³¹⁷ Raymond Poincaré, *Au service de la France*, vi, 185.

Creation of the *Sous-Secrétariat d'Etat*

By spring 1915, it was clear that the war would not be over quickly and that *ad hoc* responses to munitions and materiel shortages were not fruitful in the long-term. A more effective coordination of industrial production was needed, and, as has been touched on above, this was accompanied by an increasingly bureaucratic approach. In May 1915, the *Sous-Secrétariat à l'Artillerie et aux Munitions* was created and became the key body for industrial mobilisation and management, before subsequently evolving into the Ministry of Armaments in 1916. 'It rallied the dispersed industrialists, grouped them together, supported their development, divided orders, raw materials and manpower among them: simply put, it was the guiding force which converged all the efforts towards achieving a single goal.'³¹⁸

The man in charge of the *Sous-Secrétariat d'Etat* was Albert Thomas, a disciple of Jean Jaurès, and an eminent member of the SFIO (French Socialist Party). 'He was there – much more than the organiser – the source of inexhaustible force, the animator and the inspirer, revealing his creative capacity in all his power.'³¹⁹ Thomas was born in 1878 in Champigny-sur-Marne, the son of a baker. After studying at the *École Normale Supérieure*, he had worked since 1904 on improving worker conditions and had become a counsellor in 1908, a deputy in 1910 and subsequently a mayor in 1912. He was convinced of the need to improve the position of the lower classes through social reform and sought cooperation between socialists and trade unions.³²⁰

³¹⁸ SHAT 10 N 2, Bulletin des Usines de Guerre: Questions Economiques.

³¹⁹ Schaper, *Albert Thomas, trente ans de réformisme social*, 107.

³²⁰ Lettre à Léon Jouhaux, cited in Hatry, *Renault, usine de guerre 1914-1918*, 130.

He believed that labour had a stake in the development of the economy and therefore of industry and production methods. More could be gained through working towards actual improvements in factories rather than engaging in strikes or by debating theoretical issues at a Socialist congress.³²¹

The appointment of a Socialist was viewed as particularly novel at the time, with *The Times* carrying the headline in November 1915: "Pacifist Becomes Producer of Guns."³²² Despite the *union sacrée*, and the success Thomas would ultimately achieve, he was still viewed with suspicion and kept under surveillance by the political police. His political roots prompted his removal from office in September 1917 when the Painlevé government was formed and he was replaced by Louis Loucheur.³²³

Hardach argues that Thomas was largely successful in keeping his political views distinct from his task of mobilising the home front. He continued to address workers as "comrades", but, as Millerand had stressed 'there are no more workers' rights, no more social laws, there is only the war.' Thomas seemed to accept this view, allowing the suspension of existing social legislation and limits on working hours, and instructing factory inspectors to overlook abuses. However, he did not ignore social policy completely. Production was his chief aim, but he also sought to increase worker regulation and improve working conditions, particularly as women became increasingly involved in the manufacturing process. He felt that workers could be encouraged to produce for the state through winning their support with social efforts.³²⁴ For instance, in January 1917 a decree was passed making the Ministry of Armaments the overriding arbiter in labour disputes

³²¹ Kuisel, *Capitalism and the State*, 34.

³²² *The Times*, 30 November 1915, cited in Hardach, "Industrial Mobilization," 64.

³²³ *Ibid.*, 65.

³²⁴ Godfrey, *Capitalism at War*, 183; Smith, *France and the Great War, 1914-1918*, 65.

between workers and owners, and among other initiatives it passed rulings on minimum wages.³²⁵

At the start of the war, Thomas had spent a few weeks in a territorial regiment as a sergeant and subsequently a lieutenant, before being recalled initially to manage the running of the railways, arranging the evacuation of Paris.³²⁶ He was recruited by Millerand, with whom he was closely acquainted, in October 1914 and was an insatiable worker, arriving at eight in the morning and finishing each day at two a.m., closely managing the committees and departments under his control, and persistently encouraging those engaged in the war industries to increase their efforts. He wanted to be informed of the minutiae of all the problems and questions that were being dealt with.³²⁷ Thomas recognised that the *Sous-Secrétariat* needed 'to respond to the...needs of the army' but also 'to reach beyond the immediate programme, which varies according to circumstances... and beyond the requests of men who, because of the position in which they find themselves, cannot always foresee what will be needed for tomorrow's campaign.'³²⁸ During his time in office at the *Sous-Secrétariat*, the number of workers employed in war industries rose from 50,000 in August 1914 to 1.7 million in September 1917; the production of 75mm shells rose from 13,500 a day to 212,000 a day, and 155mm shell production rose from 405 a day to 45,000 a day. In comparison, in July 1916, Britain produced around a million shells of all calibres *per week*.³²⁹

Problems did emerge under Thomas's administration, although it is difficult to ascertain the extent to which he can be wholly blamed for them. One key issue was the overestimation

³²⁵ Hardach, "Industrial Mobilization," 65.

³²⁶ Godfrey, *Capitalism at War*, 183.

³²⁷ Carls, *Louis Loucheur*, 13; Schaper, *Albert Thomas, trente ans de réformisme social*, 107.

³²⁸ Cited in Hennebicque, "Albert Thomas", in Fridenson, *The French Home Front, 1914-1918*, 99.

³²⁹ Godfrey, *Capitalism at War*, 186.

of production capacities, resulting in persistent failures by industry to meet targets. In September 1916, he was chastised by the *Conseil supérieur de la défense*:

The *Sous-Secrétaire d'Etat* must not promise more than is reasonably possible to prevent the high command from engaging in operations for which we would not be able to furnish the promised quantities of large shells. One need only consult the monthly statements of production statistics to observe that each time Thomas has asked industrialists to make an effort to produce some shell that is required for anticipated operations, the industrialists, understandably, have promised a great deal but have never, for all their good-will and devotion, fulfilled their obligation.³³⁰

Along with ambitious promises, there were also issues with defective products, exorbitant profits and even fraud.³³¹ Indeed, the failure to control industrial munitions profits became increasingly prevalent and fuelled the anti-Thomas movement that pressed for his removal in 1917.³³²

Thomas in action

Thomas's first task was assessing the state of French industry. Due to the pre-war reliance on state arsenals, there was a distinct lack of information on the capabilities and capacities of the private sector. Between October 1914 and May 1915, before he took control of the *Sous-Secrétariat d'Etat*, he visited all the factories of France to ascertain the workshops and personnel available. All producers were considered, including manufacturers of automobiles, bicycles, vehicles and even watches. Due to the level of improvisation and the dispersal of workshops, it was very difficult to control the methods of production. Schaper argues that there was a great deal of enthusiasm to help the war effort, with Thomas declaring that the workers recruited went to their tasks with 'the same spirit as at the

³³⁰ SHAT 94 AP 72, cited in *ibid.*, 187.

³³¹ Kuisel, *Capitalism and the State*, 35.

³³² Carls, *Louis Loucheur*, 19.

front'.³³³ Indeed, no rest or holiday days were given between September 1914 and February 1915. However, while this may have been true of those on the workshop floor, it was not necessarily the case for the industrialists, who proved somewhat more reluctant to take on the burden of the nation's war effort.

The Minister of War, and subsequently the *Sous-Secrétariat d'Etat de l'Artillerie et des Munitions*, held weekly meetings with the heads of the industrial groups. There were different meetings for those producing field gun shells and heavy shells, as well as those producing iron, steel and cast iron shells. Representatives of the *Comité des Forges* and the *Chambre Syndicale du Matériel de Guerre* also attended, along with any other key industrial figures who were not heads of their respective groups. Over the course of 1915, Albert Thomas transitioned to monthly meetings. The day before each meeting, Léon-Lévy presided over a preparatory meeting of industrialists to collate the requests and observations that they planned to present, and these were passed to Thomas in advance so that he could prepare responses and avoid administrative delays. Robert Pinot was particularly complimentary about the strong working relationship between the industrialists and members of the Ministry of War: 'We remember all the exploits that we accomplished, and we all genuinely thought that the Minister thought that "impossible" was no longer a French word.'³³⁴

It was apparent that the task required greater bureaucratic management. The new structure reorganised the process through which orders were made with industry. The goal of the *Sous-Secrétariat* was summarised in six points:

- 1) To ascertain the needs of production;
- 2) To divide these needs logically among the various departments;

³³³ Schaper, *Albert Thomas, trente ans de réformisme social*, 107.

³³⁴ Pinot, *Le Comité Des Forges*, 188–9.

- 3) To make orders and to oversee their execution by industrialists after being informed of the production capacity of these industrialists;
- 4) To regulate orders through contracts;
- 5) To oversee the execution of these contracts;
- 6) To provide industrialists with the necessary materials to fulfil the contracts.³³⁵

As the *Sous-Secrétariat* was only created nine months into the war, it took considerable time to get up to speed. Further reorganisation and restructuring, and the creation of numerous sub-committees throughout 1915, added to the confusing and haphazard structure, and a sense of coherence only began to emerge after a number of months. Nevertheless, Thomas was able to draw on an increasing wealth of expertise. There were always at least seven general inspectors assigned to matters relating to artillery, and this rose to twelve following the transition to the Ministry of Armaments.³³⁶

The *Sous-Secrétariat* was made up of individuals from non-bureaucratic backgrounds, and was headed by Albert Thomas until late 1916, and subsequently by Louis Loucheur, two men who would have an enormous influence on France's mobilisation and industrial production throughout the war. It comprised three *bureaux* and seventeen *sections*, and was staffed by men that Albert Thomas knew from the *École Normale*, such as Roques, the economists Simiand and Oualid, and Arthur Fontaine, who was charged with the recruitment and control of manpower as well as the management of contracts.³³⁷

Proliferation of committees

As Albert Thomas's task grew, he continually reorganised the *Sous-Secrétariat* to respond to the urgencies that arose on a daily basis. The new structure in place following the creation

³³⁵ AN 94 AP 71, Note, Service Industriel, 17 August 1915.

³³⁶ Porte, "Mobilisation industrielle et guerre totale," 16.

³³⁷ Godfrey, *Capitalism at War*, 184; Schaper, *Albert Thomas, trente ans de réformisme social*, 107.

of the *Sous-Secrétariat d'Etat* meant that the needs of the army were better known, along with the capacities of industry. Heads of the individual armies and the key figures at the French general staff indicated to the *Service des Inspections Permanentes de Fabrication* the orders that they felt should be placed with industrialists. These orders, after being examined by the *Service des Inspections Permanentes de Fabrication* and by the new *Service Industriel* under the supervision of M. Hugoniot, were divided between the various industrialists. The *Direction des Forges* dealt with the contracts alongside the *Inspection des Forges* in each region of France, with the former also taking charge of the provision of raw materials; and then the *Inspection Technique*, with the cooperation of various heads of industry, oversaw their execution.

The primary role of the *Service Industriel* was orientating the industrialists rather than decision-making. It maximised the efficient use of industrial resources through the study and application of the best methods of work, and by the grouping of small industries that struggled to work on their own in an effective manner.³³⁸ It formulated a comprehensive understanding of the industrial resources of the nation; indicated to industrialists the best methods for production, the best use of manpower and the most suitable machinery to employ; and it facilitated visits for engineers and factory heads to companies where production was going well and was best organised.

The *Service des Forges* comprised the *Direction des Forges*, and two *Inspection* offices, one in Paris and one in Lyon. Two more *Inspection* offices were created at Nantes and Toulouse early in 1915 to ensure the supervision of the ever-increasing number of orders and contracts made with industrialists in those areas. The role of the *Direction des Forges* was to deal primarily with the preparation and negotiation of contracts, and to oversee their

³³⁸ AN 94 AP 71, Note, *Service Industriel*, 17 August 1915, 6.

execution, both for the *Administration de la Guerre* and for allied governments. The number of deals overseen by the *Direction de Forges* rose considerably, from 2,800 in 1914, to 6,000 in 1915, and 7,700 in 1916, before dipping to 5,500 in 1917, due to a consolidation of smaller contracts into larger, longer term orders.³³⁹

Outside the large meetings held by Albert Thomas with the generals and heads of departments, a daily meeting of no more than an hour would take place with each of the liaison officers of the various offices, particularly the *Service Industriel*, *l'Inspection Permanente des Fabrications*, *l'Inspection Technique*, the *Service des Forges*, and the various other Inspections, in order to ensure that each department was aware of the mindset and actions of the other sections.³⁴⁰

Albert Thomas sought to improve efficiency by retaining private initiative, driven by profit, with economic conditions maintained as close as possible to those of peacetime. The heralding of private initiative clashed with the *Commission de l'Armée's* criticisms about the suppression of entrepreneurial spirit. War profits were seemingly a necessary evil, while, as the war continued, the state was willing to assist private enterprise by giving direct grants for industrialists to construct or expand new factories. In return, the state insisted on working in close cooperation with the heads of industrial groups, retaining strict control over prices and the implementation of production plans.³⁴¹ Len Smith argues that under Thomas, 'the new administration heralded the birth of technocracy in its flexibility, pragmatism and willingness to introduce unconventional solutions.... The Ministry of Armaments combined market principles with centralised planning, both within France and at the international level, through its organisation of trade with Great Britain and the

³³⁹ SHAT 10 N 1, Note sur le *Service des Forges*, n.d.

³⁴⁰ AN 94 AP 71, Note, *Service Industriel*, 17 August 1915, 5.

³⁴¹ Smith, *France and the Great War, 1914-1918*, 64.

United States.’ It pursued a new type of government intervention that was a clear break with pre-war liberalism yet a long way from the strict *dirigisme* of a state-directed economy.

Thomas apparently sought to establish « *l'économie organisé* » or « *l'économie collective* », which he had pushed before the war and involved the close cooperation between industrial groups, aiming for the ‘permanent collaboration across class lines in a mixed economy’, combining ‘the goals of justice contained in socialism and of private initiative contained in capitalism.’³⁴² The state would be the instigator of a new corporatism that facilitated the production effort and would prompt further transitions towards reformist socialism following the war. Thomas promoted private initiative and recognised the importance of preserving incentives for profit for industrialists. He saw that France had a great opportunity to undergo ‘an enormous industrial revolution’, with the emergence of huge, modern factories across the country.³⁴³

Thomas hoped that the industrial effort made in mobilising for an industrial war ‘could be the starting point for a genuine renewal.’³⁴⁴ His outlook was expressed in a speech made to the personnel of the Le Creusot factory in April 1916:

Before, during peacetime, the industrialists had numerous criticisms of the state; they were isolated... aimlessly competing against each other. Today their efforts are focused; they have responded to the call of the nation, they have allowed this collective organisation that the most daring of us had never dared to dream of... before, there was competition, or at least the absence of unity, often infighting.... All that has been resolved by the common will in wartime.

³⁴² Smith in Horne, *A Companion to the First World War*, 420.

³⁴³ Speech to Renault Workers, 25 November 1917, cited in Kuisel, *Capitalism and the State*, 35.

³⁴⁴ Smith in Horne, *A Companion to the First World War*, 420; Becker and Becker, *La France en guerre (1914-1918). La grande mutation*, 55.

This gives far too much credit to the *Sous-Secrétariat* and to Albert Thomas and implies a distinct level of control, foresight and planning. In actuality, the reaction to the developing demands of the army was overwhelmingly *ad hoc*, with expedient decisions taken with little forethought, often resulting in a myriad of problems later on. Furthermore, the relationship with industry was not as rosy or as intentionally pro-industrialist. As will be seen in a later chapter, industrialists required considerable convincing in the form of large contracts and high prices to work for the state. This was not a conscious economic policy, but a reaction to the necessities of war and the urgent desire to increase production. While the administrative structures did become increasingly technocratic, particularly once Loucheur became Minister of Armaments in 1917, Thomas was more concerned with scrambling together the necessary resources for the army rather than putting in a new, structured administrative system.

Smith goes on to argue that 'even though Thomas came to prefer more state planning after 1916, he generally promoted war industry to a position of partnership with the state, in a relationship based on collaboration and encouragement rather than on formal control.'³⁴⁵ Again, this is too favourable towards Thomas and suggests that the relationship with industry was intentional. The evidence does not support this: industry was only in a position of apparent partnership because it held all the power in its negotiations with the state and had to be treated with a great deal of respect in order to ensure that it stayed on board. There were large profits to be made by industrialists, but this was because they could dictate their demands to the state, which desperately needed industry's help. Albert Thomas was particularly reluctant to impose strict penalties for late deadlines and delivery on industry, as he did not wish to dissuade it from further war production.

³⁴⁵ Smith, *France and the Great War, 1914-1918*, 64.

Nevertheless, despite the reactionary response, Thomas recognised that the war presented an opportunity for France to make great industrial strides. In 1915, he challenged workers that once victory was achieved, 'French industry must henceforth dominate the world in all markets and score new victories.' Having struggled to match the pre-war progress of Germany, Britain and the United States, Thomas hoped that the economy could be revitalised by the pressure to modernise and increase production. He stressed to the Chamber of Deputies in February 1917 his concern that, 'on the eve of the war, [France] had insufficient industry, and... if it wants to survive the economic struggle that will follow the military struggle, [it] will need a solid, powerful industry.'³⁴⁶

Thomas roused images of the Napoleonic era, with the entire nation striving to defend and improve France: 'the wartime spirit must not disappear. We have found a force to meet all the requirements of the war but also to make France anew: the France of tomorrow, which will emerge from victory greater than before.' He urged industrialists to embrace cooperation with each other and the government following the war, highlighting the extraordinary things that they had achieved thus far and the potential achievements to come.³⁴⁷ Therefore, although Thomas's initial efforts reflected short-term expediency rather than the implementation of a long-term plan, he embraced the developments and sought to maximise the benefits that France could reap from the increased role of the state in the management of industry.

Economic Ideology

Historians have made much of the economic ideology of those in charge at the Ministry of War and, from 1915, the *Sous-Secrétariat d'Etat d'Armement et des Munitions*. However it

³⁴⁶ Cited in Hennebicque, "Albert Thomas", in Fridenson, *The French Home Front, 1914-1918*, 122.

³⁴⁷ AN 94 AP 274, *Bulletin des Usines de Guerre*, 1 May 1916, 3.

is difficult to see how a comprehensive strategy could be implemented in the haphazard and reactionary climate of the first months and years of the war.

Before the war, the relationship between the state and industry was evolving, with growing regulation on the conditions of labour, the purchase of the Western system of rail by the state in 1908, and the establishment and increasing involvement in old age insurance and savings banks. Such intervention was largely accepted by the French people.³⁴⁸ Renouvin outlines two main perspectives on state policy on the eve of war. One called for decentralisation and the removal of bureaucracy and administrative delays by delegating control to the general and municipal councils, prompting greater initiative and control over their own affairs, and avoiding the constant interference from government. The other called for more state control, as only the state could be trusted to deal with the most important matters, and private interest and initiative often became swayed by selfish motives.³⁴⁹

During the war, state intervention occurred progressively. This was unavoidable but, in an economic regime that remained essentially liberal, it only managed to produce results in the last year of the war. The war gave the government greater legitimacy to establish control over the economy, but it did not have the necessary workforce to manage the production directly and therefore sought to let private industry and unions perform much of the work. The state did not intervene directly in foreign trade until March 1917, when the commercial fleet was requisitioned and imports were required to have government authorisation. Despite the protests of manufacturers, it was deemed necessary because of the severe lack of raw materials, the pressing need for continued, large-scale production, and the political desire to curtail excessive profits. Still, extensive intrusion in the economy

³⁴⁸ Renouvin, *The Forms of War Government in France*, 5.

³⁴⁹ *Ibid.*

was persistently resisted, and its scale never approached that of Germany, which emerged relatively early in the war.³⁵⁰

The main encroachment was seen in Albert Thomas's attempts to oversee the methods and quality of production by private industrialists. Inspectors were assigned to ensure that labour was used efficiently, that raw materials were not needlessly wasted, and that the armaments produced met the required standards. While industrialists were initially reluctant to allow this, Thomas insisted that, 'the patriotism of industrialists enables them to understand that their...factories, which they have placed at the service of National Defence, could not continue to enjoy all the liberties and independence of purely private companies.'³⁵¹

Thomas also had the authority to impose a representative of the *Sous-Secrétariat* on a firm that was performing badly to ensure that contracts were completed on time, and, as a last resort, was able to requisition parts of the factory if results were particularly poor. Nevertheless, he preferred to establish control over industrialists without having to resort to requisitioning, primarily as the owners generally had greater experience in running their own establishments.³⁵²

It is easy to see how daunting the task was for the Ministry of War. The scale of the army's needs was overwhelming, and as a result the response was rushed and the administrative structure strained under the pressure. The decisions taken in the first weeks and months of the war had a significant impact on the course of production over the next four years, and often more problems were created than solved. As a result, the situation by summer 1915

³⁵⁰ Hautcoeur, "Was the Great War a Watershed?," 193.

³⁵¹ Cited in Hennebicque, "Albert Thomas", in Fridenson, *The French Home Front, 1914-1918*, 101.

³⁵² Hennebicque, "Albert Thomas", in *ibid.*

was still very serious, and it would take a considerable amount of time before the system was working well and the armies were adequately supplied with the resources needed not just to survive in the war but to seek victory. Furthermore, French pre-war shortsightedness had severe consequences for the progress of manufacturing.

Chapter 4 - Manpower

The lack of industrial preparation for the First World War created two long-term problems that transcended the war: the shortages of manpower and of raw materials. The difficulties of securing sufficient workers to produce raw materials and armaments affected all aspects of the production process, hampering both the quality and the quantity of materiel produced. There were two key causes of the manpower shortage: the initial mobilisation plan and the German invasion of northern territories. Furthermore, two obstacles complicated the problem: the reluctance of the army to cede men to the home front and administrative complications that plagued efforts to divert workers to where they were needed most. The lack of manpower plagued the Ministry of War throughout the war as increasing casualties at the front exacerbated the tug of war between industry and the army.

Between August 1914 and December 1915, the defence industry's workforce swelled by 33.5 percent, with around 500,000 workers sent back to the factories, and it grew by a further 215.7 percent between then and January 1917.³⁵³ However, the army remained reluctant to weaken its forces at the front lines, forcing industrialists to turn elsewhere for sources of manpower, looking to women, colonials, and prisoners of war. By the Armistice, in the armaments industry alone there were 1,700,000 workers, 497,000 military workers, 430,000 women, 425,000 civil workers, 133,000 young men under the age of eighteen, 108,000 foreigners, 61,000 colonials, and 40,000 prisoners of war.³⁵⁴

³⁵³ Strachan, *The First World War*, 1050; Becker and Becker, *La France en guerre (1914-1918). La grande mutation*, 54.

³⁵⁴ Becker and Becker, *La France en guerre (1914-1918). La grande mutation*, 53.

Mobilisation Plan

Plan XVII had only allowed for keeping the minimum number of workers in the state arsenals. If the war was to be short and violent, the general staff required as large an army as possible, and therefore 'it needed to mobilise the maximum that could be mobilised.'³⁵⁵ France was at an immediate demographic disadvantage, with a significantly smaller population compared to Germany. In 1914, France's population totalled 36,600,000, with 5,940,000 men of military age, compared to Germany's 9,750,000 out of a population of 67,000,000. France's military personnel made up almost twice the percentage of the total population (2.29 percent) compared to Germany (1.17 percent), and it consequently had to mobilise a larger proportion of its available manpower.³⁵⁶ Ultimately, 63 percent of workers were called up to serve at the front, forcing almost half of businesses to close having lost the majority of their workforce.³⁵⁷ Over the course of the war, 8.6 million men were mobilised, representing 20.2 percent of the overall population and 75 percent of males aged between 20 and 55.³⁵⁸ In the early weeks of August 1914, many of those drafted were released to return to positions in public service and the railways, but industry was not seen as important at this stage. Indeed, the mobilisation of industrial workers persisted at an above-average rate.³⁵⁹

In the armaments industry, only 11,000 workers were granted exemption from the mobilisation plan, of which around 7,600 were employed in the state arsenals. By contrast, the private arms industry, which employed 50,000 workers at the start of the war, received

³⁵⁵ AN 94 AP 84, Résumé des travaux depuis le début de la guerre, 1916, 4.

³⁵⁶ Ferguson, *The Pity of War*, 93–5.

³⁵⁷ Millett and Murray, *Military Effectiveness*, 197; Braud, "Le renseignement économique militaire en France à partir de 1916," 89.

³⁵⁸ Hautcoeur, "Was the Great War a Watershed?," 173.

³⁵⁹ Gerd Hardach, "Industrial Mobilization," 60.

little to no exemption.³⁶⁰ Disorder was rife. M. David-Menet, president of the *Chambre de Commerce* summed up the situation, ‘suddenly employers, employees and other workers had to leave, abandoning work that had already been begun; for many days, some industrialists did not even know the exact number of personnel that they would lose.’³⁶¹

The German invasion of the northern departments of France heightened the manpower problem. The country lost more than just resources, it also lost many of the specialist workers engaged in the factories. In 1914, seventeen departments had more than 40 percent of their active population employed in industry, and nine of these were invaded, including those with the highest percentage employed.³⁶²

Table 7 Percentage of the population employed in industry (invaded departments in italics)

Department	Percentage
<i>Nord</i>	65
District of Belfort	61
<i>Meurthe-et-Moselle</i>	58
Seine	55
<i>Vosges</i>	55
Loire	53
Bouches-du-Rhone	53
<i>Pas de Calais</i>	53
<i>Ardennes</i>	52
Rhone	52
Seine-Inférieure	49
<i>Oise</i>	48
Seine et Oise	47
<i>Somme</i>	45
<i>Aisne</i>	44
Aube	42
<i>Marne</i>	41

Source: Fontaine, *French Industry*, 7.

³⁶⁰ Hautcoeur, “Was the Great War a Watershed?,” 174.

³⁶¹ Hatry, *Renault, usine de guerre 1914-1918*, 20.

³⁶² Fontaine, *French Industry*, 7. "Industry" here is defined as those engaged in the extraction of minerals, manufacturing, transport, and public industrial services.

The invasion hit metallurgy and mining the hardest, with these industries losing 52.7 percent and 41.8 percent of their workers respectively.³⁶³ The *Service des Forges*, charged with organising the country's resources, was severely hampered by the mobilisation of nearly all its officers, rendering it almost powerless throughout August and September 1914, when it was needed most.³⁶⁴ Private industry was similarly affected. The engineer-in-chief of Renault spent the early months of the war clamouring for more workers as his factories struggled to meet its production targets.³⁶⁵

Initial Recall

Despite the shortages on the home front, the general staff persisted in trying to call up all available men to the army to try to achieve a rapid decision through numerical superiority until summer 1915. However, the Ministry of War's response was swift. It deemed the long-term production of munitions to be more important than the short-term supply of men to the front lines.³⁶⁶ On 24 September 1914, it conducted a census of available metalworkers stationed in the depots and Alexandre Millerand asked major industrialists for lists of the workers needed from key professions in an effort to recall specialists. On 11 October, to speed up the process, he ordered all turners and adjusters who had worked in the Seine department to be sent to Paris, along with all workers from a hundred major factories in the region. These workers were grouped in special depots, from where industrialists were authorised to recruit desired personnel, but the system did not run smoothly, as many *chefs de depot* obstinately refused to cede men under their command.³⁶⁷

³⁶³ Ibid., 8.

³⁶⁴ AFGG, 21, 54.

³⁶⁵ Ibid., 211–59, Joffre to Millerand, 8 October 1914.

³⁶⁶ Millett and Murray, *Military Effectiveness*, 197.

³⁶⁷ Hatry, *Renault, usine de guerre 1914-1918*, 78.

Once again, the speed with which the Ministry of War recognised the need to bolster industry suggests that there was an awareness almost immediately of both the weakness of French industry and the overwhelming requirements of large-scale domestic production. Nevertheless, it has not been possible to find any evidence of pre-war discussion on modifying the mobilisation plan to keep more men in armaments factories.

The total number of personnel employed in artillery production increased quickly to 323,000 by the end of May 1915. However, recruitment was prone to abuse and manipulation, with favours called in by individuals close to employers, gaining recall from the front and prompting suspicion of shirkers. Albert Thomas repeatedly stressed that this was not to be viewed as a simple way for wives to get their men back from the front and that the system was to be used purely for the most urgently required specialists.³⁶⁸ To combat corruption, workers were submitted to tests of their professional capabilities to make sure that they would indeed be of vital use in industry. If they failed to pass these tests they were returned to the front.³⁶⁹ However, in spring 1915 the government perceived the need for a more structured approach to the management of personnel.³⁷⁰

First, the *Sous-Secrétariat de l'Artillerie et des Munitions* created the *Direction de la Main d'Oeuvre* on 18 May 1915 to oversee the return of mobilised manpower from the front.³⁷¹ From 9 June 1915, the heads of the groups of industrialists were invited to declare the number of workers they deemed necessary for their factories in an effort to ascertain the scale of the shortage. In August 1915, the Minister of War conservatively estimated that the production programme for heavy artillery, along with the needs for metallurgy and explosives, required over 400,000 workers. A special department, the *Service Ouvrier*, was

³⁶⁸ SHAT 10 N 29, Réunion des Industriels fabricant de gros obus en fonte aciérée, 25 June 1915.

³⁶⁹ AN C7558, Commissions du Budget et de l'Armée, 8 June 1915, 49.

³⁷⁰ Fontaine, *French Industry*, 32.

³⁷¹ SHAT 10 N 1, Direction de la Main-d'Oeuvre, 15 December 1917.

set up to centralise all questions relating to manpower for both state and private establishments. Additionally, the *Service de Contrôle* was created to help with the supervision and verification of claims for workers.³⁷² Albert Thomas maintained a hands-on approach and was personally informed every evening of the number of men who had been requested. It fluctuated from 1,000 to 15,000 per day throughout 1915. From 12 June to 30 October, 138,000 requests were passed on to the commander-in-chief.³⁷³ From early on, the Ministry of War's bureaucratic approach was clear. Numerous additional committees, commissions and sub-committees were created in an effort to get a grasp on the situation, but this often served only to complicate matters as departments overlapped and struggled to coordinate effectively with each other.

The Ministry of War struggled to establish a coordinated approach. It was so desperate for workers that it was ruthless in its requisitioning of labour. M. Haas recounted how the *Contrôle de la Main d'Oeuvre* attempted to take seventy turners and ten metalworkers from his factory at Nantes following a reduction in output at the factory in question. However, M. Haas declared that this reduction was a result of the lack of metal delivered to him, and taking a significant proportion of his workforce would mean that the factory would be unable to produce to the desired level even if the raw materials were eventually delivered.³⁷⁴ The *Contrôle de la Main d'Oeuvre* had seen only the bare facts, rather than the overall picture of the situation. Its perception was of the immediate needs and shortages, rather than a long-term or even medium-term plan, and it had failed to consult with the *Service des Forges* on the state of supplies. In response, Albert Thomas stipulated that in the future, as the agents of the *Contrôle de la Main d'Oeuvre* were subordinates of the *Officiers Inspecteurs des Forges*, the two departments would have to agree on issues

³⁷² Ibid.

³⁷³ SHAT 10 N 29, Réunion générale des fabricants de gros obus en fonte aciérée, 30 October 1915.

³⁷⁴ AN 94 AP 72, Réunion des industriels fabriquant les obus de gros calibres en acier, 27 November 1915, 6.

affecting the industrial workforce.³⁷⁵ Furthermore, he asked that any instance of manpower being requisitioned during times of temporary unemployment due to delays in the arrival of raw materials be signalled to him by telegraph so that he could assess the veracity of the claims.³⁷⁶

The initial efforts appeared to work. In a meeting of industrialists on 2 October 1915, all those present claimed to be satisfied with the manpower situation, with Léon-Levy declaring that he had noticed a considerable improvement in his region. Nevertheless, he continued to stress the need for specialist workers, who were indispensable for production and would be of more use than five times that number of inexperienced workers.³⁷⁷ Shortages persisted into 1916, with limited numbers making it impractical or impossible for factories to work throughout the night, thus hampering output and preventing the fulfilment of the ever-increasing demands from the army.³⁷⁸

The Dalbiez Law

Throughout summer 1915, public dissatisfaction with the number of *embusqués* or “shirkers” slipping through cracks in the system rose, to the extent that Victor Dalbiez, a deputy, proposed a law ‘inspired by the need to obtain the best use of mobilised or mobilisable men... it gave the military authority the ability to recall workers that were deemed indispensable to war production.’ It was passed on 17 August 1915 and facilitated the return of 550,000 men from the front lines to the factories over the next few months, with greater governmental control to cut through the army’s resistance. It also established

³⁷⁵ Ibid., Réunion générale des fabricants de gros obus, 30 December 1915, 10.

³⁷⁶ Ibid., Réunion des industriels fabriquant les obus de gros calibres, 28 January 1916, 14.

³⁷⁷ SHAT 10 N 29, Réunion générale des fabricants de gros obus, 2 October 1915, 5.

³⁷⁸ Ibid., Réunion des Fabricants de Matériel Lourde, 5 August 1916.

a more stringent examination process to assess the suitability for work of each returning soldier.³⁷⁹

The Dalbiez Law had flaws though. The case of each individual mobilised worker had to be examined to ensure only the minimum number required for armaments production returned from the army. Mobilised men returning to the home front were able to choose the establishment that they were to work in, with their choice often not conforming to the most profitable organisation of production. For instance, workers frequently chose to work in a factory close to their home or family rather than one that was actually in dire need of workers. As a result, on 15 October 1915, the Minister of War issued circular no. 7106, introducing a statute for military workers. Having been detached from the army, the individual was now attached as a military worker to the factory or establishment where he was now employed; from a civil point of view, he would benefit from social and worker legislation, and would submit to the discipline of the factory, with no special military advantages; from a military point of view, he remained at the disposal of the Minister of War, who retained direct authority and could employ him in a more suitable position at any time. Military workers could not voluntarily leave their position.³⁸⁰ Nevertheless, the government's lax enforcement of the law consistently undermined it.³⁸¹

The extensive use of military manpower in factories raised some confusion over their role. The Ministry of War clarified on 9 May 1916 that a soldier sent to a factory to work in war production remained a soldier who had merely been assigned to a new post. He could no more refuse this post than he could, if he remained at the front, refuse to obey his superiors. Similarly, this position could not be forbidden to him. An industrialist who had

³⁷⁹ Bulletin des usines de guerre, 17 July 1916, cited in Hatry, *Renault, usine de guerre 1914-1918*, 79.

³⁸⁰ *Ibid.*, 79.

³⁸¹ Smith in Horne, *A Companion to the First World War*, 421.

requested military manpower had to accept what was given. This issue arose when a factory owner attempted to refuse a mobilised worker who had been assigned by the *Service Ouvrier*. This individual had previously been employed in the factory but had been fired well before the outbreak of the war. Because of this, the industrialist did not wish to take the worker back. The depot commander's response was simple: 'You are not hiring this individual, he is a soldier who is taking up the post to which he has been ordered by his superiors.' The matter was ultimately referred to Albert Thomas, who ruled in favour of the military administration's right to assign a soldier where it wished.³⁸²

The Dalbiez Law also threw up administrative complications, as the *Direction de la Main d'Oeuvre* did not have sufficient information to track down specialist workers who had already been mobilised into the army. Indeed, it noted how inefficient and haphazard the improvised organisation was compared to a system that might have been 'prepared and put into action from the day of mobilisation.'³⁸³ On 31 May 1915, Charles Humbert called on the Ministry of War to resolve the problem, as 'the lack of manpower is paralysing us and killing us: we need to bring them back.'³⁸⁴ Humbert had a dim view of the government's efforts to aid industrialists and to mobilise the nation for the war effort. He claimed that, 'at every turn, every time we try to break free from the bewitchment that has paralysed our military production for many years, and above all since the start of the war, there is a tenacious force that throws up obstacle after obstacle and discourages our patriotic efforts.'³⁸⁵ For instance, despite the approval of the return of workers from the front to the Schneider factory on 4 May, the following day Captain Bézin, a naval engineer at the *Service des Forges du Havre*, ordered Schneider to send all workers of the 1913, 1914 and 1915 classes, both specialists and non-specialists, to the front. Similarly, Le Creusot, having

³⁸² AN 94 AP 274, Les Usines de Guerre, 9 May 1916.

³⁸³ SHAT 6 N 16, Réponse au Rapport Gervais, 22 April 1915, 7.

³⁸⁴ *Ibid.*, Rapport par Charles Humbert sur le matériel d'artillerie lourde, 31 May 1915, 9.

³⁸⁵ *Ibid.*

received a large order for 1897-model 75mm field guns, requested further manpower in order to produce this quota. General Baquet's response was non-committal: he had asked the commander-in-chief for the manpower requested, but he could not guarantee when it would arrive. Nevertheless, he made it clear that 'the delays in the sending of workers or the lack of workers would not be accepted as an excuse for the failure to complete the order according to the agreed schedule.' Le Creusot was therefore expected to produce guns to a strict deadline even if it did not possess the manpower to make them.³⁸⁶ The rushed nature in which the initial contracts were signed left many of these issues unaddressed, creating confusion and discontent among industrialists while hampering production.

The Dalbiez Law was later refined by the Mourier Law, issued on 10 August 1917, which sought to restore greater balance between the home front and the army. The high command felt that too many people were recalled from the front under the Dalbiez Law, while the French public remained suspicious of the number of shirkers avoiding service in the army. The new law required the reassessment of all mobilised workers aged between 24 and 35, with those deemed fit for service sent back to the front unless they could demonstrate that they were indispensable to armaments production. Still, it had limited success: of the 88,000 workers sent to the front lines, only 6,000 came from war factories.³⁸⁷

Struggles between industrialists and the Ministry of War

The factory of Le Creusot provides a good example of the administrative flaws caused by the government's attempts to resolve the manpower issue. In spring 1915, it requested a

³⁸⁶ Ibid., 10.

³⁸⁷ Smith in Horne, *A Companion to the First World War*, 421.

minimum of 102 specialist metallurgical workers. While it received just thirty-eight, it was also ordered to send thirty-seven workers back to the front, thus gaining just one worker overall. However, the factory also had to spend time training the incoming workers to fulfil the tasks for which they had been recruited. Le Creusot was one of the more favoured establishments, and it is likely that others were treated even more brusquely. Delaunay-Belleville, a large munitions manufacturer, received just two hundred workers, despite the mobilisation of 1,100 men from its factories.³⁸⁸ Another industrialist was ordered on 19 May 1915 to send fifty-eight men, including the foreman, the head of production, the head of supplies, and the majority of their specialists to the army. If the order had been carried out, the factory would have been forced to close immediately.

Furthermore, following a request for manpower for Chatillon-Commentry on 5 October 1915, Albert Thomas received the response that 'all the workers that have been asked for have been refused as they are indispensable to the army.'³⁸⁹ There are numerous other examples of the failure to supply the industrialists with the manpower to complete their ever-increasing orders. Schneider asked for 1,095 men between October 1915 and May 1916; at the end of May 1916, 502 were returned. In June 1916, they asked for 1,791 men; as of 20 October, 836 had been returned. The sub-contractors of Schneider (Giros et Loucheur, Chantiers de la Loire, Société Alsacienne de Constructions Mécaniques, Chantiers de la Gironde) asked for 1,617 men and were sent 679. The Forges et Aciéries de la Marine et d'Homécourt asked for 1,695 workers, they were sent 1,299. Although these numbers appear shocking in terms of the apparent shortages in the factories, it is likely that the factories overestimated their manpower needs and requested the maximum possible numbers in order to ensure that they met their production targets. This does not mean that their output quotas could not have been produced with a more limited supply of workers,

³⁸⁸ SHAT 6 N 16, Rapport par Charles Humbert sur le matériel d'artillerie lourde, 31 May 1915, 11.

³⁸⁹ Terrail, *Au sein des commissions*, 343.

and attention soon turned towards increasing the efficiency of the existing workforce as sources of manpower became scarce.

Despite the individual efforts of Albert Thomas, his office was not always accommodating when dealing with requests from industrialists. The *Sous-Secrétariat d'Etat* argued on 26 October 1915 that industrialists should be satisfied with the number of workers returned to them. Of 3,495 requested, 2,470 (roughly 70 percent) had been returned to the home front, meaning that industrialists 'only lacked 1,025'. At the army level, there was a misunderstanding of the needs of industry and the importance of different roles. One general sought to call up seventy draughtsmen, saying that he understood the usefulness of turners, adjusters and forgers but not draughtsmen, despite the fact that the number of drawings and plans required for even the smallest item was immense. The Ministry of War was asking the industrialists to expand production while refusing them the means to do so. Terrail argued that to take hundreds of specialists from the factories was to take almost as many guns away from the army, while across the front Germany was recalling all its specialists in an attempt to improve its domestic output: 'The enemy reinforces and increases its factories, we are sabotaging ours.'³⁹⁰

Despite protests, the *Sous-Secrétariat d'Etat* persisted in taking workers from the factories. On 16 October 1915, Albert Thomas ordered industrialists to make all young people from the classes of 1916 and 1917 available for call up to the army by 10 December, whatever their specialities. These would be replaced, man for man, with men pulled back from the front, despite Thomas having given assurances on 10 April 1915 that specialists would be permitted to remain in their factories. The effect of this was potentially disastrous. For instance, the Bourges factories would have to reduce their output by five guns per day.

³⁹⁰ Ibid., 348–50.

Saint-Chamond protested that it would cause ‘serious inconveniences at a time when we are asked to push production to the maximum.’ The interruptions would be considerable as more time would be devoted to the instruction and training of new individuals. Thomas subsequently promised to do what he could to keep workers classed as vital in the factories, stating that he would consider ‘all the men of the 1916 and 1917 classes occupied in the production of artillery materiel as indispensable,’ but the exchange between the depots and the factories took place nevertheless, and the incident highlights the lack of clear direction and planning within the *Sous-Secrétariat*.³⁹¹

Industrialists also complained about the seemingly arbitrary replacement of ‘unskilled labour’. In certain factories, men classed as unskilled labourers had been trained up and specialised since the war began. However, *Contrôle de la Main d’Oeuvre* replaced these workers from one day to the next with genuinely unskilled workers. This did not take into account the time necessary to bring the newcomers up to speed with the tasks of production, which was estimated to take anywhere from fifteen days to three weeks. In June 1916, Albert Thomas conceded that, while the government had hoped that the system of replacing younger workers called up to the army by older workers recalled from the front would be beneficial to all, in practice it had not been so smooth. He would therefore seek to limit it to those indicated by industrialists as being ‘unskilled workers’.³⁹²

Impact on Production

The lack of manpower inevitably placed severe limitations on production. In June 1915, the Delaunay-Belleville factory, producing 120mm shells, had thirty-five lathes unused due to insufficient manpower, although it was estimated that, if the requested labour arrived,

³⁹¹ Ibid., 350.

³⁹² AN 94 AP 72, Réunion des industriels fabriquant les obus en fonte aciérée, 3 June 1916, 6.

output could increase by 150 percent from two hundred shells per day to five hundred. In fact, in order to meet targets for 120mm output, the factory had been forced to reallocate workers from 75mm production, causing the output of the field gun shells to drop from 1,600 to 1,100 per day, illustrating the complex balancing act that faced both the Ministry of War and the industrialists as they sought to respond to the ever-changing priorities of the front lines.³⁹³

A further example of the improvements possible if sufficient manpower was supplied was given by Léon-Lévy on 28 August 1915 in the weekly meeting of industrialists with Albert Thomas. He claimed that, although his steel factory was currently producing eight hundred to nine hundred tons of steel per week, this could double or even treble if his requests for three to four hundred additional workers were met. He estimated that the total number of additional men needed in the metallurgy industry was 1,800 to 2,000.³⁹⁴

At this meeting, Albert Thomas made the surprising statement that in his opinion, apart from certain exceptions, industrialists were content with the number of men who had been returned to them from the front. This was immediately rebuffed by a number of responses from leading factory owners detailing the shortfall in their requests, suggesting a breakdown of communication between the *Sous-Secrétariat* and the industrialists. For instance, M. Vesier had received only half of the 400 men he had recalled, while M. Deries, a manufacturer of shell presses, had received just 120 largely incompetent workers out of the 300 that he had requested.³⁹⁵

³⁹³ AN 94 AP 73, Visite des Etablissements Delaunay-Belleville, 29 June 1915.

³⁹⁴ AN 94 AP 72, Réunion générale des fabricants de gros obus, 28 August 1915, 4.

³⁹⁵ *Ibid.*, 8.

The situation was improving slowly, with men slowly returning from the army, but, as the demands of the front lines continued to increase, more pressure was placed on the armaments industries, which consequently sought further workers to help bear the burden of production. While the first wave of recalls had served to bring firms close to their pre-war levels of manpower, efforts to continue the growth of production and the consequent expansion of factories meant that more and more workers were needed. Following the formulation of the production programme of 30 May 1916 for heavy artillery, the Schneider-Creusot, Saint-Chamond, and state arsenals, on which the brunt of production would fall, requested 1,831 specialist engineers. By the end of August, these requests had largely not been met. The Groupe de l'Artillerie had asked for 1,491 specialists, but received only 943, and Schneider-Creusot had received only half of the 2,139 workers it had asked for.³⁹⁶

Administrative Problems and struggles with the military

The Ministry of War faced an enormous task in its attempts to balance the manpower needs of the front lines and the home front, yet its *ad hoc* response caused complications that hindered the speedy return of workers to their factories. Once the need for increased industrial mobilisation became clear, the government promised that industrialists would be provided with the means to increase production, yet these promises were not kept, and the return of men to the factories was only made 'after innumerable discussions, long delays and significant reductions in the number of workers.'³⁹⁷ The Ministry of War appeared powerless to impose its will on the army, which protested at the numbers of soldiers withdrawn from the front. Early in 1915, the Ministry of War agreed, at Joffre's request, to limit the industrialists' demands to only the 'specialist workers of undeniable expertise.'

³⁹⁶ AN 94 AP 57, Rapport sur l'artillerie lourde par André Tardieu, 27 September 1916, 41.

³⁹⁷ AN 94 AP 84, Rapport sur les fabrications d'artillerie par Charles Humbert, 14 February 1916, 46.

Even with this restriction, the Ministry struggled to achieve significant results. The military authorities tried hard to retain their technicians, foremen, supervisors and metallurgical workers, despite industrialists arguing that their presence in the factory would enable the training of large numbers of less experienced workers.³⁹⁸

Often those requested were employed in specific roles in the army precisely because of their special skills, such as in the artillery depots, automobile depots and with the engineers, where it was deemed that they were often of more use than in the factories. They would have to be judged on a case-by-case basis, which took considerable time and resources.³⁹⁹

For certain categories of specialist there were no more men available to be recalled and therefore the turners and metalworkers of the 1917 class were all required to remain in the factories rather than join the army, as would normally have been the case. It was now deemed 'indispensable to survive with the current resources.' Albert Thomas sought to ensure that those specialist workers who were in the factories were used to the best effect and to push the work of female labour wherever possible. Special committees were formed from groups of technicians who would ensure a more judicious use of military manpower, and Albert Thomas highlighted the increasing number of roles that women were capable of performing at the Firminy and Vedovelli factories.⁴⁰⁰

As casualties mounted, the army became increasingly reluctant to cede workers. In January 1916, the French high command requested that industrialists no longer request the return of men from the front. Thomas was forced to inform industrialists that, 'General

³⁹⁸ Ibid.

³⁹⁹ SHAT 10 N 29, Réunion des Industriels fabricant de gros obus en fonte aciérée, 25 June 1915.

⁴⁰⁰ AN 94 AP 7, Réunion des industriels fabricant les obus de gros calibres, 28 January 1916, 14.

Headquarters asks that no more men be released from service at the front, because the efforts of the commander-in-chief and the Ministry of War to provide the army with all men capable of military service would be compromised if the ranks of our combatants were further thinned by new requests for industrial labour. Accordingly, men will only be released from the front in cases of urgent need.' It is interesting that Albert Thomas passed on this message at a meeting of industrialists. As the man in charge of increasing industrial production to an acceptable level, the denial of further manpower requests might have been something that he would oppose, yet by stating it to industrialists it appears that he endorsed this approach. It may be that he wanted to encourage industrialists not to rely on sheer numbers of workers but to attempt to streamline their production and become more efficient, particularly as, behind the scenes, he continued to press the reticent high command for the return of more specialist workers.

On 8 November 1916, Thomas informed Joffre, 'we can only overcome the most serious difficulties, such as manpower, through unreserved collaboration on your part.... If the rapid training of a specialised manpower is possible in the interior, it is only in the ranks of the army that we can find the specialists. Of the 5,600 that you were meant to put at my disposal on 3 November, only 2,145 specialists arrived at the Paris metallurgy depot.' Thomas was highly critical of the work that specialised workers performed in the armies. Qualified adjusters were used for repairs 'that a village locksmith could perform.' He suggested that a winter leave should be granted for industrial workers to boost the home front manpower, similar to the practice in Germany, where 'our enemies understand the enormous importance of the production of war material.'⁴⁰¹

⁴⁰¹ Hatry, *Renault, usine de guerre 1914-1918*, 79.

Thomas repeatedly lamented the difficulty of his position, pulled one way and then the other by the industrialists and the army. In a meeting of the *Comité de Guerre* on 7 September 1917, he detailed his attempts to convince the army to cede further workers, 'I defended our position of course, as I always have, by pointing to both the shortage of labour and the fact that there is an inevitable relationship in every factory between the quality of the materials and the number of specialists who work on them. But it is obvious that our position in this regard is becoming increasingly difficult.'⁴⁰²

Problems continue under Loucheur

In December 1916, Albert Thomas became the head of the newly formed Ministry of Armaments, and Louis Loucheur, a successful industrialist who began producing munitions at the start of the war, replaced him as *Sous-Secrétaire d'Etat*. Loucheur had seized the opportunity to manufacture large quantities of shells once the state began recruiting private industrialists in autumn 1914, and on 8 November 1914 secured an agreement from General Lagrange, *Inspecteur des fabrications de guerre*, to create two factories at Lyon and Puteaux. His knowledge of and connections to the other major industrialists was an important incentive for the government to offer him a role at the *Sous-Secrétariat*.⁴⁰³

Loucheur was a man of action rather than adhering to a well-defined ideology. He was pragmatic about the needs of the state, but bullish in seeking to push production and minimise delays, which meant that he remained firm in the face of protests and strikes. However, the manpower struggles continued, and Loucheur was forced to battle not only with the army, but also against other ministries seeking workers, and against Parliament,

⁴⁰² Comité de Guerre, 7 September 1917, cited in Hardach, "Industrial Mobilization," 62.

⁴⁰³ Barjot, "La grande entreprise," 775–790.

whose restrictive legislation complicated matters further.⁴⁰⁴ In summer 1917, he had to cede 9,000 workers to agriculture from munitions production, when he estimated that the metallurgy industry was still desperate for a further 26,000 men.⁴⁰⁵ In October 1917, the Mourier Law had been passed in the Senate and was being considered in the Chamber of Deputies, which would remove specialists from industry and take them to the front. Loucheur feared that this bill would severely hamper industrial efforts, as the army would be reluctant to replace those called up with workers from the front.

Loucheur worked tirelessly in his attempts to increase the manpower available to the armaments industries, but his methods were not always popular. When Albert Thomas returned from a trip to Russia in June 1917, he received a report from his staff concerning the actions of the ministry in his absence, including complaints of repeated encroachments by Loucheur into areas deemed to be beyond his jurisdiction, particularly concerning manpower. Loucheur wrote his own report, lamenting that the number of workers available to him had fallen considerably in the previous three months, with the munitions industry losing 6,000 young workers, while an additional 40,000 men had been transferred away from the armaments industry to areas such as agriculture and mining. He argued that he might be able to meet the existing production targets if his *Sous-Secrétariat* could take overall control of the placement and transfer of workers and he wanted to be informed in advance of any personnel changes. He highlighted instances where the *Direction de la Main d'Oeuvre* had failed to take the necessary care when assigning workers, to the detriment of

⁴⁰⁴ For greater depth on Loucheur's background, see Dominique Barjot, "La grande entreprise française de travaux publics (1883-1974) : contraintes et stratégies" (Thesis Doctorat d'État--Université de Paris IV, Sorbonne, 1990), 770–800 and Carls, *Louis Loucheur*. Loucheur's overall management of the Ministry of Armaments will be discussed in more detail in chapter 8.

⁴⁰⁵ Letter from Loucheur to Painlevé, 11 June 1917, cited in Carls, *Louis Loucheur*, 29.

national production. The best way to solve this problem, in Loucheur's opinion, was to grant him more power.⁴⁰⁶

The *Direction de la Main d'Oeuvre* responded brusquely, refuting Loucheur point by point. It argued that inspectors had already been asked to inform Loucheur in advance of personnel changes but that, because their mandate stretched beyond Loucheur's area of armaments production, there would inevitably be some changes that he was not aware of. It also criticised Loucheur's proposals, claiming that they would merely result in increased paperwork.⁴⁰⁷ The implication was that Loucheur should stick to his area of expertise and leave the manpower issue to the *Direction de la Main d'Oeuvre*.

It is difficult to ascertain how successful Loucheur was in imposing his desired level of efficiency on the offices of the armaments industry, but he was able to make headway in some areas. On 19 July, Loucheur expressed his satisfaction with the *Direction de la Main d'Oeuvre's* speed in introducing a proposal to streamline the allocating of steel workers, which freed a number of specialists and renewed his hope that production targets would be met. On 19 August, he received assurance from Thomas that workers' transfers would pass through Loucheur's office for approval before being carried out, which seemed to acknowledge that the system had not conformed precisely to the agreement that had been reached between the two in December 1916. Although his problems with the bureaucratic barriers eased to some extent once he replaced Albert Thomas as Minister of Armaments in September 1917, he continued to struggle to secure further manpower from the military with Philippe Pétain as commander-in-chief.⁴⁰⁸ Pétain was a firm believer in the importance of firepower, but the army had been worn thin by the engagements in spring 1917, hence

⁴⁰⁶ Notes préparées pour le retour du ministre, June 1917, AN 94 AP 176, cited in *ibid.*, 30.

⁴⁰⁷ Note for Albert Thomas from the *Direction de la Main d'Oeuvre*, July 1917, AN 94 AP 362, in *ibid.*

⁴⁰⁸ *Ibid.*, 32.

his preference to await the American troops rather than seek immediate success. Furthermore, the state of food supply became increasingly precarious throughout 1917 and 1918, prompting the release of 60,000 men from the army to agriculture in January 1917 and a further 210,000 between April 1917 and March 1918, all of which deprived industry of the workers it needed to continue to increase production.⁴⁰⁹

Loucheur's efforts might be seen as overly bullish, but another interpretation would be that they were the actions of a man driven by a desire to see the production targets met, for the good of France. Those that impeded this goal were hampering the war effort, and were therefore treated with short shrift.

Improvements to existing manpower

With dwindling numbers of men available to work in the factories, the emphasis shifted towards increasing the efficiency of those already engaged in industrial production. By late 1915, Albert Thomas was urging industrialists to improve training for their workers and to use the numbers they had more effectively.⁴¹⁰ A bulletin issued on 11 April 1916 declared, 'it is a necessity that no force is wasted. It is imperative that industry develops with the resources currently available.'⁴¹¹

On 28 May 1916, Thomas again reminded industrialists of the need to produce more with the available manpower. 'They should save and use the manpower available to them as best they can: the heads of each company should first organise their personnel into groups according to their skills and organise jobs according to their abilities to get the most

⁴⁰⁹ Fontaine, *French Industry*, 26.

⁴¹⁰ SHAT 10 N 29, Réunion des Industriels fabricant les gros obus en fonte aciérée, 29 October 1915.

⁴¹¹ AN 94 AP 274, Les Usines de Guerre, 11 April 1916, 5.

effective use out of the effort of each worker; teams should be organised so that machinery is always kept running.⁴¹²

The introduction of new production methods eased the situation slightly, particularly with the shift from drilled shells towards the pressing method, which freed workers for use elsewhere.⁴¹³ Léon-Lévy recommended in August 1915 that, when further military manpower became available, it be allocated to factories whose production was already up and running rather than those still setting up or becoming accustomed to the manufacturing methods, so that the labour could be put to work immediately and utilised as effectively as possible.⁴¹⁴

While in the early months of production the accepted solution had revolved around throwing increasing numbers of workers at the process, a much more rational process began to evolve from 1916 onwards. As specialists became increasingly scarce, the *Sous-Secrétariat d'Etat* pushed for a structure whereby each specialist supervised his own sub-team, was responsible for assuring that the men were clear on their roles, and ensured that the machinery functioned smoothly, rather than being isolated in individual tasks. Too often, factory inspectors came across technicians, metalworkers and turners involved in simple manufacturing processes or performing work that could be performed by unskilled labourers. As a result, master technicians and officers of the *Service des Forges* were tasked with drawing up an inventory of turners and metalworkers to ensure that they were being used to their capacity. If they were not, they would be reallocated to where they would be of more use.⁴¹⁵ This was echoed in attempts to shift the work of turners away from the process of finishing shells, which could be performed by women, to involvement in the

⁴¹² Hatry, *Renault, usine de guerre 1914-1918*, 80.

⁴¹³ SHAT 10 N 29, Réunion des chefs de groupes pour la fabrication des obus de 75, 28 August 1915.

⁴¹⁴ *Ibid.*, 2.

⁴¹⁵ AN 94 AP 274, Les Usines de Guerre, 11 April 1916.

more complex procedures earlier in the production process. At this stage, however, industrialists were still granted an element of freedom in the allocation of their workers and were not always pressed to make immediate changes that might disrupt the smoothness of the manufacturing operation. They had the liberty to choose which specialists to transfer, taking into account their role, the length of time they had worked in the factory, and their family situation.⁴¹⁶

Nevertheless, by 1916 a small number of industrialists had created their own apprentice schools, while a few others had begun to explore other means to develop the professional skills of their workers. This was increasingly encouraged throughout the year.⁴¹⁷ One of the problems involved in setting up technical training for individuals was that the level of training for each role was variable depending on the nature of the work and the aptitude of the individual. For instance, it was relatively easy to train a turner provided the individual was of reasonable intelligence and education, as this role required reasoning and focus. However, the role of a metalworker required technical precision only gained through extensive practice and experience, no matter how intelligent the individual in question. Nevertheless, the *Sous-Secrétariat d'Etat* sought to increase the number of apprentice schools, aided by the support of professional groups and municipalities working in collaboration with industrialists.⁴¹⁸

The Delaunay-Belleville firm set the example. It had taken the initiative when it first began to encounter serious difficulties in the recruitment of professional personnel and had sought to form its own manufacturing school. It was held up as the blueprint for others to follow. The school never had more than sixty students at a time from its creation in October

⁴¹⁶ Ibid., *Les Usines de Guerre*, 13 April 1916, 4.

⁴¹⁷ Ibid., *Les Usines de Guerre*, 11 April 1916, 6.

⁴¹⁸ Ibid., *Les Usines de Guerre*, 13 April 1916, 4.

1915 and produced hundreds of excellent turners, along with specialists in the various other areas of production. By May 1916, it was producing two new specialists each day that went back into the factories, supervising other workers and intensifying production. Initially the students of this school had been recruited from those already possessing experience in metalwork but, once this supply was exhausted, the school swiftly moved on to those possessing sufficient dexterity and skill not to make mistakes in the handling of very precise quantities and measurements. Indeed, the school reported that it had not had a single failure, with all the students passing the tests required to be classified as specialists after a certain length of time. The marks received were high, with most students obtaining sixteens and even eighteens on a scale of zero to twenty, marked on the quality of the work carried out.⁴¹⁹

Modernisation

Industrialists also sought to modernise their methods of production and in doing so reduce the number of workers required, introducing the use of conveyor belts, carts, trucks and automobiles. The heralded example for the *Sous-Secrétariat d'Etat* was the factories of l'Éclairage Électrique at Lyon, but their practices had not yet been copied as of 25 April 1916.⁴²⁰

Many industrialists hesitated to install modern machinery to ease the burden on manpower, as they believed that the installation would be too difficult and onerous to implement. Thomas felt that shifting from one method to another was possible without disturbing the smooth running of a company, provided that competent engineers oversaw it. The cost of such a switch would quickly be recovered by the saving in manpower and the

⁴¹⁹ Ibid., Les Usines de Guerre, 30 May 1916.

⁴²⁰ Ibid., Les Usines de Guerre, 25 April 1916.

increased output achieved. These results could only be obtained in relatively large factories with the help of a continuous stream of transport, which was critical to reduce the frequent fits and starts that had plagued production during the early years of the war, with machinery and raw materials arriving in dribs and drabs. Furthermore, space could be freed up as stock no longer had to be stored on site if it was picked up promptly.⁴²¹ The transition to more modern methods took time, as industrialists needed convincing of the merits of the changes. This will be discussed in more detail in Chapter 6.

Night work

Part of the drive to improve output involved the push to introduce night work in the major factories, which could give 'a marvellously rapid development... to our production,' that would enable France to make up the deficit in munitions extremely quickly.⁴²² For this, the major manufacturers such as Bourges, Schneider and Le Creusot needed an additional 1,310 workers. Charles Humbert chastised the army command for failing to see the bigger picture and cede the desired manpower, despite having been asked eleven times. For him, it was a scandal that, 'in the nineteenth month of the war, when more than ever we are lacking materiel... it is impossible for our war industries to organise night work and to double their production for the lack of 1,310 men.'⁴²³

Slowly more men returned from the front, and by September 1916, night work was in place in the larger establishments such as Schneider-Creusot and Saint-Chamond, while it was slowly being implemented in the Firminy and Renault factories. However, for the majority

⁴²¹ Ibid., Bulletin des usines de guerre, 5 June 1916, 43.

⁴²² AN 94 AP 84, Rapport sur les fabrications d'artillerie par Charles Humbert, 14 February 1916, 47.

⁴²³ Ibid., 48-9.

of the sub-contractors, either they continued to lack the manpower to introduce it or it was deemed that the requirements of production did not warrant it.⁴²⁴

Other manpower sources

The composition of the industrial workforce underwent a significant shift during the war. Initially, the Ministry of War's aim was for mobilised manpower to make up 80 percent of the industrial workforce producing armaments and munitions, but this target was never close to being achieved.⁴²⁵ Previous historians have largely covered the role of women in industry in the First World War, so I shall not dwell on this area too much. However, the Ministry of War recognised that women could serve a useful role. Although they were employed in increasing numbers, male workers were still wanted, as they trained and supervised the incoming female workers, who were rarely entrusted with complicated tasks.⁴²⁶ Nevertheless, Albert Thomas encouraged industrialists to employ women where possible in order to ease the overall pressure.⁴²⁷

The large-scale employment of women began in spring 1915 as a last option to try to solve the manpower problem. Many women had lost their jobs in the upheaval at the start of the war, so there was a large number with experience of work looking for employment to support their families. There were not, as is commonly assumed in popular histories, vast ranks of women drawn by the war effort into working for the first time. In October 1914, there were 159,000 unemployed women in Paris, representing 21 percent of the total population of active female workers, and more than half of the total unemployed. This

⁴²⁴ AN 94 AP 57, Rapport sur l'artillerie lourde par M. André Tardieu, 27 September 1916, 41.

⁴²⁵ AN 94 AP 274, Les Usines de Guerre, 2 May 1916.

⁴²⁶ SHAT 10 N 29, Réunion tenue au Sous-Secrétariat d'Etat de l'Artillerie, 28 June 1916, 9.

⁴²⁷ Ibid., Réunion des industriels fabriquant les gros obus en fonte acérée, 28 January 1916, 11.

figure was 86,000 in July 1915, with 36 percent formerly employed in the textile industry.⁴²⁸ Ultimately, the percentage of women in the overall labour force in France only increased from just under 30 percent pre-war to 37.2 percent in 1917, and declined again to 32 percent in 1920. However, there were shifts in key areas. The proportion of female workers in engineering rose from 6.5 percent of a small workforce before the war to 22.3 of a vastly expanded industry in January 1918. By mid-1917, 400,000 women were working in armaments and aviation, representing 24 percent of the overall workforce in that area, with 100,000 women in Paris making up a third of the workforce in the biggest munitions-producing region of France.⁴²⁹

Women took on an increasing number of roles, replacing men for the cleaning and finishing of heavy shells and almost all stages of the production of 75mm shells apart from casting and polishing. In one unnamed town, a large effort was made to save on military manpower; when the army removed 219 young soldiers of the class of 1910 and younger from the factory, more than 80 percent of them were replaced by women.

In spring 1916, the *Sous-Secrétariat d'Etat* sought to shift the emphasis towards the use of civilians and women, with the hope that the latter would make up a third of the workforce employed in the factories. Still, the transition was relatively slow, as demonstrated by the following table:

Table 8 Composition of manpower engaged in war industries

	1 January 1916	1 April 1916
Military manpower	47 percent	45 percent
Civilian manpower	39 percent	37 percent
Women	14 percent	18 percent

Source: AN 94 AP 274, *Les Usines de Guerre*, 2 May 1916.

⁴²⁸ Hatry, *Renault, usine de guerre 1914-1918*, 81.

⁴²⁹ Horne, *Labour at War*, 100.

Albert Thomas still did not view this as sufficient, but it was progress, particularly taking into account that the balance was skewed by the state establishments' almost exclusive employment of mobilised manpower before the war. Nevertheless, the state establishments had also begun to employ female workers, and it was in these areas that the most progress was made, with one particular explosives manufacturer recruiting more than a thousand women between the start of the war and spring 1916.⁴³⁰

Not everyone was enamoured with the arrival of women in the factories. While some saw it as affirming the spirit of the Revolution, patriotism, and heroism in the country, others were suspicious. The greatest reluctance came from the workers and unions. *L'Union des Métaux* feared that 'women begin to replace men. Is this through a lack of male workers? We don't believe it. Is it because of savings? This is more likely.' Similarly, Merrheim, secretary of the *Fédération des Métaux* declared at Cherbourg on 10 December 1916, 'whatever the state of the war, the employment of women constitutes a serious danger for the working classes. When the men return from the front, it will be difficult for them to fight against these new workers who will have acquired empowerment and earn inferior salaries.'⁴³¹

Some industrialists also resisted. The heads of the factories at Bordeaux and Toulouse declared, 'we have never had women so we cannot employ them now.' Albert Thomas's response was blunt: 'Hire them.' Ultimately, the recruitment of women was a necessity, and industrial discontent was a consequence that had to be overcome.⁴³² The *Comité du Travail Féminin* was created on 21 April 1916 and charged to oversee questions of female

⁴³⁰ AN 94 AP 274, Les Usines de Guerre, 2 May 1916.

⁴³¹ Hatry, *Renault, usine de guerre 1914-1918*, 82.

⁴³² AN 94 AP 274, Les Usines de Guerre, 2 May 1916.

wages, as well as supervising the organisation of female work and measures to improve the material and morale situation of those engaged in the armaments industries.⁴³³

Further progress in the use of female labour was made in July 1916, when the *Sous-Secrétariat d'Etat* decided that in order to make the best use of the available military manpower, mobilised workers were no longer to be employed in the execution of work that could be entrusted to women. From 20 August 1916, military workers, particularly those employed in office work, would be reassigned after eight days' notice. The work designated for women involved various operations relating to the production of 75mm and 120mm steel forged shells, particularly the casings, the cartridges, and the fuses.⁴³⁴

Colonial and Foreign workers

Another option was the use of colonial or foreign workers. The intensive recruitment of foreign labour began in 1916, with the first contingent of Greek workers arriving at Marseille on 3 July, followed by further arrivals from Portugal at the start of 1917, and subsequently Spain, Scandinavia, Italy, Serbia and Poland, after negotiations and agreements between the respective governments.⁴³⁵

The Ministry of War attempted to arrange for Italian workers to work in French factories, but negotiations persistently broke down as the Italian government wanted subsidies to be

⁴³³ Ibid., Bulletin des usines de guerre, 15 May 1916, 19.

⁴³⁴ Ibid., Les Usines de Guerre, 25 July 1916.

⁴³⁵ Nogaró, *La main-d'œuvre étrangère & coloniale pendant la guerre*, 2; John Horne, *Labour at War : France and Britain 1914-1918* (Oxford: Clarendon Press, 1991); John Horne, "Labor and Labor Movements in World War I," in *The Great War and the Twentieth Century*, ed. J. M Winter, Geoffrey Parker, and Mary R Habeck (New Haven: Yale University, 2000), 187–227; John Horne, ed., *State, Society, and Mobilization in Europe during the First World War* (Cambridge: Cambridge University Press, 1997); Gérard Noiriel, *Le creuset français : histoire de l'immigration, XIXe-XXe siècles* (Paris: Seuil, 1988).

paid for Italian workers, as well as salaries that were superior to those of French workers. As of June 1916, no resolution had been reached, with Albert Thomas remaining firm on the areas of financial dispute.⁴³⁶ By summer 1916, the French and Italian governments came to an agreement on the transfer of workers. The *Commissariat Royal de l'Emigration* was charged with recruiting and transporting men to a French border station. French industrialists would send requests to the *Sous-Secrétariat d'Etat*, and, if approved, the recruited workers would be directed to a frontier office, either at Modane or Vintimille, where the relevant establishments would take over responsibility for them. A deposit of fifteen francs per worker would be paid with the cost of transport being charged to their intended employers.⁴³⁷ Albert Thomas made further attempts to secure workers from Russia, although ultimately, little progress was made in this area.⁴³⁸

The idea of recruiting Chinese workers arose in early 1915, and, as it was difficult for the government to set up its own recruitment team in the country, a syndicate was set up in China that received remuneration for every worker recruited and delivered to France. Workers received a fixed salary of 1 to 1.50f per day of work, plus an allowance of 0.50f per day if ill, along with a grant for housing, food and medical costs, and a monthly allowance of 30 to 40f sent to their families in China. Transport to and from France was free, with the days in transit considered as days of work, and they would receive a bonus of 50f sent to their family on completion of their work. In total, around 150,000 Chinese workers were recruited in this manner during 1917, with 36,939 under French authority, 100,000

⁴³⁶ SHAT 10 N 29, Réunion tenue au Sous-Secrétariat d'Etat de l'Artillerie et des Munitions, 28 June 1916, 10.

⁴³⁷ AN 94 AP 274, Les Usines de Guerre, 23 May 1916.

⁴³⁸ AN C7558, Audition du Général Gallieni et de Albert Thomas sur le programme des armements, 26 November 1915, 58.

attached to the British army, and 10,000 to the American Expeditionary Force. Of those under French command, only 9,800 workers were put to work in industry.⁴³⁹

While workers from Greece, Italy and Portugal were recruited through official government channels, Spanish immigration was much more unregulated, with workers crossing the Pyrenean border looking for work. Many were recruited for agriculture, and it was only in late 1916 that the Ministry of Armament's Foreign Labour Service began scouring the border for potential munitions workers.⁴⁴⁰ In July 1917, the *Commission Interministérielle de la Main-d'Oeuvre* (CIMO) calculated that there were 270,000 officially registered immigrant workers in France at that time, of which 140,000 (52 percent) were working in war industries, and 31 percent in agriculture.⁴⁴¹ One problem associated with hiring foreign workers was that in many cases, such as those from Greece, the industrialists had to receive not just the workers, but their families as well, which many were reluctant to do.⁴⁴²

Furthermore, the proficiency of these workers was highly variable. For instance, in 1916, the head of Aciéries de Saint Etienne complained strongly about the 'mediocre' Spanish workers who had been allocated to him. He believed he needed French workers if he was to meet his target of doubling production.⁴⁴³ Similarly, of the 1,100 Chinese workers assigned to the factory at Luchon, 600 were sent back for being 'impossible to train and supervise' and causing 'catastrophic increases in costs.'⁴⁴⁴

⁴³⁹ Hatry, *Renault, usine de guerre 1914-1918*, 81; Paul J. Bailey, "Chinese Labour in World War I France and the Fluctuations of Historical Memory," *Studies in Ethnicity and Nationalism* 14, no. 2 (October 1, 2014): 362–82, doi:10.1111/sena.12091.

⁴⁴⁰ Horne, "Immigrant Workers in France during World War I," 60.

⁴⁴¹ *Ibid.*, 62.

⁴⁴² SHAT 10 N 29, Réunion générale des fabricants d'obus en acier et en fonte aciérée, 2 September 1916, 7.

⁴⁴³ *Ibid.*, Réunion des Fabricants de Matériel Lourd, 5 August 1916.

⁴⁴⁴ Dominique Barjot, "La grande entreprise française de travaux publics (1883-1974) : contraintes et stratégies" (Thesis Doctorat d'État, Université de Paris IV, Sorbonne, 1990), 765.

Another issue that arose with foreign workers was wariness about mixing workers of different nationalities, and therefore trying to maintain homogenised workforces. This was primarily due to the linguistic difficulties of training and managing various foreign workers that hampered the efficiency of the factory. M. Leflaive, who had employed both Alsatian and Annamite workers, brought this to the attention of the Ministry of War, as he only wanted to continue to hire Alsatians. Albert Thomas echoed the desire for homogeneity, citing examples of factories with seven hundred workers with men from three or four different nationalities alongside women from the region and Parisian workers. Such situations were to be avoided as much as possible.⁴⁴⁵

Despite the administrative difficulties, however, foreign workers played a crucial part in the expansion of industry throughout the war, both in the factories and in the field. They set a precedent for post-war industrial activity in the 1920s.

POWs

Prisoners of war provided another source of potential manpower, but they also came with complications. There were strict laws governing the use of prisoners. For instance, Alsatian POWs could not come into contact with German or Austrian POWs because of the denunciations that could be made against the former and reprisals that would be carried out against their families. Such laws created difficult situations: in one instance three hundred Alsatian prisoners were allocated to an establishment on the same day that three hundred German prisoners were removed.⁴⁴⁶

⁴⁴⁵ SHAT 10 N 29, Réunion au sujet du développement de la fabrication du Gros Matériel d'Artillerie, 28 June 1916, 10; *ibid.*, Réunion générale des fabricants d'obus en acier et en fonte aciérée, 5 August 1916, 5.

⁴⁴⁶ SHAT 10 N 29, Réunion générale des fabricants d'obus en acier et en fonte aciérée, 2 September 1916, 8.

The Ministry of War received a somewhat limited supply of POWs, despite the fact that throughout the war the number of prisoners taken inevitably increased. First, however, the army took prisoners to work on roads, trenches and in depots. Then, certain ministries in the interior and certain departments of the *Administration de la Guerre* had priority. For instance, the *4e bureau* of the general staff needed ten thousand prisoners for work in the ports and railways.⁴⁴⁷ Nevertheless, Albert Thomas was able to secure additional workers from the Ministry of Agriculture, along with priority over those with metallurgical experience or those with specialities pertaining to industrial production, but the numbers involved were relatively small.⁴⁴⁸

Injured

Finally, industrialists also had the option of employing soldiers injured during the war. By May 1916, 201 disabled or injured workers were employed in fourteen factories in Toulouse, particularly the Poudrerie Nationale and l' Arsenal de Ferronneries du Midi, where they were engaged in making shells and cartridges. The injured workers were split into two teams, with the morning team employed from six to eleven, before undergoing medical treatment and rehabilitation in the afternoon and evening, while the afternoon team worked from one until five, completing their treatment in the morning. The average output of injured workers varied, but was estimated at approximately three-quarters of that of able-bodied workers.⁴⁴⁹

⁴⁴⁷ AN 94 AP 84, Note pour Monsieur le Président du Conseil, 30 May 1915, 6.

⁴⁴⁸ SHAT 10 N 29, Réunion générale des fabricants d'obus en acier et en fonte aciérée, 4 November 1916, 10; For the influence of international law on the use of POWs, see Isabel V. Hull, *A Scrap of Paper: Breaking and Making International Law during the Great War* (Ithaca: Cornell University Press, 2014); Heather Jones, *Violence against Prisoners of War in the First World War: Britain, France and Germany, 1914-1920* (Cambridge: Cambridge University Press, 2011).

⁴⁴⁹ AN 94 AP 274, Bulletin des Usines de Guerre, 29 May 1916, 36.

Improvements

Over the course of the early years of the war, the total number of those working for the defence of the nation increased from 313,143 in June 1915 to 525,950 by October and to 1,119,992 by June 1916, an increase of over 350 percent.⁴⁵⁰ Having lost 67 percent of its workforce in August 1914, metallurgy recovered to 82 percent of its pre-war size by July 1915, and to 100 percent by January 1916. By August 1917, 518,000 soldiers were employed in armaments factories, while 300,000 worked in agriculture, representing 15 percent of the overall armed forces.⁴⁵¹

The numbers employed in metallurgy rose steadily to a peak in spring 1917, before a small dip as men were reallocated to work in agriculture as submarine warfare took hold. At their height, the numbers exceeded those of peacetime by 67 percent.

Table 9 Indices of those engaged in metallurgy (July 1914 = 100)

	Number of establishments at work	Personnel Employed
July 14	100	100
August 1914	42	33
October 1914	52	43
January 1915	66	63
July 1915	73	82
January 1916	79	110
July 1916	82	135
January 1917	84	159
July 1917	88	167
January 1918	89	150
July 1918	92	150
January 1919	87	120

Source: Fontaine, *French industry*, 269.

⁴⁵⁰ AN 94 AP 63, Les fabrications de guerre et l'industrie en France, 8 December 1916, 27.

⁴⁵¹ Hautcoeur, "Was the Great War a Watershed?," 174.

Excuses

Although there were undoubtedly a multitude of problems hindering industrial production, claims about the lack of manpower were frequently used by industrialists as an excuse for their failure to meet the targets set by the Ministry of War. Although manpower issues played a part, it is difficult to ascertain just how much to apportion blame to this as opposed to the overall efforts of the factories. Albert Thomas received a number of complaints from industrialists that the penalties for not meeting targets were being applied when the fault apparently lay with the lack of workers available. If the shortage was military manpower, they felt that the penalty should be waived, as this represented a case of *force majeure*. However, Thomas upheld the penalties, as he felt that industrialists often relied on the excuse as a way of avoiding punishment and that they should be required to show 'proof of sincere effort by the industrialist.' Thomas was happy to accept manpower shortages as a reason to forego a penalty if they could be proved to be genuine, but in the long-term it would be wiser to pursue a policy of setting more realistic, achievable goals for industrialists, rather than 'causing cruel deceptions' that served only to raise the expectations of the Ministry of War and the army.⁴⁵² He reminded industrialists when they made requests to the *Direction de l'Artillerie* that, 'delays in the delivery of workers... cannot be used as a justification for failing to meet the deadlines agreed for the work entrusted to you.'⁴⁵³

The ever-increasing reliance on manpower put the Ministry of War and industry in a potentially precarious position. Although they could call upon patriotism to motivate the workers to help defend the nation, relations between industrialists and workers were

⁴⁵² SHAT 10 N 29, Réunion des industriels fabriquant les gros obus en fonte aciérée, 31 March 1916, 11.

⁴⁵³ SHAT 6 N 16, Letter from Général Directeur Bacquet, 7 May 1915, in Rapport par Charles Humbert sur le matériel d'artillerie lourde, 31 May 1915, 10.

frequently strained, particularly when it came to salaries. After a number of instances of worker unrest, Albert Thomas encouraged industrialists to take particular care with their employees. For instance, workers should be warned of any potential changes to their salaries, rather than changing them abruptly when restructuring the organisation of production. There had been a few small conflicts that had halted production for a number of hours. These delays, although short, were still too long to be acceptable to the Ministry of War, and Thomas was swift to make clear that such problems should be foreseen and resolved before they resulted in the halting of production and not after. He also reiterated that the government was more than prepared to intervene and support the industrialists if necessary in trying to resolve the conflicts.⁴⁵⁴

Overall, the shortage of manpower was a persistent thorn in the side of the Ministry of War. Albert Thomas and his successor, Louis Loucheur, were forced once again to balance the needs of the army and the home front, attempting to mobilise industry to new levels of production while keeping the army supplied with adequate numbers of soldiers to hold the line. The systems put in place in the first two years of the war were reactionary and inadequate. There were too many inconsistencies and administrative problems that had not been thought through, resulting in persistent complaints from both industrialists and the high command, as well as scandals surrounding *embusqués* in the press. The nation survived, and as has been seen in previous chapters, output was adequate for military needs. But could greater success have been achieved with a more structured approach? Or, as the situation was unprecedented and unforeseen, did the men involved do the best they could, given the problem presented to them? Ultimately, in 1914 and 1915, when the situation was most severe, the Ministry of War's priority was to return sufficient numbers of workers to the factories, and it achieved this. As the war progressed, it struggled to

⁴⁵⁴ SHAT 10 N 29, Réunion générale des fabricants d'obus, 2 September 1916, 9.

implement a better system for managing the manpower problem and was forced to rely on pushing for more efficient production methods and the import of foreign workers to meet the demands of industry. A longer-term plan was unfeasible due to the short-term necessities of the war and the demographic shortcomings of France that placed even greater strain on the precarious balancing act that the Ministry of War attempted to maintain.

Chapter 5 - Raw Materials

'A war of machinery, in which metallurgy played a leading role'⁴⁵⁵

As demographic inferiority limited France's supply of manpower, the German invasion of northern France severely restricted supplies of raw materials, which were critical for armaments production in an industrial war. Recovery was slow. The government was forced to rely heavily on imports to meet its ever-expanding needs. Once again, the response was *ad hoc* and rushed but ultimately yielded sufficient resources to keep armaments factories in operation, although it is possible that a more structured approach might have allowed French industry to produce materiel quicker and in greater abundance in order to achieve a swifter victory. On one level, therefore, France coped remarkably well, but in actuality, the response of the French government to the underlying industrial problem was poorly coordinated.

Arthur Fontaine, a member of Thomas's ministry, characterised French industrial activity during the war as 'a period of general development lasting until spring 1917', followed by 'a growing embarrassment until the Armistice.' This 'embarrassment' was a result of the dearth of coal, metals and other raw materials, in part due to submarine warfare, the loss of shipping to the transportation of the arriving American army, and the German advance further into northern France in 1918.⁴⁵⁶

Pre-War Resources

The key requirement for a war based around metallurgy was the ore from which the metal was extracted. In this area, Germany was blessed with rich coal resources but lacked iron

⁴⁵⁵ AN 94 AP 274, Les Usines de Guerre, 2 May 1916, 4.

⁴⁵⁶ Fontaine, *French Industry*, 89.

ore, whereas France was limited in coal but possessed the Lorraine iron ore fields which were of incomparable value and among the richest deposits in the world. The iron riches available to Germany were estimated at around 700 million tons of ore, from which one could expect around 30 to 50 per cent of iron. The extractions from these mines increased considerably in the decades before the war, with 4,250,000 tons taken in 1880, rising to 28,600,000 tons in 1913, of which 21,136,000 tons came from the region of Lorraine annexed from France in 1871. France recognised that, if Germany did not have the Lorraine region, it would be almost impossible for Germany to fight a modern war. Indeed, the demands of German industry were such that they continued to import considerable quantities of iron ore from Sweden, Spain and France, receiving four million tons in 1900 and fourteen million in 1913.⁴⁵⁷

From the outbreak of the war, leading industrialists, such as François de Wendel, recognised the potential should France win the war and retake the lost provinces, and set out to influence the formation of French war aims. When the government sought the opinion of leading metallurgists through the *Comité des Forges*, de Wendel and Robert Pinot were adamant on the importance of Lorraine and the Saarland to bolster supplies of coal and iron ore and thus to increase French security.⁴⁵⁸

In October 1915 Robert Pinot pushed for the acquisition of the Saarland coalfields as well as Alsace-Lorraine, since, although the return of Alsace-Lorraine would provide considerable iron resources, the coal situation would remain 'critical'. In July 1916, the *Comité des Forges* went further, pushing for taking the Rhineland in order to strengthen French industry: 'all extension of our territory or of our economic domain beyond Alsace-Lorraine and the Saarland can only ease the problems which arise for our industry through taking or

⁴⁵⁷ AN 94 AP 274, Les Usines de Guerre, 2 May 1916, 4.

⁴⁵⁸ Jeanneney, *François de Wendel en République*, 34–5.

annexing these provinces, offering us new prospects, greater resources in fuels and transport options on the Rhine.’ Pinot’s declarations stirred support in the press, particularly from *La Victoire*, which recognised the potential for the economic exploitation of the Saarland. Still, the pursuit of the Saarland and territories on the Rhine, despite being pushed by the industrialists, only featured on the government’s radar for a short period in the winter of 1916-17. The priority remained Alsace-Lorraine, which was the most diplomatically achievable goal. Furthermore, discussions over war aims remained within the realm of the post-war settlement, rather than influencing wartime strategy. If regained, the region would probably remain within the battle-zone and therefore prove of little use in influencing the outcome of the war.⁴⁵⁹ The war aims discussions highlight the relative inferiority of French resources in comparison to Germany and the poor position in which France found itself in 1914.

Nevertheless, French metallurgy had also grown considerably in the years preceding 1914, with extraction of iron ore expanding dramatically to around twenty-two million tons on the eve of war, of which fourteen million came from the Briey-Longwy region. The internal assessment was that France was well provided in resources, despite its lack of coal, a point illustrated by the following table detailing the expansion of coal output between 1880 and 1913:

Table 10 Expansion of coal output (millions of tons)

	1880	1913
Germany	53	278
Britain	149	292
United States	65	517
France	20	41

Source: AN 94 AP 274, *Les Usines de Guerre*, 2 May 1916, 4.

⁴⁵⁹ Pierre Renouvin, “Les Buts de Guerre Du Gouvernement Français, 1914-1918,” *Revue Historique*, 235 (1966), 35-36.

French coal production had struggled to improve, and consequently more than twenty million tons of coal had to be imported a year. France's production of metallurgical coke also languished. While the United States produced forty-two million tons in 1913, Britain produced twenty million, and Germany thirty-two million, France produced just three million tons. Furthermore, French steel production in 1913 was just five million tons, in comparison to Britain's seven million and Germany's seventeen million.

Losses to the German invasion

Even before the war, therefore, France was industrially on the back foot. However, the German invasion devastated France, seizing the vast majority of its resources while simultaneously strengthening Germany. The Alsace-Lorraine and Briey regions gave Germany the advantage of around thirty million tons of iron ore per year. Still, Germany's attempt to paralyse French industrial production failed, as industry mobilised rapidly to provide the army with the necessary resources and armaments.⁴⁶⁰

Steel was produced in varying qualities and by a number of differing processes. The most relevant for this study are Bessemer steel, developed in 1855, Thomas steel, developed in 1878, and Martin steel, which adapted Bessemer and Thomas methods for the manufacture of a purer product. By the start of the twentieth century, electric furnaces were also being introduced, almost exclusively by the French and were the most promising method at the outbreak of the war. But of the 213 electric-furnaces in the world, only 22 were in France, whereas Britain possessed 16, Germany 46, and the United States 41. While France had a potential 5,875,000 hydraulic horsepower in its mountains, the equivalent of fifty-two

⁴⁶⁰ AN 94 AP 274, Les Usines de Guerre, 2 May 1916, 4.

million tons of oil, it only used 12 percent. Germany, by contrast, used 31 percent of its 1,425,000 hydraulic horsepower.⁴⁶¹

'General Recovery'

As we have seen, French territorial losses in the north-east of the country severely hampered industry in terms of its available raw materials. Steel production fell from 386,000 tons per month in 1913, to just 94,700 tons in September 1915. The loss of the invaded territories deprived France of forty-eight Martin furnaces, fifty-three Thomas converters, and thirty-eight crucibles.⁴⁶²

The shortages severely hampered the ability of the armaments industry to produce the matériel and munitions needed at the front. In the first few months of the war industrialists repeatedly complained that they could not meet the required production targets due to the lack of metal provided to them. Renault, who produced a third of all 75mm shells in October 1914, stressed on several occasions the constraints that a lack of steel placed upon him.⁴⁶³ Joffre telegraphed the war cabinet on 8 October 1914, highlighting the urgency of the situation, yet the problem persisted throughout the coming months, with similar issues raised at weekly meetings held between industrialists and Albert Thomas.⁴⁶⁴ High calibre shells were particularly affected, and the production of 155mm munitions was reduced from 1,700 to 500 shells per day at the Firminy factory, as the *Direction des Forges* had to devote five hundred tons of steel per month to aviation.⁴⁶⁵ In August 1915, Albert Thomas

⁴⁶¹ Ibid., *Les Usines de Guerre*, 9 May 1916, 3.

⁴⁶² Fontaine, *French Industry*, 279.

⁴⁶³ SHAT 10 N 29, Réunion des chefs de groupes pour la fabrication des obus de 75, 30 October 1915.

⁴⁶⁴ AFGG, 111–59, Joffre to Millerand, 8 October 1914.

⁴⁶⁵ SHAT 10 N 29, Réunion des Industriels fabriquant les obus de gros calibres en acier et les obus explosifs de 75, 29 January 1916.

observed that the only problem that industry faced at the time was the lack of steel.⁴⁶⁶ This problem remained at the start of 1916, when Léon-Lévy complained about the continuing lack of steel available, particularly from America.⁴⁶⁷ By summer 1916, France had reached the limits of its domestic production, with further gains in this area taking considerable time as it awaited the construction of new forges and factories. Therefore, the only other option was to source increased supplies of steel from abroad.⁴⁶⁸

The *Sous-Secrétariat d'Etat* pushed for industrialists to take measures to produce shells with the minimum quantity of steel, particularly by eliminating wasteful use of lower quality steel. A study of August 1916 demonstrated that some industrialists were consuming 10 percent more steel than the most efficient factories for the production of a similar quantity of shell.⁴⁶⁹ The *Sous-Secrétariat d'Etat* pushed for new practices to identify sub-standard steel before delivery, so that it could be treated and transformed into bars or different forms for use in other areas. It estimated that the proportion of defective steel arriving at shell manufacturers was around 10 percent. Furthermore, Thomas recognised that lower quality steel could be used in the shells manufactured by the pressing process, as the intense heating of the metal released impurities and reduced flaws in the steel. Only high quality steel could be used for shells manufactured by drilling, as the simpler process meant that flaws remained and resulted in poor quality, unreliable shells.⁴⁷⁰

Improvements in domestic output were slow, with production increasing to 136,083 by January 1916. However greater emphasis was placed on producing Martin steel, which was primarily used for armaments, with the proportion of this type of steel increasing from 33

⁴⁶⁶ AN 94 AP 72, Réunion des chefs de groupes pour la fabrication des obus de 75mm, 28 August 1915.

⁴⁶⁷ Ibid., Réunion des industriels fabriquant les obus de gros calibres, 28 January 1916, 11.

⁴⁶⁸ Ibid., Note sur la réunion des industriels, 11 May 1916, 2.

⁴⁶⁹ AN 94 AP 274, Bulletin des usines de guerre, 28 August 1916, 1.

⁴⁷⁰ AN 94 AP 73, Letter, 14 June 1915.

percent in 1912 to 70 percent in January 1916.⁴⁷¹ As time went on, increasing numbers of furnaces and Martin forges were either reignited or constructed. In 1912, there were 129 'high furnaces' in use, with 32 out of action. In September 1916, there were just fifty in service, with twenty-eight not in use, and two in the process of reconstruction, giving a total of only half of what had existed before the war. The production of steel in electric forges was developed considerably, with production rising from 1,323 tons before the war to over 4,000 tons in July 1916. By the end of the war, France had, either in existence or nearing completion, 103 Thomas converters, 225 Martin furnaces, 2,497 crucibles and 42 electric furnaces.⁴⁷²

In October 1915, Millerand examined the possibility of expanding the production of Martin steel. Of the twenty-one Martin forges that were unlit at the start of the war, nine had been relit, with Martin steel production increasing by 200 tons per day. Nevertheless, due to the ever-increasing need for artillery, tractors, aeroplanes and other materiel, the gap between output and demand continued to increase. Limited tests had been conducted on munitions produced with Bessemer steel, but an order for five thousand test shells had been placed with Le Creusot nevertheless. If successful, Le Creusot would be able to produce eight hundred tons of Bessemer steel per week, working day and night. Léon-Lévy also proposed the use of Thomas steel, which he would be able to produce at his factory of Neuves-Maisons, where the construction of new furnaces had already begun. Although this would boost output, it would not solve the issue of the availability of the raw materials required to produce the steel.⁴⁷³

⁴⁷¹ AN 94 AP 63, Les fabrications de guerre et l'industrie en France, 8 December 1916.

⁴⁷² Fontaine, *French Industry*, 279.

⁴⁷³ AN 94 AP 72, Réunion générale des fabricants de gros obus, 2 October 1915, 3.

In May 1916, Albert Thomas sought to boost domestic steel production and ease reliance on imports through encouraging the construction of new blast furnaces, steel mills and coke ovens. Industrialists were circumspect about the long-term profitability of the new installations after the war, and the government had to fund the construction itself. While Thomas had secured an arrangement with Schneider et Cie for the state investment of seven million francs to build a new plant at Caen, with the advance amortised through a 10 percent reduction in prices and five instalments to be paid back starting one year after the end of the war, the new agreement saw the state funding 50 percent of the project through a straight subsidy without a clause for reimbursement.⁴⁷⁴

The raw material and the manpower problems were inextricably linked. Léon-Levy was insistent that his firm would be able to produce almost three times as much steel, increasing its output from 800 tons to 2,400 tons per week, if it were provided with an additional 300 to 400 workers. Similarly, the *Acieries de la Marine* and the *Acieries d'Homécourt*, which were producing 350 tons per day, believed that they could also increase their output by around 150 tons if they were given a supplement of 300 men. In all, the total number of men that were deemed necessary by the steel production industry was around 1,800 to 2,000, but as we have seen, the shortage of manpower was just as pressing as that of steel.⁴⁷⁵ Once again, it is possible that industrialists used the shortage of raw materials and the shortage of manpower as excuses for failing to meet their targets. Due to the small numbers of inspectors available, the Sous-Secrétariat struggled to assess the veracity of these claims. Still, the problems were evidently serious and, while factories might have operated more efficiently with the resources available, factories were certainly hindered in their ability to function at full capacity.

⁴⁷⁴ Hardach, *The First World War, 1914-1918*, 76–77.

⁴⁷⁵ AN 94 AP 72, Réunion générale des fabricants de gros obus, 28 August 1915, 4.

The gradual return of manpower to the home front allowed twenty iron producing blast furnaces, 25 percent of those available, to be relit, with another twenty lit by the end of the year. The expansion of steel factories was pushed with great haste, with ninety-seven open hearth furnaces lit by January 1916, another twenty close to being ready, and thirty-five in the process of construction. The developments of domestic production increased the capacity of annual iron output by around 590,000 tons. For steel, the constructions and developments were as follows:

Table 11 Expansion of steel production

	Number	Proportional increase (percent)
Martin furnaces	109	94
Thomas converters	56	114
Crucibles	1,280	105
Electric furnaces	18	75

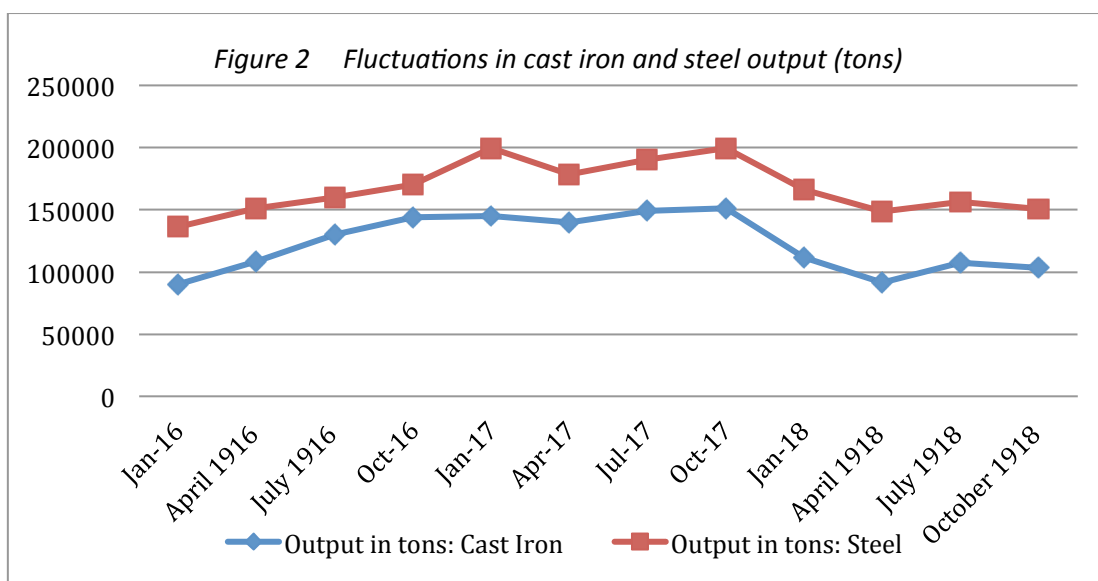
Source: Fontaine, *French industry*, 271. The second column indicates the proportional increase in the number of furnaces during the period from the end of 1914 to 1919. Martin furnaces approximate to British open-hearth furnaces and Thomas converters to Bessemer furnaces.

The new constructions raised the total production capacity of France by 1,760,000 tons of crude metal per year. Although this was the capacity of French production, actual output rarely reached such levels. The fluctuations were as follows:

Table 12 Fluctuations in cast iron and steel output (tons)

	Cast iron	Steel
January 1916	90,140	136,083
April 1916	108,414	151,432
July 1916	130,347	160,219
October 1916	143,853	170,297
January 1917	144,831	199,615
April 1917	139,967	178,644
July 1917	149,354	190,160
October 1917	151,102	199,794
January 1918	111,791	166,076
April 1918	91,538	148,509
July 1918	107,510	156,212
October 1918	103,331	150,576

Source: Fontaine, *French industry*, 272.



While October 1917 was the month of greatest production, output gradually declined from then on, despite the means of production steadily increasing, as ‘the use made of the available resources became increasingly unsatisfactory.’⁴⁷⁶ A comparison of output with production capacity yields the following results:

Table 13 Output as a percentage of production capacity

	Cast iron	Steel
1916	100	94
1917	72	74
1918	56	59

Source: Fontaine, *French industry*, 274.

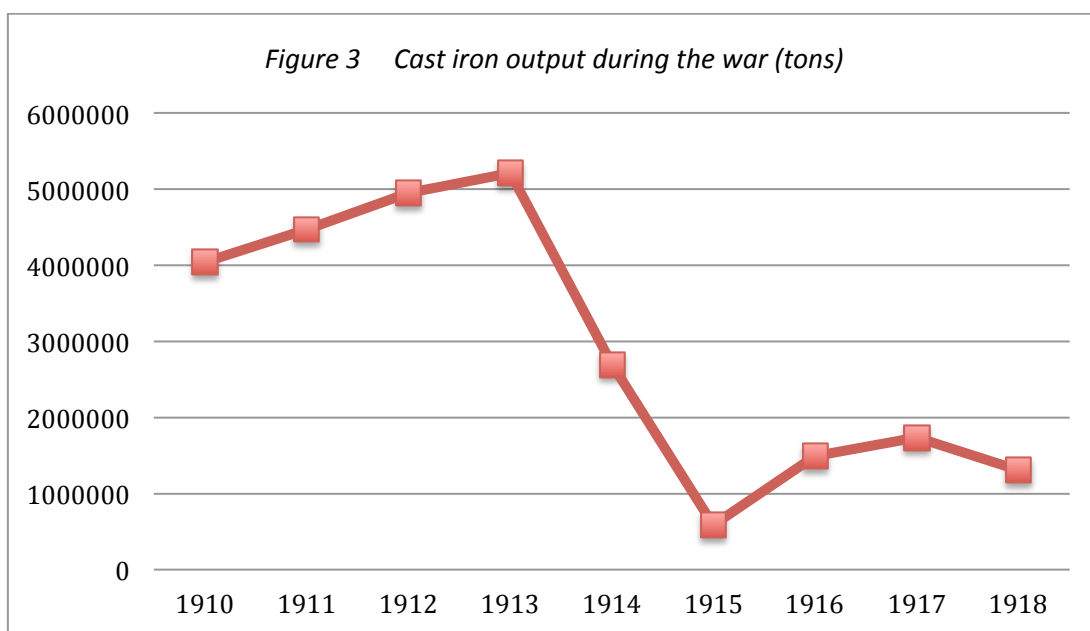
Output of cast iron rose steadily throughout the war until a dip in 1918:

Table 14 Cast iron output during the war (tons)

1910	4,039,297	
1911	4,470,141	
1912	4,949,194	
1913	5,207,307	
1914 (1 st half)		2,448,958
1914 (2 nd half)		241,588
1914	2,690,546	
1915	585,776	
1916	1,488,691	
1917	1,734,967	
1918	1,306,494	

Source: Fontaine, *French industry*, 274.

⁴⁷⁶ Fontaine, *French Industry*, 273.



Iron produced through the Thomas process, which represented two-thirds of output in 1913, was just 28 percent of overall output in 1918.⁴⁷⁷ The shortfall was made up from an increase in castings and iron from open-hearth treatment, primarily as a result of the loss of the main Thomas steel-works in the Meurthe-et-Moselle region. Fontaine highlights the rise of the production of synthetic castings, formed through the treatment of surplus steel in electric furnaces, which was a useful supplement of metal for munitions production and offered a use for scrap metal from the factories. This method was introduced in early summer 1917, with output rising to seven thousand tons per month by the end of the year.

Geographical shifts in production centres

Due to the German invasion, there was a significant geographical shift in French production. The output of iron and steel shifted away from the traditional heartlands, as necessity dictated the relocation to areas far from the front.

⁴⁷⁷ Ibid., 274.

Table 15 Geographical shifts in cast iron and steel production (thousands of tons)

	1913	1914 (1st half)	1914 (2nd half)	1915	1916	1917	1918
East	3,560	1,672	44	27	306	377	228
North	933	432	34	9	285	383	172
Centre	184	85	47	149	218	234	221
South-West	261	123	60	185	332	372	328
South-East	159	76	44	158	227	240	194
West	109	60	13	58	121	130	160
Total	5,206	2,448	242	586	1,489	1,736	1,303

Source: Fontaine, *French industry*, 275.

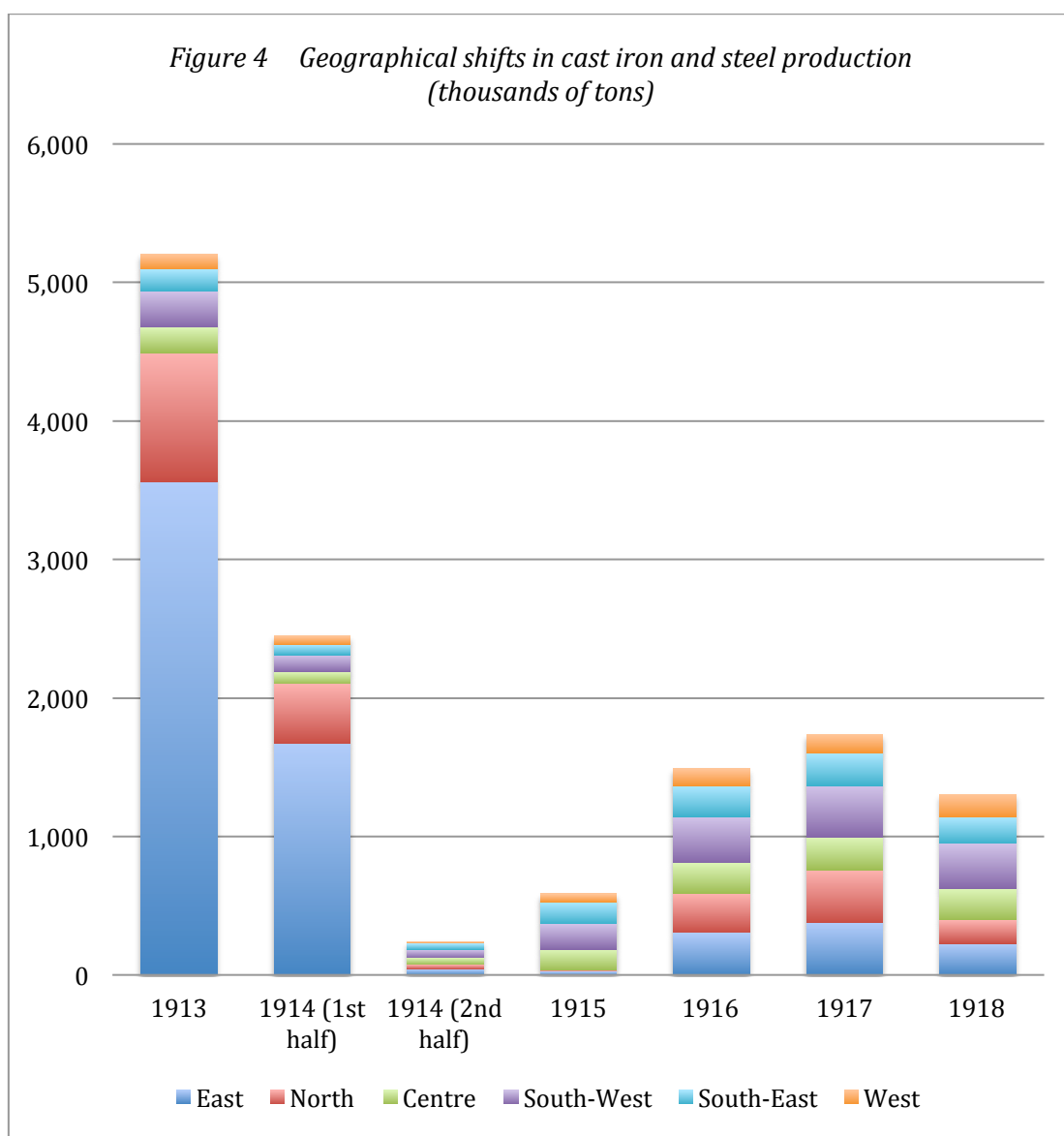


Figure 5 Map of France showing the geographical regions and the locations of the key armaments manufacturers



This table illustrates the stark shifts in the distribution of French production following the loss of the north-east. Output in the north in 1916 and 1917 was just a third of that in 1913, and the disruption of German invasion in 1918 prompted further upheaval in production. Output in eastern France fell to just ten percent of its pre-1914 levels. French industrial recovery came mainly in the south-west, thanks to the relighting of the Gironde blast furnaces, and in the west, with the blast furnaces of Caen and Rouen constructed during the war.⁴⁷⁸

⁴⁷⁸ Ibid., 275.

Total output of crude steel developed as follows:

Table 16 Output of crude steel during the war (tons)

1910	3,413,304
1911	3,837,052
1912	4,428,514
1913	4,686,866
1914 (1st half)	2,229,509
1914 (2nd half)	357,345
1914	2,586,854
1915	1,087,000
1916	1,951,892
1917	2,231,621
1918	1,807,931

Source: Fontaine, *French industry*, 278.

Again, the main reduction in output was in the loss of Thomas steel to the German invasion, and France relied on recovery and progress in other areas. Open-hearth steel slowly approached pre-war levels, while crucible and electric furnace output doubled and trebled respectively. France was somewhat fortunate that the steel works of central France produced the required quality of steel required for munitions production.

The production of different types of steel developed as follows:

Table 17 Development of the production of different types of steel

	1913 (%)	1917 (%)	1918 (%)
Thomas (acid)	5.5	2.8	4.4
Thomas (basic)	60.0	26.0	17.5
Martin	33.6	67.0	72.6
Crucible	0.5	1.8	2.3
Electric furnace	0.4	2.4	3.2

Source: Fontaine, *French industry*, 278.

The importance of steel to the war effort and the vast quantities required are illustrated by the following table of the requirements of steel of each department in March 1917, when the armaments industry was generally up to speed with production:

Table 18 Requirements of steel, March 1917

Department	Needs (tons)
Artillery	261,990
75mm shells	84,000
Other shells	101,550
Materiel	36,720
Other	39,720
Engineering	63,438
Logistics/Supply	6,576
Automobiles	11,209
Aviation	5,345
Trains	19,871
Miscellaneous	10,231
Civil Services	49,883
Total	428,564

Source: Fontaine, *French industry*, 279

As with iron production, the geography of French-produced steel shifted dramatically. Output in Eastern France had fallen by 85 to 90 percent by 1918, while in the north it fell by 80 to 86 percent. Other areas were forced to come to France's aid: production in the Loire rose by 60 to 80 percent from output in 1913, and in the south and west it rose by 15 to 30 percent. Central France was responsible for the bulk of open-hearth steel and crucible steel, with the latter rising from 22,000 tons produced in 1913 to 36,000 tons in 1918. Finally, the south-east benefited greatly from the hydro-electric potential of the Alps to drive its production of electric furnace steel.⁴⁷⁹

The Comité des Forges

The *Comité des Forges* proved vitally important to the administration of metallurgical expansion. In 1917, when Albert Thomas approached Robert Pinot to explore the possibility of creating a large Martin steelworks in the suburbs of Paris, the *Comité* took just eight days to ensure the support of the large metallurgical firms, to gather the necessary capital of

⁴⁷⁹ Ibid., 279.

around 40 million francs, to scout and negotiate potential sites, to source experienced personnel and to draw up preliminary plans. The project was ultimately abandoned in favour of prioritising expansion within existing establishments, but the example demonstrates the power and organisational capacity of the *Comité des Forges*.⁴⁸⁰

Overall, heavy industry slowly recovered from its early setbacks, doubling its output of steel between 1915 and 1917, and hydroelectric power also doubling to compensate for the lack of coal.⁴⁸¹ The extent of France's recovery is best demonstrated by the fact that it was estimated that, were France to regain possession of the furnaces and forges in the invaded regions (of which there were 106 of the former, and 62 of the latter), the capacity of steel production would be around double what it had been before the war.⁴⁸² Still, steel requirements increased daily, meaning that the gap between production and the needs of the country continued to grow.⁴⁸³

Imports

Inadequacies in domestic steel production forced Millerand to turn abroad for help in resolving the shortage of iron and steel. The import of raw materials during the war can be divided into three distinct periods. In the first period, from the outbreak of the war until 11 May 1916, supplies of metal arrived relatively unconstrained and with little distinction from peacetime. The second period began with the creation of the *Commission Interministérielle des Métaux* in response to increasing shortages in Britain and growing numbers of intermediaries seeking to profit from the situation. The *Commission* divided the available raw materials from both domestic production and imports between the relevant ministries

⁴⁸⁰ Pinot, *Le Comité Des Forges*, 96.

⁴⁸¹ Hardach, *The First World War, 1914-1918*, 90–1.

⁴⁸² AN 94 AP 63, Les fabrications de guerre et l'industrie en France, 8 December 1916, 2.

⁴⁸³ SHAT 10 N 29, Réunion générale des fabricants de gros obus, 2 October 1915, 3.

and consumers. The third period spanned the period from 1 September 1917 until the end of the war. It began with the decision on 31 August 1917 to create a single interministerial buyer for steel products in Britain, after the British government decided that the system at the time was flawed, since despite the fixing of monthly quotas and the prioritisation of orders, deliveries rarely corresponded with the targets that had been fixed. Britain therefore imposed a stricter regulation of production and exportation licences, requiring the French government to act as a single buyer.⁴⁸⁴

Although everything was being done to increase national production, the strength of German industry meant that, if France constructed ten aeroplanes, Germany had the capacity to construct twenty. The Ministry of War was urged on 10 November 1914 to look to the United States in order to redress the balance of production and output with Germany, with the belief that, 'if the quality of our soldiers and their commanders was added to a superiority of materiel, who could doubt a rapid and complete victory?' Millerand agreed. He believed that France's only option was 'the huge factory which is called the United States', as 'the millions spent on imports would save us billions and will save thousands of human lives.'⁴⁸⁵ The *Conseil des Ministres* reiterated that France had to use the advantage that it had through its access to the seas to organise the intensive production of materiel in the United States. If orders were made swiftly, the materiel would arrive in spring 1916.⁴⁸⁶

Alongside the United States, Britain was the logical choice for easing France's raw material needs. In 1913, it produced six million tons of Martin steel, whereas in the first year of the war France was able to produce just a million tons and needed at least twice as much.

⁴⁸⁴ Pinot, *Le Comité Des Forges*, 134–43.

⁴⁸⁵ AN 94 AP 84, Note, *Pour avoir une guerre courte et décisive*, 10 November 1914.

⁴⁸⁶ *Ibid.*, Note, 16 June 1915, 1.

However, the British response was disappointing. On 3 October 1914, Millerand negotiated the supply of 290 tons of British steel per day, but Léon-Levy questioned why Britain could not support France more significantly, when it required just two to three million tons to meet its own national defence needs.⁴⁸⁷ Robert Pinot, of the *Comité des Forges*, consequently examined the option of sending a representative to England to aid in the building of further ties between British and French industrialists.⁴⁸⁸

Exports of iron also proved difficult to secure. Initially, Britain promised the French government 40,000 tons of iron per month but later declared that it could not firmly commit to meeting this target, offering only to 'do all that it could.'⁴⁸⁹ The Ministry of War swiftly sent envoys to Britain to press Lloyd George for increased imports. A personal approach was even made by the Prime Minister to Asquith. Negotiations were slow and France was forced to accept whatever Britain deemed acceptable to give.⁴⁹⁰

Despite the raw material shortages, difficulties ensuring the quality of imports and the fragile diplomatic situation meant that France was reluctant to rely too heavily on foreign powers.⁴⁹¹ The assessment of Clémentel, in a meeting of the *Commission du Budget*, was that, 'the best steel is clearly French steel!' Albert Thomas redressed this somewhat simplistic and partisan assessment by pointing out that there was both high and mediocre quality steel among all suppliers.⁴⁹²

Before the war, Schneider had been able to provide itself as well as the state arsenals with high quality steel for armaments production, but the disruption in the arrival of raw

⁴⁸⁷ AFGG, 21, 59.

⁴⁸⁸ SHAT 10 N 29, Réunion des chefs de groupes, 2 October 1915, 2.

⁴⁸⁹ Ibid., Réunion des Industriels fabriquant les obus en fonte aciérée, 3 June 1916, 5.

⁴⁹⁰ AN 94 AP 72, Réunion des industriels fabriquant les obus en fonte aciérée, 3 June 1916, 5.

⁴⁹¹ Mauffré, *La Mobilisation Industrielle*, 23.

⁴⁹² AN C7558, Commission du Budget, Séance du 12 June 1915, 1501.

materials meant that not only did Schneider have to resort to the Bessemer method of producing steel, which was more time-consuming and inefficient, but it also increasingly had to rely on imports. In June 1915, Schneider sent its own representatives abroad to set up partnerships with metallurgists in Italy, Britain and the United States, but the steel from abroad was unreliable. Italian steel was the worst, with large levels of impurities. American steel was better but inconsistent, and it therefore had to be treated by Schneider before it could be used for shell production, with only the very worst rejected.⁴⁹³ Factory owners were particularly disgruntled. Despite the continued patriotic urgings from Albert Thomas, financial priorities superseded all other concerns, and the industrialists supplied by firms such as Inland and Illinois, whose steel was deemed of excessive hardness, felt that they should be compensated for the loss of output.⁴⁹⁴ It is astonishing that the industrialists did not perceive the severity of the situation and all the efforts that were being made to keep the supply of steel of any type flowing, but when they saw other factories supplied with superior steel and making large profits, their reaction was to be expected.⁴⁹⁵

Furthermore, the congestion of naval traffic between America and Europe caused regular delays at ports on both sides of the Atlantic that had inevitable repercussions on shell production.⁴⁹⁶ In June 1915, Léon-Lévy declared that after a recent visit from a representative of the Iron and Steel Company in the United States, he had been informed that it could guarantee an unlimited supply of metal, responding to all the qualities required by the *Service de l'Artillerie*. The difficulty, however, arose from trying to transport this metal to France. Freight was incredibly expensive and the means for unloading such large quantities in French ports were insufficient. Ports like La Pallice, which were generally

⁴⁹³ Schneider, 01G0326-1, Usine du Creusot, August 1930.

⁴⁹⁴ AN 94 AP 72, Réunion des industriels fabriquant les obus de gros calibres, 28 January 1916, 12.

⁴⁹⁵ Ibid., Réunion générale des fabricants de gros obus, 26 June 1915, 6.

⁴⁹⁶ SHAT 10 N 29, Réunion des Industriels fabriquant les obus de gros calibres, 28 January 1916.

well equipped, still lacked cranes and other unloading machinery, while other ports, such as Bayonne, were easily accessed in summer but were not used enough.

Nevertheless, steel imports increased dramatically. In 1913, 53,000 tons of steel were imported. In 1915, this figure was 722,000 tons and would more than double in 1916 to 1,864,000 tons.⁴⁹⁷ By June 1915, there were fifty-one providers of steel, of which twenty-seven were French, four were American, nineteen were British and one was Italian.

However, imports from America suffered in the second half of 1916, as shipping problems plagued the Ministry of War. While France received 93,000 tons of steel in September 1916, this fell to 64,000 tons in October, recovered to 72,000 tons in November and fell again to 58,000 tons in December. Unrestricted submarine warfare, announced by Germany on 31 January 1917, would only exacerbate the issue.⁴⁹⁸

Administration of imports

In the early months of the war, the *Comité des Forges* oversaw the import of raw materials. However, by summer 1915 the system was unable to cope with demand. Industrialists that were not supplied by the state were struggling to fend for themselves, as they made orders in relatively small quantities and were therefore restricted in their ability to deal with overseas steel producers.⁴⁹⁹ They complained that they were unable to source raw materials through the *Comité des Forges* and were therefore incapable of completing their contracts as a result.

⁴⁹⁷ AN 94 AP 63, Les fabrications de guerre et l'industrie en France, 8 December 1916, 2.

⁴⁹⁸ Carls, *Louis Loucheur*, 36.

⁴⁹⁹ AN 94 AP 72, Réunion des chefs de groupes pour la fabrication des obus de 75mm, 2 October 1915, 2.

The state planning of imports began in November 1915 under the impetus of Etienne Clémentel, the Minister of Commerce, the *Comité des Forges*, and the *Chambre Syndicale du Matériel de Guerre*.⁵⁰⁰ They established import monopolies for heavy industry that managed the purchase and distribution of key raw materials. Two missions were now in place sourcing materials from America for the French government, one from the *Administration de la Guerre* and one from the *Comité des Forges*, with the former supplying those not served by the latter. Albert Thomas ensured that there was no inequality of treatment or supply between those receiving metal from Le Creusot (who dealt with and distributed steel sourced by the *Comité des Forges*) and those supplied by the *Administration de la Guerre*. Shell contracts were written purely for the number of shells produced, with the price of metal dealt with separately.⁵⁰¹ Nevertheless, as the situation showed little sign of improvement, there were increasing calls for more state intervention.⁵⁰²

The second phase of the management of imports emerged during 1916. At the start of the year, French industrialists were placing orders for a total of 115,000 tons a month of British iron, which was far greater than their actual needs and far greater than the British capacity to export.⁵⁰³ In response, the British government began regulating the export of pig iron and urged the French government to do the same by centralising its procurement of materials. On 6 March 1916, Thomas authorised the *Comité des Forges* to centralise hematite pig-iron purchases from Britain, before extending this to all forms of pig iron in May. Many distrusted granting such a monopoly on imports to the *Comité des Forges*.

⁵⁰⁰ The latter two were powerful employers' organisations.

⁵⁰¹ AN 94 AP 72, Réunion des chefs de groupes pour la fabrication des obus de 75mm, 2 October 1915, 3.

⁵⁰² Smith, *France and the Great War, 1914-1918*, 62–3; Godfrey, *Capitalism at War*, 221.

⁵⁰³ Godfrey, *Capitalism at War*, 222.

However, Thomas assuaged these fears by insisting that he would superintend import distribution to ensure that needs were addressed. Until the end of the war, the *Comité des Forges* was critically important to the procurement and distribution of raw materials.⁵⁰⁴ A similar arrangement was made for steel, as the British government negotiated the centralisation of steel purchases with the French government. Consequently, on 11 May 1916, the *Commission Interministérielle des Bois et Métaux* (CIMB) was created under Albert Thomas's supervision.⁵⁰⁵ It oversaw the purchase of British steel and distributed the resources according to need. Finally, on 12 April 1916 centralised purchasing for coal was set up under the *Bureau National des Charbons*. This office fell under the supervision of the Ministry of Public Works and performed a similar role to those managing iron and steel.⁵⁰⁶

By the end of 1916, the *Service de l'Artillerie* was investigating ways to streamline the purchasing of raw materials by industrialists involved in the construction of materiel for the war effort. Until this point, industrialists had the habit of ordering relatively small amounts in a number of separate orders, primarily so that they did not overcommit themselves lest the war end early and they be left out of pocket. The Ministry of War had put provisions in place for this scenario before the war by encouraging the grouping of requests for raw materials to reduce the overall number of contracts. However, General Bossut, a factory inspector, reported that industrialists continued to divide their orders as was customary in peacetime. The *Service de l'Artillerie* sought to limit the number of individual orders by attaining a greater understanding of the needs of each region and grouping orders together. This issue had been raised following visits by the *Inspections des Forges* to manufacturers in Toulouse, Lyon and Nantes. The report recommended grouping multiple

⁵⁰⁴ Carls, *Louis Loucheur*, 34.

⁵⁰⁵ This subsequently became the *Commission Interministérielle des Métaux et des Fabrications de Guerre* (CIM).

⁵⁰⁶ Carls, *Louis Loucheur*, 34–5.

orders together in one larger individual order to alleviate the administrative burden and to secure a lower price for raw materials for industrialists.

By purchasing at a higher price, industrialists were able to charge a higher price to the *Administration de la Guerre* and secure large profits, much to the dissatisfaction of the French public. Also, by ordering small quantities for each stage of production, industrialists left themselves vulnerable to changes in programmes and fits and starts in the manufacturing process. Placing numerous small orders also strained the administrative structure, as the *Service des Forges* struggled to accommodate them in and around the larger orders, which were easier to plan for and whose supply was simpler to assure.⁵⁰⁷

Albert Thomas sought to return to the grouping of orders in early 1916. On 5 April, the *Inspecteur Permanent des Fabrications de l'Artillerie* recommended that factories declare their needs in steel for the forthcoming six months so that the *Service des Forges* could gain a clearer idea of domestic requirements. However, little progress had been made by the end of the year, with the number of orders remaining relatively constant. Establishments continued to order materials only when they were assured of production and orders were strictly limited to the specific needs of their contracts. Industrialists rarely took the initiative in establishing whether the required materials were available at other artillery establishments, which would have greatly eased the burden on the *Service des Forges*. Such administrative problems stemmed from the lack of preparation and the hasty *ad hoc* responses that resulted in a system that lacked clarity and efficiency. Trying to impose order retrospectively on a large, cumbersome structure without disrupting output proved extremely difficult.

⁵⁰⁷ AN 94 AP 74, Rapport no. 8 du Contrôleur Adjoint Jaillet, 19 December 1916.

Ultimately, the *Service des Forges* resolved to build and expand its warehouses to amass stores of materials and parts, so that they could be supplied to manufacturers at relatively short notice. In particular, they constructed a large warehouse in central France for the provision of raw materials of iron and Martin steel, as well as smaller quantities of copper, brass and other metals with the intention of meeting the short-term and unforeseen needs of manufacturers. They also created a general warehouse for ironmongery and machinery to ease the supplying of constructors seeking to expand their production or replace out-dated machines.⁵⁰⁸

Despite the centralising of raw material orders, the system still struggled to meet demand and a crisis emerged at the end of 1916 with acute shortages exacerbated by transport and supply difficulties as the German submarine campaign began to take hold. Orders had been placed in Britain and the United States, but there was a lack of boats on both sides of the Atlantic. The United States was struggling to release extra shipping, with only twelve transatlantic crossings made during January 1916 out of the twenty-five that had been foreseen, primarily a result of requisitions in both Britain and France. In February 1916, Albert Thomas made a renewed effort to press Britain to release more ships, and in March 1916 François de Wendel secured an agreement with the British government for the formation of a special office for the transport of raw materials to France, with the proviso that, if the cost of the freight exceeded a certain price, the British government would pay the difference.⁵⁰⁹

In the meantime, factories were forced to halt production, with erratic and intermittent arrival of supply trains rendering it impossible to plan smooth production. Although the

⁵⁰⁸ Ibid., Rapport no. 8 du Contrôleur Adjoint Jaillet au sujet du mode de passation de certains marchés du Service de l'Artillerie, 19 December 1916, 48.

⁵⁰⁹ AN 94 AP 72, Réunion des industriels fabriquant les gros obus en fonte aciérée, 31 March 1916, 11; *ibid.*, Réunion des industriels fabriquant les obus de gros calibres, 28 January 1916, 12.

short-term fault lay with the transportation network and the unreliability of imports, Carls places the long-term blame on Thomas's failure to develop domestic production sufficiently in the first two years of the war. The situation continued to deteriorate. In December 1916, France expected to receive 180,000 tons of Martin steel from Britain and the United States but only 85,000 tons arrived. There was a similar deficit in pig iron imports. By 1 February 1917, France was left with a stock of just 72,000 tons of steel and 75,000 tons of pig iron.⁵¹⁰

The Influence of Louis Loucheur

Louis Loucheur's arrival at the *Sous-Secrétariat d'Etat* in December 1916 brought a new vigour to industrial management. He pursued a two-pronged approach. He realised that he could not rely too heavily on foreign imports, as supply was unreliable, but he recognised that the management of imports needed to be improved significantly until domestic production increased and France was capable of supplying itself.

Domestic Production

From 20 December 1916, Loucheur met with the key French metallurgists to explore expanding steel output, but he encountered similar hesitation to that shown by armaments producers, as they were reluctant to commit to increasing production to an extent that might leave them vulnerable after the war. The reluctance from the metallurgists is surprising considering that, unlike for armaments, there would be a significant demand for steel and iron in the post-war era, particularly for reconstruction and due to the rising demand for automobiles and aeroplanes. Nevertheless, Loucheur was bullish in his optimism and managed to secure an increase in output of 35,000 tons a month for the

⁵¹⁰ Carls, *Louis Loucheur*, 35.

coming year. Although this was a significant success, it was still insufficient to meet the ever-expanding munitions requirements, and he therefore also sought to construct a new, modern steel mill on the outskirts of Paris, with the *Comité des Forges* raising 40 million francs from leading industrialists within a week. The French government would commit a further 60 million francs to support the project.

The Ministry of Finance, however, was reluctant to devote sufficient funds. Up to this point, new industrial construction had been amortised through price rises on output. 'The government paid for greater steel producing capacity by paying for more steel.' This had been successful when industrial expansion had been modest, so that it could be financed through the industrialists' own resources. However, Loucheur's new steel mill was far beyond their means and they could not wait to recoup their expenses through increased prices. Loucheur pressed the government in February 1917, stressing that it was the responsibility of the government to help fund the plant, as it was the state that was driving the factories to increase production in the name of the war effort. Ultimately, however, he recognised that he stood little chance of gaining the Ministry of Finance's support, and he was forced to give up on the steel mill project in April.⁵¹¹

Import Problems Persist

The heightening problems in agriculture throughout 1917, discussed in the manpower chapter, placed further strain on the raw materials situation and consequently armaments production in two ways. First, Loucheur lost shipping capacity to grain imports, limiting supplies to the factories, and second, he was forced to divert manpower from metallurgy and armaments production to the fields to ensure sufficient food was harvested to feed the

⁵¹¹ Ibid., 38–41.

front lines and the home front. Once again, even at this stage of the war, the fragility of the French structure was revealed, and the Ministry of War was prompted to take *ad hoc* steps to counter unforeseen problems that threatened to derail the war effort.

The continued manpower shortages exacerbated by the agricultural crisis convinced Loucheur that he was unlikely to be able to make France self-sufficient in steel production. Furthermore, he recognised that to produce a ton of steel in France, the government had to import three tons of raw materials. It therefore made more sense to import the finished product from a financial, manpower and shipping perspective. However, the shipping situation also deteriorated throughout 1917, despite Loucheur's best efforts.

Loucheur was initially successful in negotiating the renewal of British steel shipments that had been put on hold due to delays unloading at French ports. Loucheur and Thomas sought to assuage British fears by sending a representative from the Ministry of Armaments to Nantes to ensure that things moved smoothly and to keep them informed on a daily basis. The daily tonnage unloaded in Nantes increased from 250 tons to around 600 tons over the course of a few days.

Nevertheless, imports from Britain remained meagre, falling from 40,000 tons to 28,000 tons in January 1917. Loucheur ordered Commandant Hausser, the French representative in Britain, to keep him informed on a daily basis of the state of British shipping and to press the Admiralty to put more ships at France's disposal. He also sought to use the information provided by Hausser to put pressure on the French maritime transport service to increase the shipping capacity available, but the French efforts had little success, as the British actually reduced their tonnage capacity for exports to France in the weeks that followed.

The *Sous-Secrétaire d'Etat* suffered an additional setback in April, when the developing agricultural problems forced the French government to reassign part of the merchant fleet to grain shipments from the United States. Loucheur feared that the United States' government planned to suspend steel deliveries to France altogether to concentrate on grain, and pressed Alexandre Ribot, who had become the French premier in March, for the shipping capacity to be split between steel and grain, and for more British ships to be allocated to steel. Loucheur pleaded with those industrialists who had their own shipping to help with imports, securing an additional 7,000 tons of steel per month, and he sought to reduce British coal imports by 40,000 tons to free up space for more steel.⁵¹²

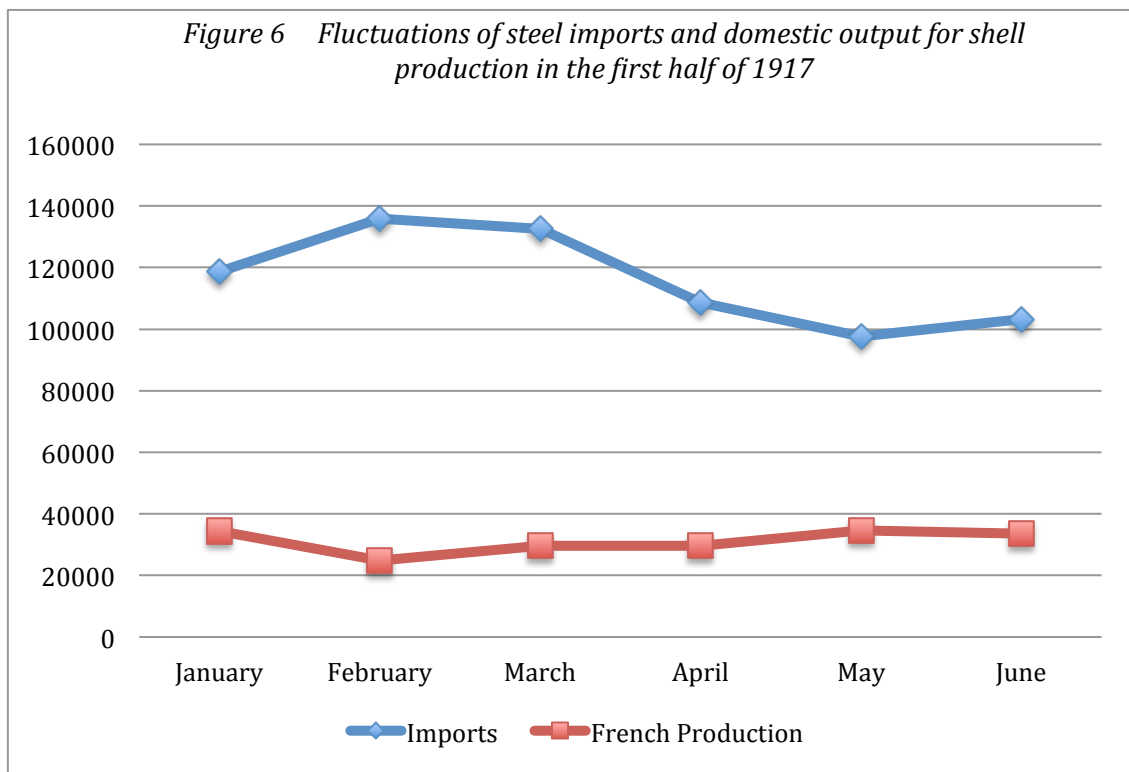
However, Paul Painlevé, the Minister of War and acting Minister of Armaments while Thomas was on a mission to Russia, informed Loucheur in May that efforts made in Britain to provide more tonnage for the supply of steel had been unsuccessful and, despite the shortages, 'there would be no imports of steel from the United States that month, and therefore production targets should be reassessed in light of reduced resources.' Loucheur was incensed in his response: 'I do not see what any programme can consist in if there is neither steel nor coke. There is no other solution than what I indicated with respect to supplies from England.'⁵¹³ Ultimately, following a meeting with Ribot, Loucheur was able to secure some tonnage for American imports as well as an allocation of coal ships for British steel deliveries. However, the situation remained extremely difficult, with the government balancing the interests of the armaments and agriculture ministries even four years into the war. When informed of the scarcity of tonnage, Thomas lamented that he had 'been forced to reduce the food for guns to assure it for the population.'⁵¹⁴

⁵¹² Ibid., 38–9.

⁵¹³ Painlevé to Loucheur, 13 May 1917, cited in *ibid.*, 40.

⁵¹⁴ Minutes, Commission de l'Armée, 3 August 1917, cited in *ibid.*, 44.

The Ministry of War was forced to draw up three munitions programmes based on maximum, minimum and ideal import forecasts to provide some degree of preparation in case imports fell. For the maximum programme, French steel provided just 19,000 tons of steel per month, with 41,000 tons imported from Britain and between 104,000 and 165,000 tons from the United States. British imports hit their targets for the first half of 1917, with an average monthly import of 44,098 tons. However there were large fluctuations, from a low of 26,208 tons in May to a high of 59,198 in July. As a result, it was difficult for industrialists to rely on a consistent supply of metal. Imports from America fared less well, beset by shipping problems, with a monthly average of around 63,000 tons, but with deliveries fluctuating between 37,903 tons in July and a high of 83,587 in February 1917. While French steel production exceeded expectations, with an average monthly output of 31,000 tons, this still only assured the requirements of the most restricted production programme.⁵¹⁵ The Ministry of Armaments was forced to reassess production and reduce targets further, with the deficit of shells made up from cast iron shells.



⁵¹⁵ AN 94 AP 85, Artillerie Lourde Moyenne, 19 August 1917, 14.

However, in August 1917 Philippe Pétain had requested the expansion of the 30 May 1916 artillery programme to increase 155mm shells by 10,000 to 50,000 and to increase 220mm shells from 3,500 to 6,000. These demands suggest a breakdown in understanding between the French high command and the Ministry of War about the inadequacies of raw materials supplies as that month, the production of 155mm and 220mm iron shells exceeded 69 percent of total output, with the *Commission de l'Armée* estimating that 'this reduced the effectiveness of the artillery by more than half.'⁵¹⁶ The new programme required an increase in steel of 20,000 tons per month, which the government sought to source from a further increase in American imports. The efforts of the Ministry of Armament were focused on securing the necessary freight to achieve this, since although the raw materials existed, the ships to transport them across the Atlantic did not. Failure to supply the resources would inevitably result in delays in armaments production and consequently shortages at the front lines.⁵¹⁷

Overall, the total resources for the first trimester of 1917 amounted to just over 330,000 tons, with 194,347 coming from imports. The total fell to 266,000 in the second trimester, which was 160,000 tons below the ideal level and 58,000 tons below the restricted programme (approximately 20 percent).

1918

By 1918, the need for steel had developed even further. The programme drawn up for the first trimester of 1918 foresaw a requirement for 341,000 tons of metallurgical products

⁵¹⁶ SHAT 10 N 85, Note de la Commission de l'Armée, 3 August 1917.

⁵¹⁷ AN 94 AP 85, Artillerie Lourde Moyenne, 19 August 1917, 16.

per month, of which only 328,000 tons was actually supplied. The supply was intended to come from the following sources:

Table 19 French metallurgy supplies, January – March 1918 (tons)

	Forecast	Supply
French production	144,000	145,000
British imports	90,000	78,000
US imports	100,000	98,000
Other imports	7,000	7,000
Total	341,000	328,000

Source: Carls, *Louis Loucheur*, 79.

Loucheur benefited from an agreement made the previous summer that saw France supplying the American army with artillery in return for raw materials. This would prove much more economical from a supply perspective, as the French armaments industry was now producing artillery at a considerable rate, but still needed large quantities of steel. Therefore, rather than the American army transporting troops and armaments alongside raw materials, French industry would supply the weaponry and more shipping could be devoted to the supply of the metallurgical factories. The agreement quickly bore fruit, with 82,000 tons of steel arriving in February 1918 and 122,000 tons in March.⁵¹⁸ Supply remained short, however, and the Minister of Armament decided on 21 February 1918 that it was necessary to restrict the requirements of each department further in order to limit the use of metal.

Loucheur deemed that restrictions could only be applied to shells, and artillery production should continue unabated. 180,000 75mm shells would be produced in place of the 220,000 requested by the commander-in-chief, and 45,000 155mm shells in place of the 80,000 requested. Nevertheless, the restrictions still resulted in a total requirement of 239,000 tons of steel. He contemplated a further reduction of 40,000 75mm shells, which

⁵¹⁸ Carls, *Louis Loucheur*, 79.

would free up 10,000 tons of steel, but he deemed it impossible considering the needs at the front and the circumstances of the war at the time.⁵¹⁹ Even in 1918, therefore, the raw material situation was severe enough to place continued restraints on the production of armaments and munitions. While this was partly a result of the manpower shortage that hindered domestic output of raw materials, it also demonstrates that, although French recovery was strong and lauded by domestic commentators in the aftermath of the war, it was never able to catch up to meet the ever-rising demand.

In summary, raw materials shortages plagued the Ministry of War throughout the war and severely restricted armaments production. France was hampered by its relatively weak pre-war situation, the German invasion of its industrial heartland, and the increasing problem of supply throughout the war, but it is a testament to the French recovery that the armaments industries were sufficiently supplied to produce the materiel to keep the army in the field. While the Ministry of War was consistently on the back foot, relying once again on *ad hoc* responses and excessive bureaucracy to meet the ever-increasing demand, its efforts were ultimately successful. Output expanded consistently throughout the war and there was a shift towards more modern and more efficient methods of production. A more rational and planned approach might have yielded better results and an earlier victory through the provision of greater resources to the front lines, but this was simply not possible considering the state in which France began the war.

⁵¹⁹ SHAT 3 N 2, Note pour le général faisant fonctions de chef d'état-major général de l'armée au sujet de la révision des programmes de fabrications, 5 April 1918.

Chapter 6 - Improvement of industrial practices

The shortages of manpower and raw materials hampered armaments production throughout the war, while the Ministry of War turned to private industry to compensate for the inadequacies of the state arsenals. This came at a cost, as industrialists were able to charge a high price for their services. As the war went on, the Ministry of War sought to reassert control over the situation, while encouraging the improvement of industrial practices both to supply the army with armaments of a higher quality and to increase the efficiency of manufacturing in the face of the shortages discussed in the previous two chapters.

Financing Production

Pre-war reluctance to rely on private industry for armaments production was founded on the fear of the high prices that factories charged. While the Ministry of War shied away from widespread requisitioning, concerns about the cost of mass mobilisation persisted and were particularly important considering Jan Bloch's warnings in 1898 about the threat of potential indecisiveness of modern war and the challenges of financing it.⁵²⁰ However, industrialists were hesitant to convert to war production and had to be persuaded with favourable contracts granting assurances in case peace was concluded before their completion.

At a meeting of shell manufacturers on 26 November 1915, Albert Thomas sought to stress the 'moral obligation' that factories had to serve France. However, one industrialist wanted

⁵²⁰ Bloch, *Is War Now Impossible?*.

greater guarantees from the government, having previously received a large order, only to have his contract interrupted at a later date, costing him a significant amount of money.⁵²¹

In the early months of the war, with the pressures of the munitions crisis weighing heavily on his mind, Alexandre Millerand had agreed to large contracts that were very favourable to the industrialists, who were able to charge high prices by pointing to the expenses and risks involved in converting their factories to war production. Furthermore, inexperience on both sides made the estimation of costs extremely difficult. As manufacturing processes became increasingly efficient, and the risk of an early end to the war diminished, private industry was able to make large profits as they resisted government attempts to modify the original base prices.⁵²²

The Ministry of War also encouraged industrialists with large advances for new machinery and factory expansion. As early as 1 October 1914, the Société de l'Éclairage Électrique was advanced 1,679,916fr and had received a further 5,634,216fr by the end of the year. Similarly, Delaunay-Belleville was given 4,800,000fr on 26 February 1915, and Renault received 3,482,000fr on 13 March 1915.⁵²³ This policy was formalised through a decree issued on 15 July 1915 and extended in 1916 to allow the advance of as much as 60 percent of the total cost of the contract.⁵²⁴

The war presented opportunities for industrialists across Europe to profit, much to the dissatisfaction of the government. Even with a relatively modest shell production contract, the Montluçon steelworks' gross profits increased from 4.6 million francs in 1913-14 to 7

⁵²¹ SHAT 10 N 29, Réunion des industriels.

⁵²² Godfrey, *Capitalism at War*, 50.

⁵²³ AN 94 AP 71, Direction des Forges, 1 September 1915.

⁵²⁴ Porte, *La mobilisation industrielle*, 191.

million francs in 1914-15.⁵²⁵ Similarly Schneider-Creusot's profits rose from 6.9 million francs in 1913 to 11.2 million by 1917.⁵²⁶ However, the war naturally favoured larger companies. The requirements for large-scale reorganisation of the methods of production and the homogeneity and standardisation of output were easier for the bigger firms to manage.⁵²⁷

Taxes on war profits had little effect. Thomas was very aware 'that the concealment of war profits is a common practice.'⁵²⁸ Hotchkiss made profits of between 37 and 51 million francs in 1916, while Citroen's profits increased to 6.1 million francs by 1917, from which just 60,000 francs were paid in war profit taxes.⁵²⁹ The large profits made by private industry resulted in a backlash from the French public, with Parliament particularly keen to curb those deemed to be benefiting excessively from the war. The Ministry of War also sought to exert greater control over the manufacturing process and to redress the balance of power with the industrialists.

On 2 July 1915, the Chamber of Deputies discussed requisitioning, lamenting that 'scandalous fortunes have already been made and are made each day at the expense of the nation. Our spending increases by many million every day, while it is possible, fair even, that all the industrial riches of France could be put to use for the defence of the country.' Requisitioning would ease the financial burden and restrict the opportunity for industrialists to make the huge profits that drew the ire of the public.⁵³⁰ Furthermore, a majority of the Chamber of Deputies' armaments subcommittee favoured such an

⁵²⁵ Hardach, "Industrial Mobilization," 70.

⁵²⁶ Hardach, *The First World War, 1914-1918*, 106.

⁵²⁷ Barjot, *Deux guerres totales*, 12.

⁵²⁸ Note, 14 February 1918, cited in Hardach, "Industrial Mobilization," 76.

⁵²⁹ Ibid.

⁵³⁰ SHAT 6 N 17, Proposition de résolution sur l'exercice immédiate de la réquisition générale, 2 July 1915.

approach, which correlated with Republican ideas of the entire nation, including industrialists and their factories, being mobilised for the war effort. However, Albert Thomas, and the Ministry of War as a whole, did not share their opinion and viewed the right to requisition, established in the law of 3 July 1911, as an exceptional measure.⁵³¹ Thomas felt that the role of the factory manager was pivotal to the success of a firm, and replacing him with a military official would remove all entrepreneurial spirit and experience. His advisor, Smiand, highlighted the dilemma: 'Can the entrepreneurial spirit be requisitioned, the taste for risk, if the *sine qua non* of risk-taking has been eliminated, namely the reward?'⁵³²

Even towards the end of 1915, certain industrialists remained reluctant to engage in the war effort, believing that the costs involved in converting their factories were too great. Thomas lamented, 'there are, alas, too many industrialists with whom we have to argue about prices, and too many as well... who threaten not to construct any new facilities unless we pay prices that sometimes seem rather high to us.'⁵³³ While he appealed to industrialists' patriotism, financial interests superseded all others. Schneider expressed its concerns that the intensive manufacturing in its factories would mean that almost all of its machinery would need replacing or refurbishment in the near future, for which it would need compensation.⁵³⁴ The Chantiers de France, in particular, tormented Albert Thomas. Its organisational structure was out-dated to the extent that it did not possess a telephone and was therefore extremely difficult to contact. The head of the factory decided that the price that had been agreed with the Firminy group for the production of 155mm shells was too low and so it refused to begin manufacturing. Thomas insisted that the Chantiers de France begin production immediately. Although he stopped short of requisitioning, he 'said to

⁵³¹ Hardach, "Industrial Mobilization," 69.

⁵³² Cited in A. Hennebicque, "Albert Thomas", in Fridenson, *The French Home Front, 1914-1918*, 95.

⁵³³ Letter from Albert Thomas, 18 November 1915, cited in Hardach, "Industrial Mobilization," 70.

⁵³⁴ Schneider, 187AQ019-01, General Assembly, 3 November 1915.

them energetically, “you *will* do it!” Thomas was very aware of the negative effect that this situation could have on other industrialists if they saw a significant establishment producing almost nothing. One deputy, Paul Benazet, stressed the likelihood that companies would turn to the Ministry of War, saying, ‘you claim that you need war material, that you do not have sufficient means to produce it, and yet there are large factories doing nothing!’⁵³⁵

By November 1915, many of the early contracts were reassessed as the Ministry of War sought to establish a more rational approach to the terms that had originally been agreed. However industrialists were now reluctant to commit to deals for less than they were already receiving and the *Service des Forges* struggled to find common ground with the manufacturers on an accurate cost price for shells of various calibres. Furthermore, industrialists had chosen to produce shells that were easiest and most profitable for them to produce. As a result, there was a shortage of the shells that were the most difficult to produce but were frequently the most effective for the artillery.⁵³⁶

Further problems exemplified the *ad hoc* approach of the Ministry of War’s dealings with industrialists. The process by which contracts were renewed proved overly complex and lengthy, frequently meaning that output dropped in the transition from one contract to another. Louis Renault proposed that contracts should be tacitly renewed for successive periods of thirty days for the duration of the war, unless one party informed the other of potential changes two months before the expiration of the contract. This was adopted for 75mm shell production as these contracts were likely to remain relatively constant, but it was not suitable for cast iron shells, which the Ministry of War was trying to phase out, or

⁵³⁵ AN C7558, Commission du Budget, 2 December 1915.

⁵³⁶ SHAT 10 N 29, Réunion des industriels, 26 November 1915.

larger calibre shells, as the more complicated nature of production warranted a longer-term commitment.⁵³⁷

Similarly, a clause was inserted into contracts from September 1916 onwards that stipulated that, if the war ended, companies could finish the production of shells that they had already begun to manufacture but only for a period of ninety days. After this point, the contract would be deemed to be finished.⁵³⁸

A *Commission des Contrats* was formed on 12 September 1915 to oversee the deals made with private industry and it cancelled many of the contracts agreed by the *Service des Forges*, such as that with the Société des Aciéries de Micheville in March 1916 because the agreed price was too high.⁵³⁹ Although it struggled to exert itself against the large industrial groups that had grown accustomed to dictating terms with the government, its formation demonstrated to the firms that the state was no longer willing to pay any price.⁵⁴⁰

Negotiations about the price of various calibres of shells persisted throughout the war and were a major source of tension between industrialists and the government. The *Commission des Contrats* sought to establish universal cost prices for shells but ran into difficulties due to the large number of variables, such as the fluctuating costs of raw materials, the size and quality of the workforce, the number of mobilised men employed, the size of the orders, the amortisation of machinery and delays in supply. It was therefore very difficult to impose uniformity on industrialists.⁵⁴¹

⁵³⁷ Ibid., Réunion générale des fabricants de gros obus, 26 June 1915.

⁵³⁸ Ibid., Réunion générale des fabricants d'obus, 2 September 1916.

⁵³⁹ AN 94 AP 71, Note pour le cabinet, 23 March 1916.

⁵⁴⁰ Porte, *La mobilisation industrielle*, 196.

⁵⁴¹ AN 94 AP 71, Note sur le prix des obus, 20 October 1915.

Alexandre Millerand recognised that the recruitment of private industry had been rushed, without a clear structure. However, he stressed to the *Commission des Finances* that the pressure of the shortage of munitions meant that the *Administration de la Guerre* 'could not wait to establish cost prices and assess the economic modifications brought on by the state of war; it called on the good will of all and made sacrifices so that output could increase as quickly as possible.' While production was still below the targets demanded by the army, he wondered how low production might have been had concessions not been made to industrialists or if they had drawn out the discussions on the conditions of the contracts. Each time the contracts were renewed, the Ministry sought to reduce the prices and insert clauses that were more favourable to the government, but it had to tread lightly lest production drop once more.⁵⁴²

The government took measures to ensure that industrialists supplied the agreed orders on time. The *Commission des Contrats* stressed that firm dates should be stipulated for the delivery of each section of a contract, with the Ministry of War reserving the right to terminate an agreement if the industrialist did not supply the agreed amount by a month after the deadline.⁵⁴³

The imposition of penalties for the production of poor quality shells or for failing to meet deadlines caused greater controversy. Penalties had not been applied from the start of the war but were reintroduced in May 1915. The quality of shells was determined by taking a sample of two hundred shells. If no defective shells were found following the assessment of this sample, then the overall delivery was deemed to be acceptable. Otherwise, the entire delivery had to be withdrawn, modified, and returned for inspection. Each shell would be

⁵⁴² SHAT 6 N 16, Note de le Ministre de la Guerre à M. Peytral, July 1915.

⁵⁴³ AN 94 AP 71, President de la Commission des Contrats à Albert Thomas, 22 September 1915.

examined individually, and if more than a hundred shells needed to be replaced, then a penalty of 11.5 francs per shell would be applied, with the maximum fine of 500 francs.⁵⁴⁴

The government applied further penalties if a contract was not completed to schedule but met serious resistance from the industrialists. At a meeting on 27 November 1915, Léon-Lévy, an executive manager of the *Compagnie des Forges de Chatillon Commentry et Neuves-Maisons*, chairman of the *Chambre syndicale des fabrications de matériel de guerre* and a vice-chairman of the *Comité des Forges*, recognised that penalties were frequently necessary in peacetime but argued that in wartime it was unfair that the same penalties be applied. Unforeseen cases of *force majeure* frequently hindered production, particularly delays in the delivery of raw materials and machinery. Albert Claveille, a member of the *Sous-Secrétariat d'Etat d'Artillerie et des Munitions* recognised that according to the law of 1903 governing contracts made with the Ministry of War, cases of *force majeure* gave the industrialist the right to defer the penalty and that the excuse of delays in delivery of raw materials was perfectly acceptable. Still, the Minister would not abandon the principle of penalties. Louis Loucheur and Louis Renault both outlined examples in which their production had been slowed as a result of delays in the delivery of steel, and yet, when they had informed the *Service des Forges*, the response had been that this was not an acceptable excuse. The industrialists felt that they were being punished twice, as they had to pay not only a penalty, but also the salaries of their workers for the time that they were unable to manufacture shells due to the lack of raw materials. Albert Thomas responded that the *Service des Forges* had not yet been made aware of the changes regarding *force majeure*, but this represented a further example of the lack of coordination that continued to plague the Ministry of War.⁵⁴⁵

⁵⁴⁴ SHAT 10 N 29, Réunion générale des fabricants d'obus, 26 June 1915.

⁵⁴⁵ Ibid., Réunion des industriels fabriquant les obus, 27 November 1915.

Another clash occurred over manpower and whether penalties should be applied when the fault lay with the shortage of workers requested from the army.⁵⁴⁶ Every industrialist present at a meeting on 31 March 1916 expressed his opposition to this policy, declaring that it was at odds with the approach taken with raw materials. Many remarked that the contracts that they had undertaken were 'often almost imposed on them; they had accepted because of their desire to do what they could and contribute to the defence of the nation.' They threatened that in future, 'if penalties were to be applied for delays that were not their fault, they would be forced to refuse to take on future contracts.' However, Albert Thomas remained firm, as it was too easy to be deceived by fallacious claims. The excuse of a lack of manpower was being used systematically by industrialists to such an extent that he could no longer allow it. He realised that this approach might mean that factories took on smaller or fewer contracts, but he preferred this to the situation whereby they accepted large contracts only to let down the Ministry when they failed to achieve their targets. Nevertheless, if the industrialist could prove that a sincere effort had been made to complete the contract, the penalty could be removed following an investigation.⁵⁴⁷

Due to the lack of pre-war preparation, the Ministry of War was always on the back foot in its dealings with industrialists, particularly in the early months of the war when the needs of the army outweighed financial considerations. However, it was difficult to redress the balance as the war dragged on, with private industry reluctant to relinquish its position of strength. While financial issues rarely impinged on production, the Ministry of Finance put increasing pressure on the Ministry of War to control expenditure and reined in Louis Loucheur's demands for increased imports in 1917, deeming the proposed costs unjustifiable.⁵⁴⁸

⁵⁴⁶ Ibid., Réunion des industriels fabriquant les obus, 31 March 1916.

⁵⁴⁷ SHAT 10 N 30, Réunion des industriels fabriquant les gros obus, 31 March 1916.

⁵⁴⁸ AN 94 AP 63, Ribot to Thomas, 6 January 1917.

Quality

In the early months of the war, the desire to provide the army with munitions and artillery in sufficient quantity meant that quality was sacrificed. The clearest manifestations of this were the second munitions crisis, inaccuracies of fire due to inconsistencies in shell production, and the production of the shells that were easiest to manufacture rather than those that were the most effective from a military perspective. Sacrificing quality proved to be a false economy, as the consequences of the short-term solution placed further strain on an already struggling armaments industry, while hampering the effectiveness of the army at the front lines.

The second munitions crisis was the result of poorly produced shells that exploded in the artillery barrel upon firing, resulting in the casualties of numerous artillerymen and the loss of matériel. Problems began in December 1914 as shells produced since the start of the war began arriving at the front lines.⁵⁴⁹ The exploding of artillery barrels put a large number of guns out of action, exacerbating the lack of pieces that had already put the French army on the back foot.⁵⁵⁰ Between 20 December 1914 and 2 May 1915, there were 487 reported cases of barrel explosions for the 75mm. The Fourth Army suffered in particular, with one explosion per 10,000 shells explosive shells fired. At its worst, the proportion was one explosion for every 3,000 shells fired in March 1915, resulting in a deficit of 518 75mm guns.⁵⁵¹

⁵⁴⁹ AFGG, 21, 391.

⁵⁵⁰ Reboul, *Mobilisation industrielle*, 24.

⁵⁵¹ AFGG, 21, 391.

The high command took a number of precautions to mitigate the crisis. To reduce their casualties, artillerymen were ordered to fire while standing at a distance, but despite reducing the casualties, this did not address the problem of the loss of matériel, and it negated one of the main advantages of the 75mm field gun: its high rate of fire. As a result, artillerymen sought to use the most reliable shells when the guns were being used most intensely, while the unreliable shells were reserved for periods of relative calm, so that they had time to shelter during the firing of the gun.⁵⁵²

The *Commission de l'Armée* was highly critical of how the Ministry of War handled the situation. On 1 May 1915, M. Jeanneney questioned why, 'seven months after the first explosions occurred, the *Administration de la Guerre* had still not managed to determine the cause of the problem.' Alexandre Millerand was forced to admit that had industry continued along the same guidelines as in peacetime, the army 'would have nothing'. Therefore 'quantity took precedence over quality.'⁵⁵³

Joseph Joffre instructed General Gossot to conduct an investigation into the causes of the explosions. Gossot identified that the main problem stemmed from the newly-produced, drilled shells. Before December 1914, only six explosions had been recorded out of three million shells fired. He highlighted three key factors: the haste with which factories had sought to convert their factories towards shell production, which resulted in a dip in the overall standard of production, the adoption of drilled shells in two parts in place of forged shells, and the lenient controls put in place to verify the quality of shells produced.

⁵⁵² Reboul, *Mobilisation industrielle*, 24; SHAT 6 N 16, Rapport par M. Jeanneney, 31 May 1915.

⁵⁵³ SHAT 6 N 16, Note sur les éclatements des pièces d'artillerie, par M. Jeanneney, n.d., probably Summer 1915.

Gossot believed that the demands placed on unprepared manufacturers had driven them to adapt their equipment to mass production as quickly as possible, resulting in short-cuts and imperfections. He hoped that once the transition period was over, the quality of output would improve as workers became more accustomed to the methods of production and more suitable machinery was put in place.⁵⁵⁴ Jeanneney's report had recognised that the desire for the rapid expansion of production had resulted in the dissipation of quality as the Ministry of War broadened its search for factories that could aid the war effort. Furthermore, the increasing numbers of companies working in production made it very difficult for the Ministry to monitor manufacturing methods and ensure that the industrialists were adhering to high standards. Unfortunately, 'the extreme good will of the industrialists had not compensated for their all-too frequent-incompetence.'⁵⁵⁵

The adoption of drilled shells in two parts presented more complications. In the first weeks of mobilisation, private industrialists had declared that they were unable to produce shells by forging and the Ministry of War therefore permitted them to produce shells in two parts, by drilling. Forging produced a shell with a relatively thin wall but assured a high standard of reliability, as the process of heating the metal removed many of the impurities. However, drilling enabled a larger number of industrialists to engage in armaments production, as it only required simple lathes. A bar of metal of a similar width to the shell was drilled to form the shell interior, before the outside of the shell was shaped with a lathe. The body of the shell and the nose were often manufactured separately.⁵⁵⁶ The shells in two parts were therefore deemed adequate at the time. Unfortunately, the seal between the two parts was not always tight, and small amounts of explosive were able to escape the edges of the nose cone. In January 1915, 25 percent of a shipment of 19,500 shells produced by a

⁵⁵⁴ AFGG, 21, 391.

⁵⁵⁵ Reboul, *Mobilisation industrielle*, 24; SHAT 6 N 16, Rapport par M. Jeanneney, 31 May 1915.

⁵⁵⁶ SHAT 10 N 1, Note sur l'organisation en France de la fabrication des munitions.

subcontractor of the Schneider group were deemed 'completely unusable'.⁵⁵⁷ Joffre immediately ordered the artillery to only fire forged shells and to avoid the drilled shells in two parts wherever possible.

On 1 March 1915, the manufacturing of shells in two parts was forbidden, although those already in production would continue with some modifications. Furthermore, the monitoring of production was increased. Due to the high demand for shells and the lack of machinery available to those new to armaments production, the standards for testing shells had been relaxed. In peacetime, shells were tested at a pressure of 1,400kg. However, after the recruitment of private industry, shells only had to be tested at a pressure of 400kg. From 1 May onwards, the standard of quality control was raised to 1,400kg once more, but the consequence was a drop in shell output from 75,000 per day to just over twenty-five as industrialists were forced to adapt to meet the new target. On 26 June 1915, Millerand told a meeting of 75mm shell manufacturers of his desire for industrialists to convert gradually to the production of forged shells. Indeed, the Ministry of War sought to incentivise production by forging through bonuses and by promising that the size and length of future contracts would be sufficient to amortise the cost of the required machinery.⁵⁵⁸ Louis Renault observed that it would take at least four months to make the transition, and it was therefore necessary to guarantee industrialists a contract of at least six months to cover sufficiently the costs of conversion.⁵⁵⁹

Nevertheless, problems persisted throughout the summer and the Ministry of War decided in August 1915 to permit only the production of explosive shells in one piece, reinforced with a brass base plate, and charged with 0.620kg of powder instead of 0.665kg. From then

⁵⁵⁷ Schneider, 01G0442, Note, 19 January 1915.

⁵⁵⁸ SHAT 10 N 29, Réunion générale des fabricants de gros obus et d'obus monoblocs 75, 26 June 1915.

⁵⁵⁹ Ibid., Réunion des chefs de groupes pour la fabrication des obus 75, 26 June 1915, 4.

on, the armies were supplied with reliable munitions and the premature explosions ceased, but more than a million explosive shells had to be recalled from the front to be modified, further exacerbating the already severe shortages at the front lines.⁵⁶⁰ In addition, the *Sous-Secrétariat d'Etat* estimated that throughout the summer of 1915, the army lost four to five guns per day, and while around half of these could be repaired, an additional 150 barrels were required from the Bourges arsenal to meet the deficit.⁵⁶¹

The transition from drilled to forged shells was still being discussed in summer 1916. On 1 June, 76.9 percent of 75mm shells produced in private and state establishments were forged.⁵⁶² By August, the *Service Technique* declared that there were no contracts in place for the delivery of drilled shells after 15 August 1916, although the army would continue to receive drilled shells as the reserves were slowly depleted and delayed production was completed. As of 9 August 1916, 14,000 shells out of 150,000 produced were drilled and this was expected to fall to zero between 15 September and 1 October. An additional advantage of forged shells was that they were both cheaper and quicker to produce once the machinery was put in place as considerable savings could be made on the amount of steel required per shell. The Ministry of War estimated that, for the production of 72,000 shells (the daily output of drilled shells in January 1916), forged shells would save 200,000fr per day.⁵⁶³ A study in the second half of 1916 demonstrated that, with a fixed number of lathes, twice as many forged shells could be made than drilled shells. The downside was that the process required a higher level of training, but by this point this was deemed necessary to ensure adequate output.⁵⁶⁴

⁵⁶⁰ *AFGG*, 111, 211; SHAT 10 N 46, Réponse aux questions posées par Raiberti, 26 August 1915.

⁵⁶¹ SHAT 10 N 11, Note pour M. le Sous-Secrétariat d'Etat, 24 July 1915, 4.

⁵⁶² SHAT 10 N 84, Réponse aux questions posées par M. E. Treignier, 19 June 1916.

⁵⁶³ *Ibid.*, Réponse aux questions posées par Raiberti (Letter of 9 August 1916), 30 September 1916.

⁵⁶⁴ SHAT 10 N 4, Rapport sur les munitions, présenté par Raiberti à la Commission du Budget, 2 December 1916, 21.

The second munitions crisis thus presents a clear example of the difficult situation faced by the Ministry of War in 1914 and 1915. While it recognised that the most reliable and highest quality shells were forged shells produced by pressing (*emboutissage*), the urgent and enormous demands from the army meant that Alexandre Millerand took the logical step of allowing private companies to produce shells by drilling. He was thus able to increase output dramatically over the first few months. Still, as the war progressed, the flaws of this approach became apparent and the army began clamouring shells of a reasonable quality when the pressures of short-term expediency gave way to long-term practicalities.

The Ministry of War recognised that the measures in place to oversee armaments production were insufficient in light of the rapid expansion of the first few months of the war, and the second munitions crisis emphasised the shortcomings. In peacetime, the supervision of the charging of shells fell to the *Commissions des Poudres de Guerres de Versailles*, under the command of the *Service de l'Artillerie*. However, its remit ceased once war broke out, 'based on the idea that the war would be short.'⁵⁶⁵ Such an oversight emphasises that while there were some key individuals who foresaw the potential for a protracted conflict, the structures in place were set up for a short war. The *Commission* was only reformed in early May 1915, ten months after the war began, with bases close to each of the key manufacturing groups. Henry Bérenger of the *Commission de l'Armée* lamented that the *Commission des Poudres* had not been reformed in the first few weeks of the war, 'even if that meant going against the mobilisation plan... never was the need to control and to oversee the charging of shells more pressing. It was an inexplicable oversight by the *Services Techniques de l'Artillerie*.' Bérenger deemed it 'inconceivable and inadmissible that, after the Battle of the Marne, once the length of the war and the need for intensive

⁵⁶⁵ SHAT 10 N 1, Note pour Budgets et Comptes. 19 January 1918.

production became clear, the *Administration de la Guerre* did nothing to set up a body to monitor quality.⁵⁶⁶

Further problems arose from variations in the weight of shells produced. The different and improvised methods of manufacturing meant that there was often a discrepancy of ten grams between the heaviest and the lightest shell produced, which resulted in significant differences in the accuracy of fire. In December 1914, General Maunoury called for the classification of munitions by weight and source to enable consistency at the front lines.⁵⁶⁷ This example typifies the link between the munitions industry and the front lines. The inconsistencies in weight hampered the accuracy of artillery fire. As a result, these issues were then passed back to the rear and mechanisms were put in place to resolve the problem. Greater regulation was also introduced in order to enable the artillery officers to fight to the best of their ability on the front. The personnel of the *Service des Forges* was considerably increased as specialists in metallurgy were recalled from the front and two new *Inspections des Forges* were created at Toulouse and Nantes to supplement the two pre-existing at Paris and Lyon. Furthermore, the responsibility for ensuring the smooth running of industrial operations, providing technical advice, and resolving difficulties of all natures arising in the manufacturing of shells was delegated to officers.⁵⁶⁸

Clearly a number of compromises were made in the months following mobilisation to provide quantity at the expense of quality in munitions production, but this approach applied to artillery as well. The relative shortage of guns in comparison to the German artillery meant that French guns continued to be used long after they would traditionally have been replaced. Under normal circumstances, artillery barrels would be repaired if the

⁵⁶⁶ SHAT 6 N 16, Troisième rapport sur l'état des chargements, 29 May 1915.

⁵⁶⁷ SHAT 16 N 696, Maunoury to Joffre, 28 December 1914.

⁵⁶⁸ SHAT 10 N 46, Réponse aux questions posées par Raiberti, 26 August 1915.

wear reached 0.3mm, but in wartime, the limit was extended to 0.6mm. In practice, the pieces sent back to Bourges frequently showed wear of 0.9mm or 1mm, with the grooves all but removed, such that fire became incredibly inaccurate. Over the course of two months in spring 1915, eighty-four pieces were withdrawn from the front due to barrel wear, which, coupled with the losses due to the explosion of faulty shells, placed even greater demands on the Bourges arsenal to produce sufficient guns to meet the needs of the army.⁵⁶⁹ For much of the first three years of the war, output struggled to mitigate the losses at the front, let alone increase the numbers of pieces available to the army.

The short-term approach that the Ministry of War took in the early months of the war was understandable given the front line situation and the belief that, if the resources were provided to the front in sufficient quantity, then victory might be achieved within the near future. However, sacrificing the quality of the materiel produced had severe consequences that became apparent and increasingly pressing as fighting dragged on. As a result, the changes and stipulations that the Ministry of War was reluctant to enforce in 1914 and early 1915 ultimately had to be introduced, with the perception that they were shutting the door after the horse had bolted.

Technology and Modernisation

The combination of the demand for the production of huge quantities of materiel and the shortages of raw manpower forced Albert Thomas and subsequently Louis Loucheur to seek a more rational approach to the manufacturing practices in operation in the factories and to introduce more modern methods to facilitate increases in output. Furthermore, the

⁵⁶⁹ SHAT 6 N 16, 3e rapport sur le canon de 75mm par Charles Humbert, 17 May 1915.

Ministry of War pushed production of certain products that represented a more efficient use of resources.

Cast iron shells were 'uncontestably a better use of raw materials, explosives, and manpower' than iron shells. In 1915, therefore, the Ministry of War encouraged their production where possible. Only the most poorly equipped factories were permitted to continue with the production of iron shells. Frequently, the decision was made to suspend production in these firms and to reallocate the military manpower and resources, rather than waste them on the manufacture of poor quality munitions.⁵⁷⁰

Albert Thomas pushed for greater collaboration between industrialists, with those whose factories were performing particularly well encouraged to instruct others in their methods and organisation. He promoted cooperation not just between armaments producers but also producers of raw materials such as iron and steel forges.⁵⁷¹ However, the drive for more efficient methods came from industrialists as well.

The attempts by the *Commission des Contrats* to reduce prices of shells and artillery pieces placed the onus on the industrialists to seek more efficient manufacturing methods in order to reduce their cost price and therefore conserve their profits. Officers of the *Contrôle des Forges*, along with engineers from the *Service Industriel* attached to the *Direction Générale des Fabrications*, sought every opportunity to highlight where factories could improve their machinery or their production processes, drawing on best practices observed elsewhere. The *Direction Générale des Fabrications* had recruited specialists with experience in metallurgy to work closely with both state and private producers and to advise on areas in which they could make better use of their resources. Finally, the *Sous-Secrétariat d'Etat de*

⁵⁷⁰ SHAT 6 N 17, Rapport de Charles Dumont, 12 August 1915.

⁵⁷¹ Ibid.

l'Artillerie et des Munitions began methodical studies of the production of factories to assess the extent to which their output was insufficient. Sanctions, such as the withdrawal of mobilised personnel, were then enforced.⁵⁷²

At the start of 1915, Henry le Chatelier was entrusted by Albert Thomas with the task of investigating the best methods of shell manufacturing. Reporting in July 1915, he found that there was a multitude of different approaches even to the production of relatively simple parts, differing from company to company, but also from workshop to workshop within the same establishment. In fact, in one factory, there were three different machines for the process of *ceinturage* (affixing copper bands to the base of the shells), with each used indiscriminately from one day to the next. Le Chatelier discovered that analysis of best practices had largely been completed by General Gossot, but the difficulty was putting them into action. The required machinery was often not available in many factories, and it would take considerable time and money to orientate towards new processes. Nevertheless, it was certainly possible to require that new factories that were preparing to start producing shells followed defined methods, particularly if financial benefits were demonstrated to the industrialists.⁵⁷³

The war encouraged a more scientific approach to industrial production, particularly with the aim of facilitating manufacturing and testing by unskilled labour. For instance, optical and electrical pyrometers were adopted on a large scale to allow one female worker to oversee ten furnaces at a time without the need for prior experience.⁵⁷⁴ There were early signs of transition towards 'technocracy': 'the transfer of [governmental] power from

⁵⁷² SHAT 10 N 8, Note, 28 July 1916.

⁵⁷³ AN 94 AP 84, Note de H. Le Chatelier à Albert Thomas, 5 July 1915.

⁵⁷⁴ Fontaine, *French Industry*, 93.

“political leaders” to the “experts”.⁵⁷⁵ However, the concept had much deeper roots in the writings of the Comte de Saint-Simon, an early proponent of developing a greater technological approach through economic and social change in the late eighteenth and early nineteenth centuries. Kuisel describes the archetypal French technocrat as seeking economic modernisation through ‘economic expansion, the scientific utilisation of resources, and an organised national economy directed by technicians’, with ‘society infused with the values of efficiency, productivity and expertise.’⁵⁷⁶

A number of forward-thinking industrialists led the transition towards modernisation. Louis Loucheur, whose aptitude led him to rise to Minister of Armaments, proved particularly open to adopting new methods. He began producing shells in Lyon in November 1914, with output swiftly exceeding his target of 10,000 shells per day and rising to 30,000 per day by the end of 1916.⁵⁷⁷ He set optimistic targets: ‘we must set a target superior to our needs, do everything we can to reach it, and then we have a good chance of succeeding.’⁵⁷⁸ Albert Thomas was extremely impressed by Loucheur’s work when he visited his factory in January 1915: ‘I think I can say that in the course of my extended travels I have never seen a comparable effort.’⁵⁷⁹ Loucheur bought the latest American machinery, introduced the assembly line to enable the use of unskilled and female labour, and adopted the principles of Taylorism.⁵⁸⁰

⁵⁷⁵ Richard F. Kuisel, *Ernest Mercier; French Technocrat* (Berkeley: University of California Press, 1967), viii.

⁵⁷⁶ Ibid.

⁵⁷⁷ Carls, *Louis Loucheur*, 11.

⁵⁷⁸ Louis Loucheur, *Carnets Secrets* (Brussels: Brepols, 1962), 21.

⁵⁷⁹ Thomas Report, 21 January 1915, cited in Carls, 12.

⁵⁸⁰ Carls, *Louis Loucheur*, 11.

The rise of Taylorism in France has traditionally been associated with the post-war period, but it had its roots firmly in armaments production.⁵⁸¹ It involved a structured approach to the management of factories developed by Frederick W. Taylor, founded on time and motion studies, with bonuses for increased output.⁵⁸² Taylor's philosophy was: 'i) the determination of best or standard ways, implements, and materials by scientific investigation and experimentation, and ii) a control so extensive and intensive as to provide for the maintenance of all standards in this way reached.'⁵⁸³ He began by timing basic actions in the workplace to establish the most effective methods and assign targets for output. He also introduced wage scales based on piecework to encourage workers to feel that they had a stake in the productivity of the factory and to ensure that they were efficient, as the basic wage was insufficient if they failed to meet required standards.⁵⁸⁴

Louis Renault was the first major French industrialist to explore Taylor's methods, but he was firmly in the minority in 1914.⁵⁸⁵ One year after the translation into French of Taylor's key principles in the *Revue de métallurgie* in 1908, Renault decided to introduce in a workshop of more than 150 workers the American system. The Taylorisation took two forms: the renovation and replacement of machinery, transitioning to new tools and machines, and *chronométrage*, the timing of work in order to determine salaries. It had three joint aims: to increase production (in eighteen months, the factory increased its output by more than 100 percent), to increase worker productivity, and to introduce 'a natural selection' that weeded out mediocre workers. Although the methods proved

⁵⁸¹ Charles S. Maier, "Between Taylorism and Technocracy: European Ideologies and the Vision of Industrial Productivity in the 1920s," *Journal of Contemporary History*, 5 (1970), 27–61; Dominique Barjot and Christophe Réveillard, eds., *L'américanisation de l'Europe Occidentale Au XXe Siecle, Mythe et Réalite* (Paris: Presses de l'Université de Paris-Sorbonne, 2002).

⁵⁸² Carls, *Louis Loucheur*, 11.

⁵⁸³ Frank Barkley Copley, *Frederick W. Taylor: Father of Scientific Management* (New York: Taylor Society, 1923), xvi.

⁵⁸⁴ Maier, "Between Taylorism and Technocracy," 29.

⁵⁸⁵ Anne Rasmussen, "Science and Technology," in John Horne (ed.), *A Companion to World War I* (Oxford: Blackwell, 2010), 312.

effective, they sparked unrest among the workers who feared lower salaries and losing their jobs. Renault was reluctant to push his changes further, with only a quarter of his workshops implementing *chronométrage* on the eve of war.⁵⁸⁶

The war allowed Renault to continue the transition towards Taylorism, with a production line system established for shells, aeroplane engines and tanks. While it was still not full Taylorism and was not introduced across all of his factories, it was progress, allowing production on a much larger scale. Between August 1914 and July 1920, the size of Renault's factories increased from 115,322 square metres to 339,280 square metres, power rose from 1,300kW to 6,200kW and the number of machine tools more than doubled from 2,250 to 5,210.⁵⁸⁷

During the war, others followed. Albert Thomas implored Arthur Fontaine to explore the potential of Taylorism in August 1916, while Georges Clemenceau weighed in to support the adoption of Taylorism in February 1918, supporting the Ministry of War in declaring that 'all heads of military establishments should turn to the study of... Taylorism [and] the employment in every kind of work of the minimum of labour through scientific research into the most advantageous methods of procedure.' Industrialists were encouraged to consult Taylor's writing, alongside other studies of his methods.⁵⁸⁸ The adoption of Taylorism at the Penhoet factory, which employed 3,000 workers, resulted in a saving of 215,380 working hours in 1917, while the hourly output of the explosives factory at Ripault increased from 15 kilograms per workers in November 1916 to 48 kilograms by 1918.⁵⁸⁹

⁵⁸⁶ Fridenson, *Histoire Des Usines Renault*, 71–72.

⁵⁸⁷ *Ibid.*, 95–98.

⁵⁸⁸ Note, 26 February 1918, cited in Copley, *Frederick W. Taylor*; John Horne, *Labour at War : France and Britain 1914-1918* (Oxford: Clarendon Press, 1991), 117; AN 94 AP 274, Bulletin des usines de guerre, 29 May 1916; 12 June 1916; 10 July 1916.

⁵⁸⁹ Fontaine, *French Industry*, 94.

Albert Thomas intended the new arsenal at Roanne to adopt modern production techniques, principles of Taylorism, and American machinery with the hope that the establishment would become 'a model state enterprise', fully mechanised, and organised with worker participation in management and relatively little involvement from state bureaucracy. Unfortunately, Thomas's plans fell apart in the face of heavy resistance from Parliament and industrialists, and the Roanne affair ultimately severely damaged his reputation.⁵⁹⁰

While Taylorism only really took off in France in the decade following the First World War, it was because of the demonstration of its potential in the limited cases in which it was attempted before 1918.

Rationalisation of production

The first stage to increasing output from the manpower resources available was to mechanise as much of the manufacturing process as possible, thus reducing the requirement for skilled labour. The new Citroen factory, built in 1915 to fulfil a contract for one million shells, was organised to facilitate efficient production. Wherever possible, the production process would be conducted on one floor and in one room, with the manufacturing processes in a single chain, close together, to minimise the time taken moving from one station to the next. Officers from the *Service des Forges* toured factories inspecting methods of production and recommending improvements. Citroen developed 'the trench', a production chain 280 metres long over the course of which a bar of steel was transformed into a shell that was ready to be sent to the front.⁵⁹¹

⁵⁹⁰ Kuisel, *Capitalism and the State*, 36.

⁵⁹¹ Porte, *La mobilisation industrielle*, 207.

Albert Thomas wrote frequent articles in the *Bulletin des usines de guerre*, imploring the adoption of more modern methods.⁵⁹² He also encouraged rationalisation in a different direction by pushing for the standardisation of production and trying to limit the number of different models of each artillery piece and shell in service ‘to build up a large reserve, to facilitate supply and to expand production.’ Porte describes this process as the pursuit of ‘*economico-industrielle*’, aiming to simplify manufacturing operations and increase the compatibility of different machines, pieces and constituent parts.⁵⁹³

War-time progress concluded with the creation of the *Commission Permanente de Standardisation* on 10 June 1918 by the Minister of Commerce, the Minister of War and the Minister of Armament. Etienne Clémentel presided over the *Commission*, which recognised the shift towards mass production and the need to work towards more rationally organised production not just in wartime but also in peacetime. It promoted the mechanisation of factories, the reduction of superfluous transportation, and the standardisation of production methods and products to ensure greater integration between firms. Taylorist principles were a cornerstone of its approach.

The *Commission* was particularly important for the transition to peacetime. Clémentel foresaw the need to maintain the momentum of wartime industrial production to ensure that France did not continue to be ‘overtaken by its rivals.’ ‘In peacetime struggles as in wartime, mass production has come to dominate.... The scientist has to come down from his ivory tower and the industrialist has to look beyond his immediate needs.... The

⁵⁹² Horne, *Labour at War*, 117; AN 94 AP 274, Bulletin de Usines de Guerre, 29 May 1916; 12 June 1916; 10 July 1916.

⁵⁹³ Porte, *La mobilisation industrielle*, 208.

necessities of war have brought the scientist and the industrialist together; from now on, they will no longer ignore each other.⁵⁹⁴

In sum, both at the front and in the interior there was a slow realisation of the need to improve the efficiency, the effectiveness and the quality of methods rather than simply relying on quantity to achieve targets. Once again the problem was that it took considerable time to introduce structural change, and, for the industrialists, the overhaul of existing methods and machinery came with financial risks. As a result, the modernisation of manufacturing practices, including the implementation of Taylorism and Fordism occurred quicker in the more stable post-war environment, with demobilisation offering a chance to introduce changes and plan for the future. Nevertheless, such developments would not have occurred without the advances made during the war, catalysed by the need to meet the huge demands of the army with limited manpower and resources.

⁵⁹⁴ France, Ministry of Commerce, *Rapport général sur l'Industrie française sa situation, son avenir* (Paris, 1919) i, ix; *ibid.* iii, 173, 211.

Chapter 7 – 1916 – ‘The Pivotal Year’?

Porte has argued that, for France, 1916 was the ‘pivotal year’ of the First World War, as it saw the rationalisation of the organisational structures managing the war economy. The improvisation of the early months of the war gave way to a more empirically structured approach to industrial mobilisation that culminated in the formation of the Ministry of Armament in December 1916. By 1918, these developments had facilitated the development of domestic armaments production to the extent that it was able to produce more munitions and artillery than Britain and Germany, while supplying the arriving American army.⁵⁹⁵

However, the profundity of the changes that emerged in the relationship between the front lines, the Ministry of War, and industrialists, should be questioned. Rather than seeing a profound shift in the management of the war, 1916 saw the gradual fruition of the actions taken in the first two years of the war. Munitions supply continued to increase at a considerable rate, facilitating the large, materiel-intensive battles at Verdun and on the Somme, and as the shells crises receded, attention shifted from quantity to quality, particularly with efforts to increase heavy artillery production. The key development of 1916 was therefore that industrial production began to facilitate large-scale offensives in which the limiting factor was the tactical approach of the high command rather than munitions or matériel. This was accompanied by the Ministry of War’s attempts to respond more directly to the doctrinal needs of the army, as industry became increasingly capable of coping with new production.

⁵⁹⁵ Rémy Porte, “Mobilisation industrielle et guerre totale,” 26–35.

The ever-increasing scale of warfare

The industrial nature of the battlefield and the magnitude of resources required by the third year of the war were demonstrated at the battle of Verdun, which was of critical, strategic importance to France's war effort. If France lost the battle, defeat might follow. While the army suffered enormous casualties, victory provided a significant morale boost and offered belief that Germany could be defeated. To match the resources that Germany threw into the battle, France expended vast quantities of munitions, materiel and men. General Janin reported that France sent 10,300,000 75mm shells to the front during the battle, along with 1,200,000 80mm and 105mm shells, and 8,600,000 shells for heavy artillery. In total, 20,100,000 shells were delivered to the front.⁵⁹⁶ This feat in itself was a testament to French industrial recovery, particularly when taking into account other obligations on the Somme and along the rest of the front.

However, shortages persisted, demonstrating that France had not yet overcome the difficulties of the first two years and that demands from the army continued to rise. On 1 January 1916, deliveries of 75mm shells reached 168,000 per day, while the French possessed 9,000,000 75mm shells and 2,800,000 heavy artillery shells, but these were not sufficient to cope with the demands of intensive fighting at the front lines. Throughout 1916, Pétain remained reluctant to launch the attacks requested by Joffre. He felt that the resources available were not yet enough to ensure operational success, and he preferred to wait until sufficient stocks had been accumulated.⁵⁹⁷

Although industrial production was improving, restrictions persisted. In January, Joffre commanded that 'strict conservation of munitions will have to be practised outside periods

⁵⁹⁶ Philippe Pétain, *La bataille de Verdun* (Paris: Payot, 1929), 189.

⁵⁹⁷ Pedroncini, *Pétain*, 103; SHAT 16 N 2595.

of battle in order to have sufficient munitions available for future offensives.⁵⁹⁸ Similarly, on 4 February, General Dubail, commander of Army Group East, chastised the commanders of the Seventh Army for exceeding their allocations of munitions. The severity of restrictions was illustrated by the extent to which these allowances were surpassed. For the ten-day period from 21 to 31 January 1916, the allowances and consumption were as follows:

Table 20 - Seventh Army Shell Consumption, 21-31 January 1916

Calibre	Allocation per gun	Consumption	Percentage exceeded
155mm	900	1,278	142
120L	800	1,554	194
90mm	1,500	3,968	265
75mm	10,000	16,171	162

Source: SHAT 18 N 293, Dubail to Villaret, 4 February 1916.

Allocations were not merely exceeded, but in some cases, the artillery was firing more than twice the number of shells assigned to it. Dubail stressed the severity of the situation and its possible consequences for the overall war effort, but artillery commanders clearly felt that such consumption was necessary to maintain their position at the front.⁵⁹⁹ It was evident that although the high command sought to conserve munitions, it could not control the actions of the enemy and it would be suicidal for artillery commanders to curtail firing in the face of a German offensive, a point detailed in the response of General de Villaret, commander of the Seventh Army.⁶⁰⁰

Even at Verdun and on the Somme, artillery consumption was curtailed. The Second Army, fighting at Verdun, saw its munitions allocation continually reduced on 30 September 1916, receiving just 20,000 155mm shells when 95,000 had been requested.⁶⁰¹ Although the

⁵⁹⁸ AFGG, 4, 74, GQG Note du 3e Bureau pour le 1er Bureau et la D.A., 19 January 1916.

⁵⁹⁹ SHAT 18 N 293, Note: le Général de Division Dubail, Commandant le GAE, au Général Commandant le 7e Armée, no. 7096, 4 February 1916.

⁶⁰⁰ Ibid., Villaret to Dubail, 15 February 1916.

⁶⁰¹ AFGG, 43, 156.

purpose of these restrictions was to bolster the supplies of the Sixth Army on the Somme, they had the inevitable effect of limiting the capabilities of the French at Verdun. Clearly, therefore, the munitions situation had not fully recovered. While it was no longer as critical as in the early months of the war, it still constrained the army's actions. That is not to say that output had not improved. Indeed, production had increased significantly. However, the scale of matériel requirements had also continued to rise, so industry was always struggling to catch up.

Developments in the use of artillery

After the experiences of the first two years of the war, the high command had a much clearer idea of how artillery should be used and what roles should be assigned to specific guns. Howitzers targeted the trenches, machine-gun nests and observation posts; short-range mortars could also target the trenches and specific points on the front lines; heavy mortars were used against strongpoints and fortified villages. Mines were used more often in conjunction with an attack to destroy or disable key points on the front line.⁶⁰²

The French army was also starting to develop more nuanced tactics. Attacks were not to be pursued beyond the range of the artillery bombardment and the preparatory bombardment was increasingly defined. The tactical philosophy of the French high command in January 1916 was 'the artillery devastates, the infantry overwhelms.' Furthermore, neutralisation and interdiction fire were slowly finding favour alongside destruction to provide a more sophisticated approach to the battlefield.⁶⁰³ Neutralisation fire involved the use of "special shells" (primarily gas shells) to temporarily disable enemy

⁶⁰² Philpott, *Bloody Victory*, 147.

⁶⁰³ *Ibid.*, 146.

positions or artillery. This was an important step from the traditional approach of seeking to destroy everything on the battlefield before an advance could be launched.

Still, despite developments in these areas, the emphasis on destruction persisted into 1917, with the *Instructions* issued on 16 December 1916 stressing the aim of 'the destruction of all active or passive elements of the enemy.'⁶⁰⁴ In pursuing this, generals attempted to calculate the number of shells that were required to achieve 'the total destruction of the enemy defences, trenches, interior, flanks and batteries,' while emphasising that it was impossible to reduce this number, without exposing the infantry to almost certain failure.⁶⁰⁵ French attacks therefore became very inflexible, restricted by the need to fire a huge quantity of shells, despite the fact that destruction was still not assured. From late 1916, however, following the arrival of increasing numbers of special shells at the front lines, neutralisation fire became an increasingly possible alternative.

At the start of 1916, neutralisation shells were at a very early stage of development, but commanders were beginning to recognise their importance in an offensive. Following the failures in 1915, Foch declared that a breakthrough was not possible 'so long as we are unable to supply an offensive with large quantities of modern weapons, such as asphyxiating gas.'⁶⁰⁶ Production of gas shells began in May 1916, and rose dramatically, with the output of 75mm gas shells overtaking shrapnel in July 1917.⁶⁰⁷ By the end of 1916, seven thousand gas shells were supplied daily to the front, representing around 5 percent of total 75mm shells, and output more than doubled by 1918, representing between 8 and 12 percent of total 75mm shells.⁶⁰⁸

⁶⁰⁴ SHAT 16 N 1995, Note sur l'emploi de l'artillerie, 7 August 1917, 1.

⁶⁰⁵ SHAT 18 N 272, Colonel Mouchon, De l'Offensive, September 1916, 18.

⁶⁰⁶ Daille, *Histoire de la guerre mondiale*, 127.

⁶⁰⁷ Reboul, *Mobilisation industrielle*, 28.

⁶⁰⁸ SHAT 16 N 2595.

Neutralisation was employed in the assault on Fort Douaumont on 24 October 1916 with considerable success, after which Colonel Wisse declared, 'the production of special shells of all calibre appears indispensable.'⁶⁰⁹ Following the failure of the initial offensive on the Somme, the emphasis of the generals shifted further, with the phrase 'destruction or neutralisation' increasingly present in artillery documents from then on.⁶¹⁰ A synergy of the two methods emerges, with destruction of the key defensive points carried out during the preparation stage, while, at the moment of attack, neutralising fire 'completes the job that could not be carried out by destruction fire.'⁶¹¹

The emphasis on the role of neutralisation fire culminated with the *Instructions* of 31 October 1917, which stated that, 'the chances of success... reside above all in surprise and in the actions of neutralisation at the moment of the attack, rather than in seeking complete destruction.' Surprise could be restored, and the length of preparations reduced 'through intensive use of neutralisation fire, with a very large use of special shells' which would nullify the defences that had not been destroyed.⁶¹² The development of 'special shells' was crucial to this. They represented 'the most effective method of neutralisation' and could, if fired in sufficient quantity, even cause enemy casualties.⁶¹³

Neutralisation by 'special shells' proved particularly effective at the Battle of Malmaison in October 1917. Although preceded by a relatively short but extremely powerful preparation, the gas shells fired at the moment of attack were very effective at neutralising the enemy

⁶⁰⁹ SHAT 18 N 272, Centre d'Etudes d'Artillerie, 20 January 1917.

⁶¹⁰ AFGG, 431-540, 748, Note sur les contre-batteries, 20 September 1916; Letter from Pétain to Painlevé, 28 May 1917, in Pedroncini, *Pétain, général en chef, 1917-1918*, 41; Lucas, *L'Evolution des idées tactiques en France et en Allemagne pendant la guerre de 1914-1918*, 147.

⁶¹¹ SHAT 16 N 1995, Instruction sur l'action offensive, 31 December 1917, 26.

⁶¹² Maitre, "Des idées sur l'emploi de l'artillerie pendant la guerre," 337.

⁶¹³ SHAT 16 N 1995, Instruction sur l'action offensive, 31 December 1917, 165.

batteries, with the French soldiers advancing over six kilometres, one of the largest gains of the war to that point.⁶¹⁴ An interesting conclusion drawn from this attack was that neutralisation by gas shells rather than through explosive shells was more economical in terms of the number of shells that needed to be fired to achieve success. Even in late 1917, considerations of shell supply were still prevalent, with gas shells also allowing a significant reduction in the length of the preparatory bombardment, further preserving shell stocks.⁶¹⁵ The role of industry was crucial to the development of 'neutralisation' tactics, as it was able to supply 'special shells' in sufficient quantity for the artillery to exploit them for tactical success.

The development of 'neutralising fire' was a significant step forward, but artillery tactics were becoming much more structured from much earlier, with different methods employed depending on the task faced. Although 'destruction fire' has been discussed already, the artillery also employed 'harassing fire' and 'interdiction fire'. The former sought to move away from the firing of isolated shells or prolonged bombardments that had been shown to have a negligible effect and involved the use of very short, well-prepared, and brutal bombardments that maintained the element of surprise. It was designed to inflict losses on the enemy, and make it impossible for soldiers to break cover without exposing themselves to the artillery, while preserving French troops.⁶¹⁶ Harassing fire was frequently used at night to hinder the repair of trenches damaged during the day, focusing on a front of a hundred metres at a depth that guaranteed hitting the enemy trenches.⁶¹⁷ Harassing bombardments were intended to be small operations.

⁶¹⁴ Doughty, *Pyrrhic Victory*, 389.

⁶¹⁵ *AFGG*, 52, 1107.

⁶¹⁶ *Ibid.*, 41, 320.

⁶¹⁷ SHAT 16 N 1995, Note sur l'emploi de l'artillerie, 7 August 1917, 24.

Interdiction fire was used in conjunction with destruction and neutralisation during an attack, and targeted the support and communication trenches to prevent the resupply of the front lines with soldiers and munitions. It required a mix of shrapnel, explosive and gas shells to isolate the forward trenches so that they could not be strengthened during the preparation stages of an attack and to hinder the possibility of a counter-attack.⁶¹⁸ The downside of these two methods was that they required large quantities of munitions. The artillery could still not afford to expend vast quantities of shells without assurances of success. Harassing and prohibitive fire served a clear purpose, but it was felt by June 1918 that munitions could be better served if more were devoted to counter-battery fire and concentrated fire on key objectives.⁶¹⁹ Therefore, although munitions production facilitated the majority of artillery tactics by 1918, some methods that proved effective still had to be constrained.

Increasing shell supply did enable the introduction of the 'rolling barrage', a tactic designed to support the infantry by tying down the enemy while they advanced. A high concentration of artillery was required, firing a density of eight shells per hundred metres of front, with the bombardment advancing in bounds of approximately 150 metres every three minutes depending on the terrain.⁶²⁰ The infantry followed behind the wall of shells at a distance of between fifty and a hundred metres.⁶²¹ The rolling barrage was conducted by the 75mm field gun, firing both shrapnel and explosive shells.⁶²² Ahead of this was a barrage of high calibre shells that advanced in much larger bounds of five hundred metres to a thousand metres and focused on the important tactical points such as trenches and

⁶¹⁸ Ibid., Note sur l'emploi de l'artillerie en liaison, 7 August 1917, 25.

⁶¹⁹ SHAT 16 N 2096, Lt-Colonel Picot, Compte-rendu de mission, 1 June 1918.

⁶²⁰ SHAT 16 N 1995, Note sur l'emploi de l'artillerie, 7 August 1917, 28.

⁶²¹ AFGG, 431-612, 856, Note pour les armées, 24 September 1916.

⁶²² Ibid., 43, 346.

concrete defences.⁶²³ This approach needed much greater coordination between the infantry and artillery divisions than had been previously seen, but it required a vast quantity of munitions, and even after the war Colonel Roger remained sceptical about the merits of devoting so many shells to this tactic, describing it as ‘a huge devourer of munitions.’⁶²⁴ He calculated that, for a barrage advancing a hundred metres in three minutes, the total bombardment would last around an hour. With a conservative estimate of firing five shells per minute, each piece would fire three hundred shells in this period, which was the equivalent to one day’s allowance of shells. This was, in his view, simply not feasible for much of the war, particularly considering the need for a preparatory bombardment and subsequent counter-battery fire before and during the attack.⁶²⁵

Although the rolling barrage was first seen in 1915, and was employed more frequently from June 1916 onwards at Verdun, the state of munitions production meant that the artillery lacked the shells for it to be truly effective.⁶²⁶ However, its use began to take on greater subtlety throughout 1916, and by late 1917 shell supply had increased to allow an unconstrained adoption of the approach.⁶²⁷ Again, at Malmaison, the tactics were employed with great success, with German soldiers surprised at the arrival of the French infantry so close behind the artillery.⁶²⁸ Without the improved industrial output of shells, the implementation of this important tactic, which proved so successful in gaining territory, would not have been possible.

⁶²³ SHAT 16 N 1995, Rapport du Goumoens, 94.

⁶²⁴ Colonel Roger, “Les méthodes d’appui de l’attaque par l’artillerie au cours de la guerre”, *Revue Militaire Française*, 10 (1921), 342; Herr, *L’artillerie*, 154.

⁶²⁵ Roger, “Les méthodes d’appui de l’attaque,” 342–3.

⁶²⁶ Doughty, *Pyrrhic Victory*, 306; Lucas, *L’Evolution des idées tactiques*, 146.

⁶²⁷ Philpott, *Bloody Victory*, 147.

⁶²⁸ Doughty, *Pyrrhic Victory*, 308.

The 1916 battles of Verdun and the Somme were a key learning experience for French generals in which they saw the importance of artillery and the nuances of its employment. The high command became increasingly insistent with its tactical instruction. Fayolle, for instance, the former professor of artillery at the *École Supérieure de Guerre*, repeatedly stressed methods for increasing the effectiveness of artillery fire, such as improving the accuracy of barrages in order to preserve munitions, limiting the attrition of artillery barrels, improving observation through greater coordination with air support, improving long range firing, and counter-battery fire.⁶²⁹

New Technology

Before the outbreak of the war, one of the main problems had been how long it took the French high command to commit to the production of modern heavy artillery. The war provided the incentive for haste. The pressure was such that research was ‘driven from the front’, which, by a process of technical Darwinism, picked the most effective from the proposed prototypes.⁶³⁰ However, the demand for new technology at the front lines varied. The level of training and instruction of soldiers was poor and it was not always beneficial for the army to adopt new weapons if the soldiers were not capable of using them. French troops were made up of men largely from rural backgrounds, which made them less receptive to technical innovations than the more urbanised British or German soldiers. According to Colonel Serrigny, inspecting the training of the Army Group Centre in 1916, ‘the technical knowledge from one soldier to the next was generally very weak.’⁶³¹

⁶²⁹ “Sixth Army: Somme Offensive Correspondence”, cited in Philpott, *Bloody Victory*, 267.

⁶³⁰ Goya, “Le Processus d’Evolution,” 359.

⁶³¹ Général Serrigny, cited in *ibid.*, 360.

As for the officers, apprehension towards the increasing 'technicalisation' of warfare varied. The *polytechniciens* were understandably the most open to it, while among those further up the chain of command, there were many who were favourable to the concept of potential 'miracle weapons' that might hold the key to unlocking trench warfare. This was especially important for the recognition of the importance of mobile heavy artillery. Pétain in particular took a much more 'managerial and economically-minded' approach, rather than being a *technicien*, and was frequently compared to a captain of industry.⁶³²

Ultimately, advances in artillery tactics would be worthless unless the infantry were capable of completing the job. Although the German army has traditionally been heralded as the forerunner in the development of infantry tactics, all sides strove to find a solution to trench warfare and France was already pursuing the introduction of similar 'storm-troop' tactics in early 1916. These were slowly introduced throughout 1916, particularly on the Somme, with increasing troop specialisation in the use of weaponry, particularly grenades and light machine guns, while assault tactics were designed to give soldiers greater serendipity and the capability to sweep up pockets of resistance or to press on with the advance when the opportunity arose. Manoeuvre in small groups or squadrons began to take precedence over the traditional advance in waves. Furthermore, greater coordination with artillery was promoted both during the advance of the infantry and in the targeting of strongpoints that had not been fully destroyed by the preparatory bombardment.⁶³³

The tactical advances since the start of the war and throughout 1916 were significant. On one level, these developments were not possible without the rapid expansion of industrial production that facilitated artillery action at the front lines. On another level, however, these developments explained the need for even greater supplies of munitions and

⁶³² Ibid., 360–1.

⁶³³ Philpott, *Bloody Victory*, 149.

matériel, thus placing yet more pressure on industry. What was important was that the munitions and matériel were supplied in sufficient quantities, so that the high command could pursue tactical and operational objectives free from constraints.

The Home Front

By 1916, the Ministry of War had managed to mobilise a large section of domestic industry for war production, but the gap between output and demand remained. As has been seen in the previous chapter, longer-term structural problems hampered the smooth running of the production system. Porte argues that by the third year of the war the Ministry of War imposed a more rational structure on the industrial process to meet this rising demand, but it proved difficult to achieve. The important development was the closer orientation of industrial production with the needs of the army through the introduction of two new armaments programmes on 30 May 1916 and 23 July 1916. This section will explore the make-up of these programmes and the Ministry of War's response to the new challenges, including administrative changes designed to ease many of the problems that had arisen in the first two years of the war. The emphasis slowly shifted from throwing more money and resources at the problem to a more sophisticated approach to production methods and organisation. However, the system remained far from perfect and the *ad hoc* decisions of the early months of the war continued to influence and restrict the management of war production.

First, it is necessary to establish the state of French production and the needs of the front lines at the start of 1916.

Artillery

Since the start of the war, the high command had strengthened its heavy artillery in two ways. It had modified existing, out-dated models to suit the purposes of trench warfare, while awaiting the arrival of modern artillery from the factories. By 14 May 1916, the number of old-fashioned models that had been sent to the front since the start of the war was as follows:

Table 21 Out-dated artillery pieces delivered to the army since the start of the war

Calibre	Total delivered
95mm	342
100TR 1897	40
120L	1,164
155L	716
155C Mle 81-1912	196
220mm	136
270mm	32
14cm 1891	12
14cm 1910	27

Source: SHAT 10 N 33, L'artillerie depuis la mobilisation, 31 May 1916.

Many of these calibres required installation on modern platforms so that they could be transported across the battlefield, particularly as they primarily came from forts and the navy, and were therefore unsuitable for manoeuvre. Other adaptations included the installation of more modern braking mechanisms to ensure the gun returned to its original position after firing, and the strengthening of the barrels to cope with the volume of fire. The wide variety of calibres and models presented additional complications for supply.

The number of new artillery pieces delivered to the front since August 1914 was as follows:

Table 22 Modern artillery pieces delivered to the army by May 1916

Calibre	Number ordered	Number delivered
105	440	249
120 howitzer	96	40
155 howitzer	500	4
155L on Schneider plat.	120	13
220 mortar	40	0
280 mortar	62	16
370 mortar	10	10

Source: SHAT 10 N 33, L'artillerie depuis la mobilisation, 31 May 1916.

Monthly production of the main pieces had developed as follows:

Table 23 Monthly artillery production, August 1914 - January 1917

	75mm	155mm	Field artillery	Heavy artillery	ALGP
August 1914	20	-	-	-	-
January 1915	222	-	222	10	-
July 1915	227	-	227	12	-
January 1916	467	-	467	20	7
July 1916	618	40	622	59	12
October 1916	773	87	793	200	7
January 1917	902	229	926	340	3

Source: AN 94 AP 63, Fabrications de Guerre. Field artillery included 65mm, 75mm, 80mm and 90mm calibres. Heavy artillery included 95mm, 100mm, 105mm, 120mm, 145mm, 155mm and 220mm calibres.

As can be seen from the tables above, the French army had been able to rely on a considerable number of old-fashioned artillery pieces over the course of the first two years of the war, but these were unsuited to the requirements of modern warfare, lacking mobility, range and speed of fire. The production of 75mm field guns had developed at a reasonable rate and although they were more useful in certain scenarios, they lacked the effectiveness of modern heavy guns and howitzers. However, these had not been produced in large quantity before 1916. The Ministry of War had again taken the expedient option of focusing on what it could produce in large quantities, which were 75mm guns. Only a few establishments, such as Schneider and Saint-Chamond, possessed the machinery and expertise to produce heavy artillery on a large scale. By 1916, French industry was in a

much more comfortable position and the Ministry of War turned its attention to fulfilling the wishes of the French high command.

30 May 1916 programme

Throughout 1916, the high command and the general staff repeatedly sought to assess the state of their resources and those necessary to achieve their tactical and strategic aims. On 4 April 1916, Flaminus Raiberti presented a study on the use of artillery in the offensive and provided his assessment on the available materiel. This became the foundation of the 30 May 1916 armaments programme. He proposed the formation of groups of howitzers, 155C or 220mm, assigned to army corps in order to increase their offensive capabilities. At the time, the artillery was organised around lower calibre models of 120C or 155C, whereas Raiberti called for four groups of 155C howitzers and one of 220mm. He also deemed it necessary to form regiments of long pieces (105mm, 120mm and 155mm) for use in counterbattery fire.

While Albert Lebrun, who had been Minister of War in 1914 and was now the President of the *Sous-Commission des Armements de la Chambre des Députés*, felt that the proposal was unrealistic considering industry's capabilities at the time, Raiberti maintained that the present state of armaments did not support the possibility of mass offensive warfare or manoeuvre by the four main armies France had in the field. He believed that it would be possible to produce sufficient long barrelled pieces in reasonable time, along with the necessary short howitzers for three armies that would facilitate the operational goals of the French high command.⁶³⁴

⁶³⁴ SHAT 10 N 1, Report by Raiberti; *ibid.*, Response of Lebrun, 14 June 1916.

Joffre's programme of 30 May 1916 had a similar foundation and focused on providing increased modern heavy artillery. Up until this point, the army had to persist with obsolete guns that were outmatched by their German counterparts. The programme recognised the following necessities:

- a) A short barrel, quick-firing artillery piece capable of preparing infantry attacks and mobile enough to move forward during operations to fire on successive lines of defences.
- b) A long barrel, long-range artillery piece powerful enough to provide counter-battery fire on enemy batteries while being positioned at such a range as to be protected from lower-calibre enemy fire.
- c) A short barrel, very powerful artillery piece to focus devastating fire on particular points of support and defence such as concrete dugouts and shelters.⁶³⁵

The numbers required to meet this programme were as follows:

Table 24 Pieces required to complete the 30 May 1916 production programme

Model	Total Required
105L	960
155CTR	1,440
155L	960
220TR	320
280TR	80

Source: SHAT 10 N 12, Note, 30 May 1916.

Joffre recognised that the programme represented only a part of the total needs of the army. Nevertheless, compared to the number of modern heavy artillery pieces supplied to the army up until this point, the numbers detailed above would represent a significant improvement. Calculating on the basis of ninety divisions and forty army corps, the programme would result in an increase of sixty 155C groups (720 pieces) and four 155L

⁶³⁵ SHAT 10 N 1, Note, Joffre to Roques, 30 May 1916.

groups (480 pieces). The creation of such a wealth of matériel would facilitate the concentration of pieces necessary for an attack.

However, French industrial capacity and resources in artillery personnel available at this time meant that the complete realisation of this programme was optimistic. The expansion of the artillery required drawing men from the cavalry and the infantry and giving them the technical training necessary to man the new formations. Furthermore, it would take industry some time to reorient towards the manufacturing of higher calibre pieces.⁶³⁶

When the programme reached the Ministry of War, Albert Thomas expressed his fears that it could take as long as three to four years to be completed. He sought to 'intensify production by all means,' but this depended on two factors: first, it relied on the *Administration de la Guerre* and the return of manpower to the factories, particularly to Schneider et Cie and Marine-Homécourt, where they could be used most effectively for artillery production; second, it relied on the industrialists. Thomas mooted the idea of agreements among armaments manufacturers to facilitate the production of specialist items and weaponry, expanding the network of those capable of producing by sharing expertise, knowledge and methods. M. de Courville, a leading industrialist, responded that they had already sought cooperation from many others, and that, if further manpower were provided, production could be intensified through these channels. In his opinion, the regular production of twenty-four 105mm guns and thirty to thirty-two 155mm howitzers per month could continue until 1 July 1917. For new production, and in particular for that of high power 155mm howitzers, it would evidently be necessary to find additional support, and this would require more time and work before assessing its viability. However, the machines and technology for the large-scale production of artillery were restricted to the

⁶³⁶ SHAT 10 N 12, Le Général Commandant en Chef à M. le Ministre de la Guerre, 30 May 1916.

large factories, and thus support from smaller industrialists could only serve to provide accessories to the artillery production at best.⁶³⁷

Wearing out of materiel

When drawing up artillery programmes, the general staff had to take into account not just the numbers required at the front lines but also the rate of barrel wear caused by relentless firing. This varied from piece to piece but was much higher than pre-war forecasts due to the vast quantities of shells that were being fired.

Table 25 Rate of barrel wear

Model	Barrel Life	Estimated Time	Shells per day	Waste/loss
155C old mod.	10,000 shells	16 months	20 shells per piece/day	3/40,000
155C Sch.	8,000 shells	8 months	30 shells per piece/day	3/40,000

Source: SHAT 10 N 12, Programme de rechanges de l'artillerie, July 1916.

The production plan foresaw the delivery of thirty-two guns per month from June 1916 onwards to replace those lost, rising to thirty-four in spring 1917, but as more entered the battlefield, inevitably the number of replacement barrels rose as well.⁶³⁸

23 July 1916 programme

A second programme emerged following a meeting between the head of the Girolou firm and future Minister of Armaments, Louis Loucheur, and Albert Thomas on 19 June 1916. Loucheur presented a new production plan to Thomas, entailing the expansion of the finishing process that had been introduced by the Girolou firm in the assembly of 155mm L and 220mm C guns. Loucheur sought to coordinate with other industrialists to raise 15

⁶³⁷ SHAT 10 N 29, Réunion au sujet du développement de la fabrication du gros matériel d'artillerie, 13 June 1916.

⁶³⁸ SHAT 10 N 12, Programme de rechanges de l'artillerie, July 1916.

million francs to enable the introduction of this process elsewhere. Ultimately, the *Société en Participation pour l'Usinage d'Artillerie Lourde* was formed in September, with Girolou and Schneider-Creusot, the dominant shareholders, overseeing its administration. Loucheur also committed his own factories to undertake production of 155mm L and 220mm C guns.⁶³⁹

After subsequent meetings with other industrialists, Thomas formulated the heavy artillery programme of 23 July to meet the demands of the French high command. The plan created output schedules and organised new industrial groups to coordinate and facilitate production, with the most important being Groupe Schneider, which was asked to produce 390 155mm C guns, along with a significant quantity of other calibres including 155mm L by the end of June 1917. Girolou and Alsacienne would produce 110 155mm L and 110 220mm C, with the deadline for the first guns of January 1917. However, each of the companies declared that they would struggle to meet such deadlines and that it would be at least March 1917 before guns would arrive. The schedule was revised in September and again in November 1916, as it became clear that the targets would not be achieved.⁶⁴⁰

Joffre was dissatisfied with the new deadlines. On 18 August, he wrote to Albert Thomas to discuss progress, declaring that the forecast for sixty-six 155CTR howitzers per month from October 1916, with an increase of four pieces per month from March 1917, was 'not sufficient to meet the pressing needs for guns of this calibre.' The wearing out of howitzers following the hard campaign of the summer of 1916 meant that a large proportion needed replacing during the winter of 1916-17, and Joffre pressed for the formation of the first forty groups of 155CTR pieces and the replacement of around two-thirds of the out-dated guns to be completed before spring 1917. This required the production of a total of 300

⁶³⁹ Carls, *Louis Loucheur*, 18.

⁶⁴⁰ *Ibid.*, 18-9.

pieces to be delivered by April at the latest, 120 guns more than forecast, requiring an increase of twenty guns per month from November 1916. These were very optimistic demands when industry was already straining to meet the levels set by Albert Thomas. Either Joffre had little appreciation of this fact, or he felt that more could be done.⁶⁴¹

Charles Humbert was more open with his criticism, but blamed the general staff for its indecision:

They place orders, they cancel orders, they stop work in progress, then start it again. They slow the production of 75mm guns to accelerate that of 105mm, and the next day they slow 105mm production to encourage that of 155C, which we will undoubtedly sacrifice in favour the 220mm or 280mm someday soon. We make guns for which we have no shells and shells when we do not have the guns. They demand the adaptation of naval pieces, and a few weeks later they no longer want them. And on top of all this, we are rebuilding and modifying out-dated artillery from forty years ago. The truth is that they do not want modern artillery. They have never wanted it. Would they even know how to use it? In any case, they slyly hinder its production; they disrupt the programmes, they refuse to cede manpower, they do not instruct the men. The country is in danger, and the army withers in the face of it. The cause of all the damage... is in this disastrous organisation that has resulted in the command of the army becoming a state within the state, giving it formidable autonomy, and all the powers of the nation buckle in the face of its irresponsibility. They forget that we are at war.

He also blamed the government for its inaction: 'it has the authority and it does not dare to use it. It has not adopted the strong mentality of wartime.' To some extent, Humbert was right. The cession of power to the army in the first few months of the war, in anticipation of a relatively brief conflict meant that, despite the recall of Parliament, the army continued to hold the upper hand and was reluctant to cede control over affairs. The government and Parliament only managed to re-establish themselves from the end of 1916, first with the removal of Joffre, and subsequently the removal of Nivelle, following disappointing results.

⁶⁴¹ SHAT 10 N 12, Joffre to Thomas, 18 August 1916.

Still, it took the arrival of Georges Clemenceau as Prime Minister in November 1917 to take a firm grip of the management of the final year of the war.⁶⁴²

Humbert rarely missed an opportunity to criticise the management of the war effort. At a secret committee on 19 December 1916, Loucheur described the delivery of Humbert's report: '[He] began, charging full tilt at Thomas and the government.... Humbert profited by being more and more violent. All in all, it was a bad meeting for the cabinet.'⁶⁴³ The tension between the *Commission de l'Armée* and the government was further exemplified in Loucheur's description of his first appearance before the *Commission* alongside Albert Thomas:

Thomas and I left at 2:45pm. He was more scared than me! After arriving in the room reserved for ministers, the secretaries of the *Commission* came to find us almost like school children going into detention. I spoke for more than an hour.... Doumer became agitated. He was two steps from me, and corrected in a whisper all the figures like a school inspector correcting the lesson that a teacher recites.⁶⁴⁴

François de Wendel suggested that much of Humbert's criticism of Millerand and the Ministry of War throughout 1915 was encouraged by Eugene Schneider, who had bought Humbert's newspaper *Le Journal*, and therefore also 'bought' Humbert. *Le Journal* was the medium for many of Humbert's public attacks against the Minister of War and his management of the war. De Wendel suspected that Schneider's opposition to Millerand was fuelled by the fact that the Minister of War had consistently taken de Wendel's side in the various industrial disputes between the two large metallurgy firms since 1907, and that by securing the removal of Millerand Schneider might get a replacement who was more favourable to his own interests.⁶⁴⁵

⁶⁴² AN 94 AP 84, Report by Charles Humbert, 14 February 1916, 65-68.

⁶⁴³ Loucheur, *Carnets Secrets*, 29.

⁶⁴⁴ Carls, *Louis Loucheur*, 31.

⁶⁴⁵ Jeanneney, *François de Wendel en République*, 50.

The *Commission de l'Armée's* agitation reached its peak in 1916. Georges Bonnefous, a deputy during the war, claimed that the government was 'literally tormented by parliamentarians... obliged to appear three times a week before the commissions of the Chamber and Senate.'⁶⁴⁶ In June, the Chamber of Deputies sought to take command of the situation by establishing control by direct delegation rather than by commissions, which would have seen the war industries fall under the immediate control of Parliament. However, while the motion passed by 444 votes to 80, Prime Minister Aristide Briand strongly resisted and the system was never put into action.⁶⁴⁷

It must be remembered that the targets and demands from the front lines were inevitably ambitious. There were numerous complaints about the failure of industry to meet these required levels, but the basis for these targets must be questioned. Although officers frequently blamed the lack of munitions or artillery for the failure of their offensives, this was an easy scapegoat to cover up failures in command. It was impossible for factories to produce artillery pieces immediately, having had no prior technical experience in this area. Still, if an industrialist deemed these targets acceptable and promised to meet them in order to secure sizeable contracts, then the blame lay at his door. Nevertheless, the quantity of heavy artillery at the front lines increased steadily throughout the war. In September 1915, France had one heavy gun for every forty metres of front in the battle of Champagne, and per thirty-six metres in Artois. This improved to one every twenty-five metres on the Somme in July 1916, and one every eleven metres at Malmaison in October 1917. In the latter, the tactical benefit of the increased density of fire afforded was particularly clear, and key to the success of the offensive.⁶⁴⁸

⁶⁴⁶ Bonnefous, *Histoire politique de la Troisième République*, ii, 119.

⁶⁴⁷ Godfrey, *Capitalism at War*, 55.

⁶⁴⁸ Reboul, *Mobilisation industrielle*, 47.

Changes in production direction

Despite Thomas's best efforts to intensify production, the sudden shift to heavy artillery production caused new problems regarding the quality of matériel produced. In his urgency to meet the demands of the front lines, Thomas had split the order for 155mm howitzers between the two models available, one produced by Schneider and the other by Saint-Chamond, without awaiting the results of trials. Although output had increased, front line tests over the course of the second half of 1916 showed that the Saint-Chamond 155mm model was significantly poorer than the Schneider model. The results, given to Joffre on 12 November 1916, revealed that the Saint-Chamond platform was too unstable, had inherent weaknesses, required regular repair and made accurate firing very difficult, while the barrels had a high rate of wear. It was deemed 'notably inferior to the 155C Schneider howitzer.' This prompted the commander-in-chief to demand the substitution of Schneider howitzers for Saint-Chamond howitzers as soon as possible.⁶⁴⁹

Paul Doumer was quick to raise concerns, fearing that the upheaval from shifting production towards the Schneider model would hamper overall matériel output. At this point, the Aciéries de la Marine were in the middle of completing an order for four hundred Saint-Chamond pieces and one hundred extra barrels, which was due to be completed by June 1917. Even in December they were already behind on their targets, producing thirty pieces per month instead of the intended thirty-six. Furthermore, there appeared to be a breakdown in communication between the industrialists and the Ministry of War. The director-general of Saint-Chamond had informed Doumer that Thomas expected the Aciéries de la Marine to shift production towards Schneider model pieces at the same time as completing their existing order, which would inevitably hamper the speed of production

⁶⁴⁹ SHAT 10 N 8, Renseignements demandées par Doumer, 12 February 1917.

as machinery was modified, with output likely to drop to around twenty pieces per month. Furthermore, the decision was taken without informing the Aciéries de la Marine of the tests and problems with the Saint-Chamond model at the front line. Doumer questioned why Thomas had not sought to discuss potential modifications that could be made to the Saint-Chamond models with the Aciéries de la Marine to mitigate or resolve the flaws that had arisen during testing, such that they might prove to be of use at the front lines.

The director-general recognised that the Schneider howitzer outranged the Saint-Chamond model by a kilometre and had proved more reliable. However, the goal had always been to produce a high calibre artillery piece that was light enough to follow closely behind the armies, and, if necessary, it would be simple to increase the weight of the carriage to facilitate a range of one or two thousand metres more, potentially reaching twelve thousand metres. This would not slow production, while further changes could be made to the brake, shifting from a spring mechanism to a hydro-pneumatic model, which would improve accuracy with no additional production time.⁶⁵⁰

Albert Thomas responded on 16 February 1917, seeking to clarify the situation. He recognised that it was not possible to stop the order in hand without a considerable shortfall in output. The Saint-Chamond order would have to be completed, while the Aciéries de la Marine should prepare the machinery necessary to transition to the Schneider model, for which 150 pieces had been ordered, and production would begin immediately after the completion of the Saint-Chamond order. He hoped that the transition would be seamless, with output attaining thirty-five pieces in November and fifty-five in December 1917.⁶⁵¹

⁶⁵⁰ Ibid., Note from Doumer, 12 February 1917.

⁶⁵¹ Ibid., Renseignements demandés par Doumer, au sujet des obusiers de 155, 16 February 1917.

The 155mm howitzer debate demonstrates once again the problems caused by the Ministry of War's rushed approach to production from a tactical point of view. The commander-in-chief had highlighted the need for a rapid-fire, heavy howitzer capable of supporting the infantry on the battlefield, but the pressures of war had forced Albert Thomas into making a quick decision on the two models available at the time. Once it became clear that one was significantly superior to the other, the wheels of production were already in motion, and it proved too late to modify the original order. Thus, the army was left with four hundred Saint-Chamond model howitzers that were inferior to their Schneider counterparts, and the offensive capacity of the army was restricted.

Munitions

While the expansion of artillery production had been slow to get underway and lagged behind schedule, munitions production had received close attention from the very start of the war and was beginning to run smoothly. Still, ever-expanding demands from the front lines meant that industrialists still struggled to meet their targets. On 31 January 1916, General Galliéni considered the state of French field artillery munitions (75mm and 105mm) to be sufficient. The rest he laid out as follows:

Table 26 State of French artillery, January 1916

	Necessary	Currently	Deficit
Medium heavy artillery (155mm)	2,500	1,900	600
Heavy trench artillery	500	60	440
Medium trench artillery	6,000	1,200	4,800

Source: SHAT 6 N 52, Note de M. Brongesse, 31 January 1916.

In terms of munitions:

Table 27 State of French shell supplies, January 1916

	Necessary	Currently	Deficit
Field artillery (75m and 105mm)	16,000,000	6,200,000	9,800,000
75mm per day	160,000	100,000	60,000
105mm per day	4,500	2,500	2,000
Trench artillery	1,750,000	400,000	1,350,000
Per day	10,000	5,000	5,000
Medium Heavy artillery	4,000,000	1,050,000	2,950,000
120mm per day	5,000	5,000	-
155mm per day	12,000	5,000	7,000
ALGP	700,000	150,000	550,000
Per day	4,000	600	3,400

Source: SHAT 6 N 52, Note de M. Brongesse, 31 January 1916.

Based on these figures, it was necessary to double the current levels of production, and in some cases, such as for heavy artillery, to do even more. Furthermore, these figures were drawn up with the aim of permitting a decisive effort on the French front. The army was even further from the overall total that was required for the continuation of French action across all fronts. Galliéni estimated that industry required a minimum of six months for output to meet with the present levels of demand.⁶⁵²

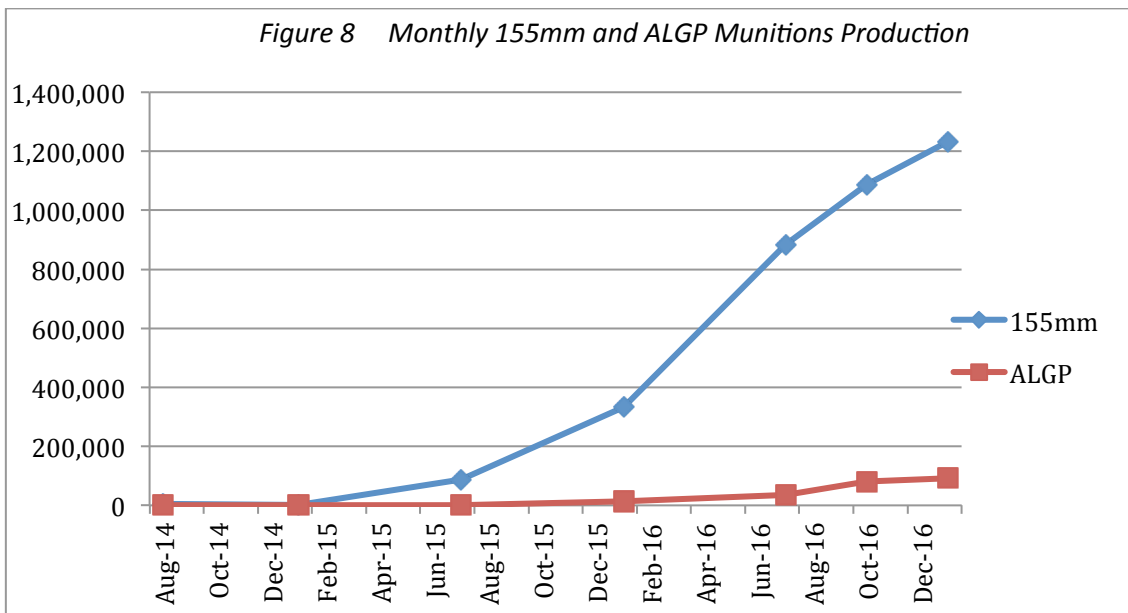
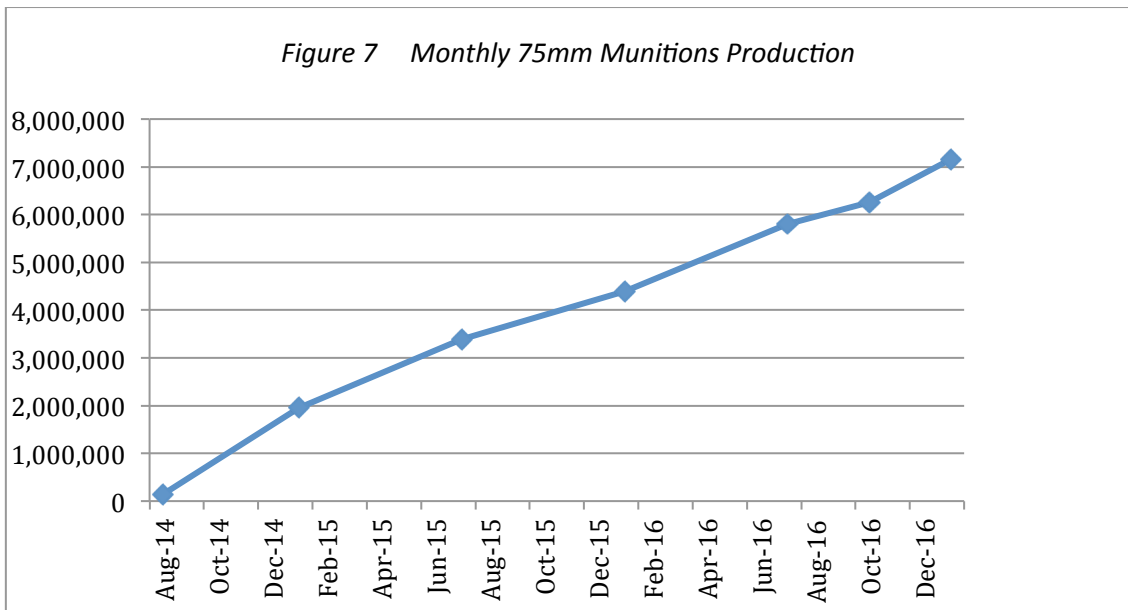
Shell production up until the end of 1916 developed as follows:

Table 28 Expansion of shell production, August 1914 - January 1917

Date	75mm	155mm	Field artillery	Heavy artillery	ALGP
August 1914	147,000	4,225	n/a	11,075	-
January 1915	1,960,000	1,500	2,039,350	54,750	-
July 1915	3,396,000	87,820	3,682,650	384,790	1,350
January 1916	4,393,000	332,600	4,804,770	893,580	13,270
July 1916	5,807,000	883,880	6,379,860	2,167,400	35,940
October 1916	6,264,000	1,087,000	6,797,000	2,739,400	82,000
January 1916	7,159,348	1,233,636	7,691,751	2,997,130	91,850

Source: SHAT 6 N 52, Fabrications de Guerre.

⁶⁵² SHAT 6 N 52, Note de M. Brongesse, 31 January 1916.



Although requirements continued to increase beyond 250,000 shells per day as the ambitions of the army grew, the factories were in a much stronger position to respond, and output continued to rise at a reasonable rate.⁶⁵³

As with artillery, the technical development of munitions production was driven both by their tactical importance to the army but also industrial limitations. While Albert Thomas

⁶⁵³ SHAT 16 N 2595.

sought to accommodate the needs of the army, he maintained the need to manage raw materials and the capacity of production. Gas shells were complicated and time-consuming to produce but were desperately needed at the front. However, Thomas continued to prioritise cast iron explosive shells rather than steel shells to accommodate the capabilities of private industrialists and because they could be produced, and thus supplied to the army, quicker. Despite continual progress in output, such constraints persisted until the end of the war and illustrate the importance of the link between industry and the tactical prowess of the army.

Administrative Changes

Porte argues that by 1916 the intense scrambling of the initial months of the war had receded into a more settled system of industrial management.⁶⁵⁴ Certainly the administrative structure was beginning to be reassessed, with the hope of improving efficiency.

One of the major problems facing the Ministry of War was accurately ascertaining the resources of the nation, in terms of both raw materials and machinery. In spring 1915, the *Sous-Secrétariat d'Etat* called on industrialists to declare their stocks of lathes, presses and power hammers. However, while the information gathered was extremely useful for the management of the mobilisation process, the initial method was scarcely comprehensive, and a more coordinated approach was required to enable industrialists who wanted to work for the war effort to do so as effectively as possible. In November 1915, the *Sous-Secrétariat d'Etat* created a *Comité d'évaluation des ressources industrielles* in each *département* to ascertain the real potential offered by the different regions of France. Run

⁶⁵⁴ Remy Porte, "Mobilisation industrielle et guerre totale," 26–35.

under the supervision of the prefect, it was assisted by an engineer-in-chief from the *Service des Ponts et Chaussées*, a representative from the *Service des Mines*, the *Inspecteur départemental du travail*, the Chamber of Commerce and an artillery officer from the *Service des Forges*. The committee's aim was to verify the existing documentation collected up until this point by the *Administration de la Guerre*, the *Commission du Budget* and the *Inspection du Travail*, to launch a new in-depth study of the current resources in raw materials and all elements pertaining to industrial production, and to organise production by indicating the measures to take to ensure the maximum output for industrialists through the use of the best methods of production, the best machinery and the optimisation of manpower. This extremely large programme was put in place by the start of 1916 but was incredibly onerous, and information only began to be fully formulated by summer 1916. The committee addressed a questionnaire to all of the industrialists working for national defence, requiring them to state their resources of raw materials and machinery, along with the number of workers, male and female, and the contracts in place. All the information gathered was classified geographically, enabling the committee to find all of the industrialists of a region capable of producing a certain item.⁶⁵⁵ While the changes created greater bureaucracy, they represented attempts by the Ministry of War to exert greater control over a decentralised structure of armaments production.

The attempts to rationalise the administration of the war effort continued throughout 1916. In March, the Ministry of War produced a document examining the role of the *Sous-Secrétariat d'Etat d'Armements et des Munitions*. The report foresaw a transition into a separate ministry controlling all the areas of production of artillery and engineering, as well as manpower questions. This new ministry would govern all areas such as manpower, the functioning of factories and metallurgical production. It would function, therefore, 'like a

⁶⁵⁵ AN 94 AP 274, Bulletin des Usines de Guerre, 5 June 1916, 42.

vast industrial establishment.’ Officers and other necessary personnel would be at its disposition but would also continue to be governed by the Ministry of War in terms of discipline and promotion. A similar separate ministry was mooted for controlling supplies and provisions for the army. In simple terms, ‘the Ministry of War would remain the consuming body, while the Ministry of Armaments and the Ministry of Supplies would become the creating and producing bodies.’ The Ministry of Armaments was not formalised until the end of the year in the changes that followed the disappointing summer campaign, but it is interesting to see seeds of thought emerging at the start of 1916.⁶⁵⁶

The Creation of the Ministry of Armaments and War Production

The *Sous-Secrétariat à l’Artillerie et aux Munitions* became the Ministry of Armaments and War Production on 13 December 1916, with Albert Thomas named as minister. The decree governing its formation declared that the new Ministry of Armaments would coordinate all the public departments and the private forces involved in armaments production, including scientific research, manpower, industrialists, and factories in order to provide ‘all the matériel and munitions necessary for national defence.’ It would work closely with the French high command to assess and oversee the technical use of materiel and munitions by the army to help avoid needless waste or deterioration of matériel. It concentrated not only on the production of armaments, which had been the remit of the *Sous-Secrétariat d’Etat de l’Artillerie*, but also on the purchasing of materiel necessary for the wide gamut of armaments manufacture, while handling many of the social aspects in cooperation with the Ministry of Labour.⁶⁵⁷ Two new *Sous-Secrétariats* fell under the new Ministry’s control, the *Sous-Secrétariat des Inventions* and the *Sous-Secrétariat des Fabrications de Guerre*.⁶⁵⁸

⁶⁵⁶ SHAT 6 N 52, Note relative aux Sous-Secrétariats d’Etat, 4 March 1916.

⁶⁵⁷ Hardach, “Industrial Mobilization,” 66.

⁶⁵⁸ Porte, “Mobilisation industrielle et guerre totale,” 20.

Article 5 of the decree ensured that resources would be prioritised for the areas of production most necessary for national defence and submitted private industry to the arbitration of the Ministry of Armament for its orders, work, production and transportation, in alignment with similar public departments. This meant that if competition or a clash emerged between two or more orders coming from different departments of the Ministry of War, the Ministry of Armament, public departments or private industry that might affect war production, the Ministry of Armament, after taking advice from the relevant inter-ministerial committees, would rule on the most viable distribution of resources for production.

Article 9 granted the Ministry control over all aspects of the use of manpower and its recruitment, although the sourcing of colonial manpower remained under the authority of the Ministry of War, with the two ministries working in cooperation in this area. It also gained the authority to requisition men from other industries not crucial to national defence.⁶⁵⁹ Finally, it centralised the scientific collaboration of universities, research bodies, technological groups and individual researchers and inventors under the body of the *Sous-Secrétariat des Inventions*. The Ministry of Armament therefore became 'the industrial organism of the army.'⁶⁶⁰

Still, the new ministry was essentially the *Sous-Secrétariat* with a different name. The personnel and the administrative structure remained largely unchanged. In theory, it would have greater authority to make executive decisions, free from the supervision of the Minister of War. However, there is little evidence that its new responsibility actually cleared

⁶⁵⁹ AN 94 AP 63, Décret constitutif du nouveau ministère, in *Bulletin des Usines de Guerre*, 8 January 1917, 2.

⁶⁶⁰ *Ibid.*, *Bulletin des Usines de Guerre*, 8 January 1917.

up any of the bureaucracy that plagued its previous incarnation, and Louis Loucheur, who took up Thomas's position as *Sous-Secrétaire d'Etat* in December 1916, frequently encountered many of the same problems, such as clashes with the Ministries of Commerce and Public Works and overlapping responsibilities and demands between the ministry's various committees and commissions.

Another attempt at reorganisation also emerged in 1916, with General Galliéni proposing the reorganisation of the administration of the Ministry of War. He highlighted that Ministers of War were constantly grappling with difficulties resulting either from the existence of overly large and cumbersome bodies, a consequence of extreme centralisation, or from multiple similar organs incapable of working together towards a clear and simple goal. Since the restructuring following the 1789 Revolution, there had been fluctuations between two extremes, with either an overwhelming number of bodies or too few, highly concentrated centres of administration. Through exploring the developments since the Revolution, Galliéni demonstrated that the circumstances of war and peace had little influence on the organisation and structure of the Ministry of War. He made three main points:

- 1) The conditions of the current war require a hitherto unforeseen development of industrial production for military needs.
- 2) In an organism as vast and complex as that of the *Administration de la Guerre*, we must create specialised bodies with a clearly defined domain so that business is conducted rapidly.
- 3) These bodies should each be managed separately and should have clearly defined roles, in order to avoid overlap.

He proposed a much more structured, decentralised structure for dealing with specific areas while maintaining an element of coordination so as not to lose overall control. This involved the creation of management groups, charged with providing direction to specific bodies, and coordinating their efforts. The more specific bodies, or *organes spéciales*,

would retain an element of autonomy in their remits of administrative action but would focus on their own clearly defined areas: organisation, personnel, production, and materiel.⁶⁶¹ While this proposal presented a sensible structure for the Ministry of War, it was too radical a change to be feasibly introduced during the war and, despite the possible benefits in terms of improved efficiency, the reorganisation would prove too lengthy and detrimental to the war effort.

Albert Thomas also made some progress in bringing greater coordination and structure to the main departments of the *Sous-Secrétariat* towards the end of 1916. Within the *Direction Générale des Fabrications de l'Artillerie*, many offices had been created in an *ad hoc* manner according to the needs that arose as the war went on. These different bodies were consolidated and attached to four departments reporting directly to the *Direction Générale des Fabrications*: the *Services des matières premières*, the *Service des Fabrications dans les Etablissements de l'Etat*, the *Service des Fabrications dans l'industrie privée*, and the *Service des moyens de production et des enquêtes industrielles*. Of particular note was the formation of the two Departments of Production, which were formed from the *Inspection de Fabrications de l'Artillerie* and the *Direction des Forges*, creating bodies with greater coordination and a clearer reporting structure.⁶⁶²

The timing of the changes to the *Sous-Secrétariat d'Artillerie* and the *Direction Générale des Fabrications de l'Artillerie* is particularly interesting, as they both emerged during December 1916. It was at this time that the Ministry of War and the government as a whole assessed the state of the war effort, the outcome of the major battles on the Somme and at Verdun, and the Brusilov offensive in the east, and recognised that the war was likely to continue for some time. Furthermore, the winter months were a sensible moment to institute

⁶⁶¹ SHAT 6 N 52, Note de Galliéni, n.d.

⁶⁶² SHAT 10 N 1, Note par Albert Thomas, 17 December 1916.

changes. The potentially negative impact of transition on events at the front line could be mitigated, while both French and German armies caught their breath and prepared for the spring. It was sensible to examine which areas could be improved and managed more efficiently both on the home front and within the army; hence a similar change was made with Robert Nivelle replacing Joseph Joffre as commander-in-chief.

While Porte argues that 1916 was a pivotal year, the Ministry of Armaments did not represent a significant departure from the *Sous-Secrétariat d'Etat*, while the key effort to organise and mobilise industry for war production had already taken place. While the *Sous-Secrétariat* did have its flaws and bureaucratic struggles, the new Ministry did little to overcome these. Furthermore, the initial months of production were inevitably slow due to the time required to set up production, output did increase significantly long before the transition to the Ministry of Armaments, and there was no marked improvement afterwards. In 1914, both industrialists and the Ministry of War declared that it would take between twelve and eighteen months for industry to produce on the scale requested by the army. In reality, this closely correlated with the rapid expansion seen throughout 1916 once factories were finally equipped and up to speed with war production. The roots of this success are therefore in the actions taken over the preceding months that set the wheels in motion.

Overall, 1916 was indeed a pivotal year of the war that saw a number of key developments. At the front lines, huge battles of attrition increased the pressure on the home front to supply the vast quantities of munitions and materiel required to fight, but these battles were only possible because industry had already undergone considerable expansion. This growth continued throughout the year, and by early 1917 munitions no longer appeared to constrain front line action. The artillery programmes of May and July demonstrate that the

Ministry of War was beginning to take a broader approach to domestic production and concentrate increasingly on meeting the artillery needs of the army. Up to this point, Albert Thomas had been forced to weigh the importance of producing either munitions or materiel. Now the infrastructure existed to manufacture both without compromise. The constraints on what could and could not be produced, which characterised the 1914-15 period, were no longer present. Finally, 1916 saw recognition by the Ministry of War that a more structured and organised system of administration was required to enable the home front to function effectively as the end of the war appeared increasingly distant. By the close of the year, the creation of the Ministry of Armaments gave greater authority to Thomas to exert control over the armaments industries, while there were efforts by the Ministry of War to introduce greater coherence and coordination over the multitude of committees and offices that had sprung up to meet the demands of the war.

While the first two years of the war were characterised by the *ad hoc* scrambling of the government to meet the exorbitant demands of modern warfare and to cope with the multitude of unforeseen problems that emerged, 1916 laid the foundations for the subsequent two years, establishing a strong platform that could provide the resources necessary for the Nivelle offensive in April 1917, and Pétain's attacks on Verdun and Malmaison in the autumn that relied so heavily on intensive artillery bombardments.

Chapter 8 – 1917-1918 - The Fruits of French Labour

Following the attritional battles of 1916, the last two years of the war saw significant shifts in direction within the French army as the increasing availability of artillery and munitions turned the focus back onto doctrine. Still, doctrinal development remained a battle of two schools of thought, as it had before the war, with one in favour of speed of movement and daring and the other preferring a methodical approach with the emphasis on firepower. As a result, fluctuations in the approach of the army during the war corresponded closely to changes in personnel. Joffre's replacement, Nivelle, pursued an ambitious attempt to achieve a significant breakthrough on the Aisne in spring 1917 with disastrous consequence, while the introduction of Pétain as commander-in-chief brought a pragmatic team of individuals to the high command and a more modern organisational structure capable of absorbing the lessons from the front. He rationalised the use of modern weaponry and diffused these ideas through an extensive system of training. The artillery was incorporated into a combined-arms structure in which it worked closely with infantry and aviation. This facilitated a flexible and mobile operational approach with limited tactical actions that took the form of individual jabs or punches, rather than always seeking a knock-out blow, relying on a huge quantity of matériel and the comprehensive training of the troops involved. The arrival of Foch as commander-in-chief of the Allied armies saw a move away from limited targets and a return to large-scale operations on multiple sections of front.⁶⁶³ Armaments production continued to expand, with improvements not just in output but also in methods of manufacturing as French industry began to realise its potential. Despite continued modifications, the artillery programmes started to produce modern pieces in large quantities, facilitating increasingly intensive bombardments and enabling the supply of the arriving American army.

⁶⁶³ Goya, "Le Processus d'Evolution," 490–2.

The Nivelle offensive was launched on 16 April 1917 following a lengthy preparatory bombardment that began on 2 April. The Fifth and Sixth Armies attacked along a forty-kilometre front. Between them they possessed 5,350 guns, made up of 2,000 field guns, 1,650 heavy artillery pieces, 1,500 support artillery and 160 long-range heavy pieces. Over the course of the bombardment and the subsequent attack, General Micheler's *Groupe d'Armées de Réserve* fired over eleven million shells, of which 2.5 million were heavy shells. Still, the offensive was hindered by poor weather, a lack of air superiority and supply problems, whilst the artillery bombardment failed to clear the enemy defences to allow the infantry to advance.⁶⁶⁴ On 14 April, a liaison officer with the First Army Corps declared that 'the preparation is not what we hoped, not what we expected... The infantry will face strong resistance. They will find the breaches not made or repaired.'⁶⁶⁵

General Nivelle was criticised for going ahead with the offensive after the German army withdrew to the strongly fortified Hindenburg Line in February 1917. Whilst the Parliament blamed the failure of the Aisne offensive on Nivelle's lack of flexibility and adaptability following the German retreat, limitations on materiel and munitions placed serious constraints on the success of the operation.⁶⁶⁶ Nivelle sought to emphasise firepower, building on the success that he had achieved at Verdun in late 1916. However, although Joffre's artillery programme of 30 May 1916 had seen some progress in the quantities of modern pieces available to the army, delays in manufacturing and obligations to supplying allies such as Russia and Romania meant that the artillery still did not have the ability to achieve the density of fire required for success.

⁶⁶⁴ Doughty, *Pyrrhic Victory*, 349.

⁶⁶⁵ Officier de liaison près le 1er CA, 14 April 1917, cited in *ibid.*

⁶⁶⁶ Daille, *Histoire de la guerre mondiale*, 436.

Table 29 Density of artillery fire

Density	Champagne 1915	Somme 1916	Verdun Dec. 1916	16th April 1917	Verdun Aug. 1917
1 Heavy gun per	60m	46m	46m	40m	30m
1 Howitzer per	120m	62m	69m	53m	30m
1 Field gun per	22m	33m	28m	23m	20m

Source: Pedroncini, *Pétain, general en chef, 1917-1918*, 43; AFGG, 432-2003.

The table shows that the density of fire achieved on the Aisne was not significantly improved on that of the Battle of the Somme, particularly in terms of heavy artillery, and thus the level of destruction achieved by the artillery was insufficient to facilitate the breakthrough foreseen by Nivelle. While the numbers were slightly better than Nivelle's offensive at Verdun in December 1916 that secured his promotion, the increased depth and scale of the April 1917 offensive diluted the effect of the artillery. Furthermore, munitions shortages continued to plague the army. Following the battle, the 32nd Artillery Corps complained that their supply of shells had been insufficient and that they had been required to conserve shells during the preparation phase in order to have enough available for the day of the attack.⁶⁶⁷ The veracity of such complaints is uncertain considering the ever-present temptation to blame an exterior factor.⁶⁶⁸ However, they appear justified, as it was not just the lack of sufficient artillery pieces, but also the inability to fire sufficient quantities of munitions rapidly over the whole front that contributed to the low density of fire.⁶⁶⁹

On 15 May 1917, General Pétain replaced Nivelle as commander-in-chief of the French army. His appointment marked a shift away from the idea of breakthrough. He had

⁶⁶⁷ AFGG, 52-82, 32e C.A. Report, 3 May 1917.

⁶⁶⁸ Strachan, *The First World War*, 1003.

⁶⁶⁹ Doughty, *Pyrrhic Victory*, 349.

remained sceptical throughout the war about the ability of the French army to create a breach in the enemy lines of sufficient width and depth to allow a return to manoeuvre, particularly with the resources available.⁶⁷⁰ Pétain's administration took a much more rational approach to an industrial war: 'the new organisation accepted the changes as a normal part of modern war and not as a series of accidents.'⁶⁷¹ While commander-in-chief, Joffre had focused almost exclusively on conducting operations rather than seeking to examine changes that could be brought to the underlying structures of the military machine. He had demonstrated that he was not against change: he had supported individuals such as Barès and Estienne, who pushed for the adoption of new weapons, but 'he left the modification of structures and methods, as well as the organisation of training, to the *3e bureau* of the French high command.'⁶⁷²

Pétain, on the other hand, had risen up through the levels of command since the start of the war and felt strongly that the high command should seek to draw on the lessons and experiences of the front lines. He worked closely with the heads of the army corps and army groups, increasing their power and responsibility. He sought 'to think of the war, not as something brief or transitory, but from larger perspectives', and improved the transfer of information from the front to the high command.⁶⁷³ Representatives of each army came to the commander-in-chief's headquarters to 'summarise the state of affairs in their sector, their observations, and their experiences, while the delegates of various offices took notes.' This was a much more detailed and involved process than had been in place under Joffre, with 'a more effective and more flexible sense of activity and criticism.'⁶⁷⁴ According to Goya, 'this new organisation, adapted to the conditions of the new war, enabled the cadre

⁶⁷⁰ Griffiths, *Marshal Pétain*, 12.

⁶⁷¹ Goya, "Le Processus d'Evolution," 371.

⁶⁷² Joffre, *Journal de marche de Joffre*, cited in *ibid.*, 373.

⁶⁷³ Goya, "Le Processus d'Evolution," 373.

⁶⁷⁴ Jean de Pierrefeu, *G.Q.G. Secteur 1. Trois ans au Grand quartier général par le rédacteur de "communiqué"* (Paris: L'Édition française illustrée, 1920), 45.

of general orders, which made up the new body of doctrine, to transform the army in depth... through a continuous exchange between the experiences from the front and the authority of the commander-in-chief.⁶⁷⁵

Pétain surrounded himself with 'the best experts in the use of weapons and the scientific and reasoned use of materiel.'⁶⁷⁶ These included General Herr, as artillery expert, General Estienne for tanks, and Colonel Duval for aviation, who all acted as both commanders of the general reserve of their area as well as being attached to the Minister of War to act and advise on all matters relating to the industrial production and development of their arm. This arrangement was particularly designed to improve the cooperation and communication between the army and both the rear and the home front, which, as has been seen, was lacking in the early years of the war.⁶⁷⁷

Doctrinal Change

Pétain was reluctant to launch an attack without adequate matériel. He wrote to Painlevé on 28 May 1917, stating, 'the last offensive demonstrated once more... that infantry should only be sent into the attack if the enemy artillery is for the most part either destroyed or neutralised; the enemy defensive structures destroyed... or neutralised; the defenders unable to counterattack.'⁶⁷⁸

⁶⁷⁵ Goya, "Le Processus d'Evolution," 373.

⁶⁷⁶ Émile Laure, *Commandant Laure, Au 3e bureau du 3e G. Q. G., 1917-1919* (Paris: Plon-Nourrit et Cie, 1921), 29.

⁶⁷⁷ Goya, "Le Processus d'Evolution," 373.

⁶⁷⁸ Pedroncini, *Pétain, général en chef*, 41.

Following the mutinies of 1917, Pétain's new goal was to preserve the infantry by moving away from wasteful offensives, and placing increasing emphasis on the artillery.⁶⁷⁹ He declared that, 'I will wait for the tanks and the Americans.' Although not necessarily seeking a war of pure attrition, he favoured limited offensives in which the artillery and infantry worked closely together.⁶⁸⁰ He called upon industry to make 'a prodigious effort' to supply the resources that the army required to achieve victory.⁶⁸¹

Pétain proposed to wear down the enemy: 'when the enemy is exhausted... we will seek to exploit it but not before.' He does not appear to have adopted a modern interpretation of attritional warfare. His concern was preserving manpower and prioritising firepower, seeking success in the interim through limited attacks. He recognised that the army had achieved some success capturing the first German position but struggled to advance beyond this. Therefore, he sought to repeat these offensives on the first position at different points along the front to maintain an element of surprise. This required a very mobile artillery that could be moved around the battlefield with reasonable speed. 'If we have a lot of mobile artillery units we can achieve results, that is to say the breach of the first enemy position, without using a lot of infantry, of which we are very short. As a result, the shells will take the brunt of the workload.'⁶⁸²

Pétain introduced a number of doctrinal changes over the course of his year as commander-in-chief in the form of '*Directives*' and '*Instructions*'. In *Directive No. 1*, issued on 14 May 1917, he outlined his new approach, stating categorically that 'the balance of

⁶⁷⁹ Millett and Murray, *Military Effectiveness*, 201.

⁶⁸⁰ Griffiths, *Marshal Pétain*, 24.

⁶⁸¹ Pedroncini, *Pétain*, 129.

⁶⁸² AFGG, 521-144, Communication du Général Pétain à l'EMA, 8 May 1917; Pedroncini, *Pétain*, 119.

the opposing forces... does not allow us for the moment to envisage a breakthrough followed by strategic exploitation.⁶⁸³

The new goal was 'to wear down the enemy with the minimum of losses':

There is no point launching large attacks in depth on distant objectives to achieve this attrition. These attacks do not have the benefit of surprise... they are costly, because the attack generally loses more than the defender, they are unpredictable... because they risk the artillery having an insignificant effect.... The attacks should be launched economically in infantry and with the maximum artillery available. They should proceed by surprise.... They should be launched successively on different sectors of the front, chosen as being those that the enemy has strong reasons not to evacuate willingly. They should follow each other as quickly as possible, in order to pin down the enemy.

The key element was the final paragraph, in which Pétain stated, 'this [approach] corresponds to the situation of the forces available to us on the Western Front. If this situation changes, the commanders of the armies and army groups will receive new orders for the subsequent operations.' Pétain made it clear that the operational and tactical approach for the army was directly linked to its materiel capabilities. If more materiel and munitions were to arrive then a different approach might be possible.⁶⁸⁴

By summer 1917, industry was producing almost 30,000 155mm shells and 300,000 75mm shells per day, allowing the artillery to play an ever-greater role in an offensive.⁶⁸⁵ However, Pétain persisted with attempts to preserve munitions wherever possible outside of attacks, in order to allocate as many shells as possible to his autumn offensives and for the planned operations in 1918. He also had to factor in conserving shells to supply the American army arriving the following year.⁶⁸⁶ Furthermore, Pétain's matériel-heavy attacks were incredibly expensive financially, with the cost of the shells fired at Malmaison exceeding 500 million

⁶⁸³ Griffiths, *Marshal Pétain*, 49.

⁶⁸⁴ AFGG, 521-235, Directive no. 1, 19 May 1917.

⁶⁸⁵ SHAT 16 N 1995.

⁶⁸⁶ AFGG, 52, 1249.

francs, twice the cost of all the tanks produced by France during the war. While there is little evidence that the Ministry of Finance placed significant financial constraints on the matériel requirements of the army, these figures illustrate the enormous size of the operations that Pétain was launching for relatively small operational goals.⁶⁸⁷

Pétain recognised that the scale of such offensives was difficult to replicate on a larger scale, as had been demonstrated in part with the 1917 Aisne offensive. The artillery therefore continued its attempts to become more efficient in its operations and methods of firing, particularly through the improvement of the preliminary registration of fire, the increasing autonomy of action of artillery units, and the mechanisation of matériel to improve its mobility.

As has been seen, surprise was severely compromised by the long preparatory bombardments, as the army sought to ensure that destruction of the enemy defences was complete before allowing the infantry to advance. Artillery preparation also took considerable time as the gunners sought to target enemy positions, which required multiple adjustments made difficult by the limitations of observation. The ever-increasing range of the guns and the siting of batteries on reverse-slope positions or under cover had rendered terrestrial observation largely redundant. However, aerial observation also presented complications. There was an ever-present battle for supremacy of the skies as more and more fighter aircraft accompanied reconnaissance aircraft to ensure the success of their missions. Furthermore, observation was always complicated by weather conditions and the persistent difficulties of communication even with the arrival of wireless radio transmitters.

⁶⁸⁷ Herr, *L'artillerie*, 89; Goya, "Le Processus d'Evolution," 401.

The dominance of French air power by this point in the war was vital to the improvement and ultimate superiority of the French artillery by 1918. Aviation's capacity to improve the observation and targeting of enemy defences and batteries conferred a huge advantage. Over the course of 1918, the aviation division downed 637 German planes and 125 balloons, while also playing an important role in harassing the rear of the enemy. The army had six groups of fighter aircraft at its disposal to protect the observation aircraft, although this was still deemed insufficient by the high command, who persistently called for reinforcements.⁶⁸⁸

Over the course of 1917, instead of continuing with increasingly lengthy fine-tuning of the guns, the artillery began to reduce preparatory registration thanks to the significant efforts to improve the 'scientific preparation of fire' by artillery officers and the *Commission central de l'artillerie*. Mapping of enemy defences and artillery positions was critically important. Furthermore, flash spotting and sound ranging became increasingly widespread at the front lines, facilitating the locating of enemy batteries.⁶⁸⁹ It was now possible to fire accurately almost immediately, with minimal help from aerial observers, thanks to the accumulation of information and minor improvements over the course of the war. Batteries were brought up to the front lines at the last moment, thus hiding the preparation of an attack from the enemy, and night bombardments and firing in bad weather were much more effective. Above all, surprise was restored to the offensive, as the enemy had much less warning of an attack.⁶⁹⁰

The importance of strategic and tactical surprise was the focus of two further *Instructions* issued by Pétain on 31 October 1917 and 19 November 1917, which replaced the

⁶⁸⁸ Goya, "Le Processus d'Evolution," 478–9.

⁶⁸⁹ SHAT 16 N 1751, Procès-verbal de la CCA, 6 June 1917; SHAT 1 K 101; SHAT 7 N 603.

⁶⁹⁰ Corda, *L'Évolution des méthodes*, cited in Goya, "Le Processus d'Evolution," 402.

Instruction issued by his predecessor on 16 December 1916.⁶⁹¹ Strategic surprise required attacking after a swift and unexpected preparation on a section of front where the enemy did not have time to divert reserves or to carry out preventative manoeuvres. Tactical surprise meant choosing the precise moment and point of the attack, and overwhelming the enemy by the speed of execution. ‘The chances of success of an offensive reside just as much in surprise and in process of neutralisation at the moment of the attack as in the pursuit of complete destruction of batteries, defences and observation points of the enemy.’⁶⁹²

A brief preparatory bombardment prevented the enemy from reinforcing his defences in anticipation of an attack. Pétain recognised that the longer the bombardment, the less potent it became in terms of facilitating the advance. Thus, he emphasised the role of neutralisation rather than destruction of enemy defences in the few hours preceding an attack, which not only proved to be more effective, but also much more economical in shells.⁶⁹³

Batteries would be hidden from view in advance of an attack and the registering of the guns was restricted to avoid alerting the enemy to their presence. This required precise technical measurements, which were slowly being introduced by autumn 1917. The positioning of the batteries was determined topographically, and their bearings for the bombardment were drawn out precisely. The *Instructions* of 18 September 1917 and 19 November 1917 laid out the methods for the preparation of fire and the processes for fine-tuning the sighting of the guns so that, once the bombardment began, the fire would be as accurate as

⁶⁹¹ Lucas, *L'Évolution des idées tactiques*, 177.

⁶⁹² Général Hellot, *Histoire de la guerre mondiale, iii, Le commandement des généraux Nivelle et Pétain, 1917* (Paris: Floch, 1936), 292.

⁶⁹³ Maitre, “Des idées sur l’emploi de l’artillerie pendant la guerre”; Goya, “Le Processus d’Évolution,” 402.

possible. The ALGP was responsible for the first studies determining the effects of atmospheric conditions such as air pressure and wind on trajectory and range. The artilleryman was therefore capable of firing without a lengthy process of initial adjustments on an identified target.

Objectives would be limited. The *Instruction* of 19 November distinguished between the 'normal objective' and the 'potential objective'. The first was determined by the ability of the artillery and in certain situations the capabilities of tanks. The latter would only be reached if the battle progressed well and within the timeframe fixed by the generals, who would always remain in control of the depth of the attack so that the infantry did not overreach and become vulnerable. Any advance beyond the 'potential objective' was only permitted with the authorisation of command. Finally, intermediate objectives were specified as points where units could regroup and reorganise during an attack.⁶⁹⁴

The artillery also began to act with greater independence over the course of 1917. At Verdun in 1916 the army had experimented with separating the divisional artillery groups from the infantry, although initially there were misunderstandings on both sides about the precise roles of these units. From autumn 1917, the increased training and information provided to the artillery enabled an improved standardisation of methods and artillery structures, particularly at the corps level, enabling groups to be removed and redistributed to other areas of the front where necessary.⁶⁹⁵

Although the output and quality of materiel produced improved throughout 1917, the fruits of Pétain's labour were not seen fully until spring 1918, by which time he had ceded overall command to Foch. Pétain was one of the few generals to take a longer-term view of

⁶⁹⁴ Hellot, *Histoire de la guerre mondiale*, 293.

⁶⁹⁵ Goya, "Le Processus d'Evolution," 402.

strategic and operational planning, rather than pinning all of his hopes on the next offensive. It may be that it was only because he came to command after three years of failed attempts, but he had consistently campaigned for the need to build up artillery reserves and conduct limited operations since the early battles of 1914 and 1915. Pedroncini posits that, 'people have cried "genius" and "visionary spirit" for much less.'⁶⁹⁶

Pétain's tactical and operational approach was much more than simply allowing the artillery to do the majority of the work. Due to the relative inexperience of a large proportion of the infantry and their fragile state of morale following the spring mutinies, Pétain felt that they were only suited to limited operations, sweeping up the enemy that was trapped in dugouts and suppressed by an intense bombardment. The role of the artillery developed in an increasingly sophisticated manner. First, the enemy's communication with the rear was cut by a bombardment which prevented the soldiers from fleeing, forcing them to hide underground, blocked in on three sides by shells. The fourth side, that of the attack, was also stopped off but by a more mobile bombardment that resembled the movements of a piston, beginning by creating breaches in the barbed wire and then forcing the soldiers and sentries to shelter in their dugouts. At the same time, the enemy artillery was struck by a barrage of explosive and gas shells to hinder their counterbattery fire. Finally, the machine gun aided the artillery by firing over the heads of the advancing infantry into the flanks and rear of the enemy.

The formalisation of Pétain's tactical developments continued into 1918, even after the changes in command structure. The transition towards speed of attack was completed by *Directive No. 5*, issued on 12 July 1918, which stated that the artillery preparation would be 'as brief and as violent as possible.' Heavy rapid-firing artillery would use gas shells to

⁶⁹⁶ Pedroncini, *Pétain*, 129.

ensure the neutralisation of the enemy rather than their destruction.⁶⁹⁷ Attacks would be 'simple, audacious and rapid... in which surprise was one of the essential conditions of success.' The army would achieve strategic surprise by preparing in secret, with limited reconnaissance fire and meticulous planning. Such developments were, according to General Herr, 'a sign of a key evolution in combat doctrine' of the artillery. Frédéric Hellot, who became the chief of the general staff of Army Group East in June 1917, declared, 'these new processes, when added to the acceleration in the output of rapid-fire matériel from the factories, allowed the artillery to play a much more effective role and to reduce the length of preparations.'⁶⁹⁸ The artillery preparation might even be foregone completely if tanks could be used.

However, industry initially struggled to provide tanks in large numbers, and artillery continued to take the primary role. Pétain had called for the production of 3,500 light tanks from Renault on 20 June 1917, but a few months later he was informed that only 500 could be supplied by 1 July 1918. In reality, industry failed to reach even this target, with only one Renault tank under the control of the army at the time of the first German attack in March 1918. Pétain therefore had to rely on the larger, heavier Schneider and Saint-Chamond models.⁶⁹⁹

Tactical Developments

Continued improvements in the production of armaments contributed considerably to developments in the use of artillery at the front. As increasing quantities of munitions and guns arrived at the front lines, the artillery was able to concentrate large numbers of shells

⁶⁹⁷ Lucas, *L'Evolution des idées tactiques*, 251; AFGG, 623-1928, 451, Directive générale no. 5, 12 July 1918.

⁶⁹⁸ Hellot, *Histoire de la guerre mondiale*, 293.

⁶⁹⁹ Pedroncini, *Pétain*, 177.

on relatively small sections of the front. The army only really began to recognise the importance of density of fire, rather than simply firing large numbers of shells on a broad and deep front, after the appointment of Pétain, who stressed that the critical factor was the number of shells fired per kilometre of front and the depth to which they were fired. The weight of fire per square metre of ground truly revealed the destruction effected by a bombardment. This was something already under consideration by the German army before the war and employed to great effect at the Battle of Verdun in February 1916.⁷⁰⁰

The transition was most clearly illustrated by the difference between the Champagne offensive of September 1915 and the Battle of Malmaison in October 1917. At Champagne, the French army fired 1,390,000 75mm shells over the course of five days, equating to a weight of fire of 320 tonnes of 75mm shells per kilometre of front. However, at Malmaison Pétain limited both the depth and the width of the offensive, and therefore, on the six days preceding the attack, on a front of 11km, 'an unprecedented concentration of guns' fired 1,750 tonnes of shells per kilometre of front.⁷⁰¹ In the battles of Verdun and Malmaison in autumn 1917, the number of artillerymen often exceeded the number of infantrymen. It required 32 days and 266 trains to supply the army at Malmaison with the 80,000 tons of munitions required for the target of conquering just 70 square kilometres of ground. Indeed, such a density of fire was not exceeded until the battle of Orel in Russia in 1943.⁷⁰²

The matériel requirements for such an approach only began to arrive over the course of 1918. The density of artillery deemed indispensable for the planned 1918 offensives was set on 19 October 1917 at one 75mm field gun per 16 to 18.9 metres of front and one heavy artillery piece per 12.2 to 14.45 metres of front. The numbers available were a

⁷⁰⁰ Gudmundsson, "Learning from the Front," 23.

⁷⁰¹ Jean de Pierrefeu, *French Headquarters, 1915-1918* (London: G. Bles, 1924), 186; Reboul, *Mobilisation industrielle*, 30.

⁷⁰² Goya, "Le Processus d'Evolution," 391.

significant improvement on the situation at the outbreak of war, when the army could supply at best one battery for eight hundred metres.⁷⁰³ The required density of fire relied on armaments manufacturers to produce the required matériel, but also to produce sufficient munitions. By September 1918, the munitions industry was producing 5,635,000 shells per month, almost twice its output in January 1916, and enormous compared to the 790,000 shells manufactured in August 1914, thus facilitating the intense density of fire that was the cornerstone of French tactics in the final two years of the war.⁷⁰⁴

Training

Pétain's emphasis on artillery was further demonstrated in the changes he made to the training of artillerymen. Goya has highlighted the lack of technical expertise within the ranks of the artillery that contributed to the failure of the Nivelle offensive. The number of experienced soldiers decreased as the war went on, resulting in a stark drop-off in quality as the most able served the guns, while the less capable were assigned to less prestigious roles, such as observers, which suffered as a consequence.⁷⁰⁵ The expansion of the artillery was meaningless if the army did not have the artillerymen to operate the guns. This proved particularly problematic considering the already existing pressures on manpower both at the front and on the home front.

Men were drafted in from the cavalry and engineering corps, but this diluted the levels of experience. The pieces themselves and the skills required to prepare, register and fire them were also becoming more complex as modern models were produced and arrived at the front in growing numbers. In peacetime, it took three years' training to operate the 75mm

⁷⁰³ Reboul, *Mobilisation industrielle*, 38.

⁷⁰⁴ *Ibid.*, 28.

⁷⁰⁵ Goya, "Le Processus d'Evolution," 369.

field gun and more than two years for a graduate of the *École Polytechnique* to become an artillery officer. While Albert Thomas had set up training centres close to the key armaments factories, in practice, this organisation was 'lamentably superficial.' At the Schneider workshop, officers received just three days of training for 105mm and 120mm pieces.⁷⁰⁶

Joffre had also tried in 1916 to create training schools and specialism centres, but Pétain went further.⁷⁰⁷ His *Directive no. 2*, issued on 23 May 1917 laid out that the 'head of a company was its permanent and responsible instructor' and modern war dictated that he would need to be helped by 'specialised instructors.' 'There would therefore be various artillery schools that were grouped around training centres [*centres d'instruction*], where carefully chosen officers would have all the necessary resources to teach in a practical manner.' In each army, a *centre d'information* would bring generals and colonels up to date with the most recent ideas on offensive and defensive tactics. Specialist training schools would cater for various infantry roles, as well as for artillery, aviation, cavalry, engineering and communication. Finally, further training would also be given in the *depots divisionnaires* and the *bataillons d'instruction*, where the most recently recruited soldiers arrived before being sent to the front.⁷⁰⁸

The training of artillerymen became more pragmatic and relevant to the war at hand. For instance, instead of being taught how electricity worked in order to be able to use a field telephone or a wireless, artillery officers were simply taught how to ensure their communications were received. Drill was sacrificed to allow more time for firing and operating artillery pieces. In summary, the general staff recognised that they 'must break

⁷⁰⁶ AN 94 AP 84, Rapport sur les fabrications de l'artillerie, par Charles Humbert, 14 February 1916, 59.

⁷⁰⁷ Hellot, *Histoire de la guerre mondiale*, 163.

⁷⁰⁸ AFGG, 532-542, Directive no. 2, 20 June 1917.

from the peacetime traditions of the training schools and accept a more modest but achievable ideal of an artillery officer.⁷⁰⁹

Directive no. 2 set up a *section d'instruction* within the 3e Bureau, 'to gather and to exploit the information available in order to develop improvements to regulations and training,' thus separating the formulation of doctrine and tactical methods from the conduct of operations.⁷¹⁰ General Debeney, commander of the Seventh Army, summarised its role and methods: It will 'pursue questions regarding the tactical use of weapons. It will visit the front, the troops, and the schools. It will gather opinions and the requirements of the relevant sections, and then it will draw up texts to guide them.'⁷¹¹ As proof of the shift in approach, the *section* was commanded by Lieutenant-Colonel Paillé, who had not come through the *École Supérieure de Guerre*, but had risen through the ranks during the war and therefore possessed a far more practical education in the conduct of battle.⁷¹² Paillé sought to form a consensus with front-line troops before extensively testing their ideas: 'The commander-in-chief wants [us to] gather the thoughts of the soldiers at the front; discuss our proposals with them, and only draw up instructions once we are sure of the army's ability to carry them out.'⁷¹³

The number of men serving the artillery in relation to the infantry transformed dramatically. In May 1915, 18 percent of soldiers served with the artillery, with 72 percent in the infantry. By November 1918, the artillery had doubled to represent 37 percent of those mobilised into the army, with the infantry making up 48 percent.⁷¹⁴

⁷⁰⁹ AN 94 AP 84, Document sur l'instruction des artilleurs, n.d. (late 1917).

⁷¹⁰ Pedroncini, *Pétain, général en chef*, 78.

⁷¹¹ Laure, *Commandant Laure*, 16.

⁷¹² The *École Supérieure de Guerre* was closed for the duration of the war, although some training continued close to the front lines.

⁷¹³ Laure, *Commandant Laure*, 34.

⁷¹⁴ Aublet, "L'Artillerie Française," 235.

Pétain's efforts to improve the training of artillerymen laid the ground for more advanced methods, such as those laid out in the *Instruction sur le tir*, issued on 19 November 1917. By this point, 'topographical preparation of fire, subdivision of munitions, calibration of explosives and atmospheric adjustments had become the daily bread of numerous gunners. The technology was available, the tables of fire gave all the necessary information to make adjustments, the *Service météorologique* worked closely with the armies and the gunner could prepare his shots in good conditions and open fire with surprise.'⁷¹⁵

Pétain formed the *Commission Centrale de l'Artillerie* on 6 June 1917, chaired by General Herr, to coordinate the ideas of the front lines and the interior on materiel and its use. Through the *Commission*, the high command and the Ministry of Armaments sought to improve the relationship between industry and artillery, by focusing the efforts of the former on improving the fortunes of the latter. Its expressed role was 'to coordinate all the areas of the Interior that related to the artillery' and it remained in constant contact with the army and with industry in order to remain abreast of their needs, meeting on a weekly basis.⁷¹⁶ It is revealing that the two key issues raised at the first meeting of the *Commission* were improving accuracy of fire through the formation of accurate 'tables of fire' and improving the production of munitions. These two matters were closely linked, with one member observing that because of the limits of supply, it was vitally important to maximise the potential of the artillery batteries.⁷¹⁷ This committee is a key example of both the recognition by the high command of the important link between industry and artillery and their attempts to improve the performance of artillery in the face of insufficient munitions production. However, the fact that it took until mid-1917 to form such a committee reveals

⁷¹⁵ Maitre, "Des idées sur l'emploi de l'artillerie pendant la guerre," 212.

⁷¹⁶ SHAT 16 N 1751, CCA, Procès-verbal de la réunion du 6 Juin 1917 de la CCA, 1.

⁷¹⁷ Ibid., CCA, Procès-verbal de la réunion du 6 Juin 1917 de la CCA, 3-4; *ibid.*, CCA, Procès-verbal de la réunion du 21 Juin 1917 de la CCA, 4.

that the army had previously taken an *ad hoc* approach to relations with the home front or even neglected it entirely.⁷¹⁸

Pétain's Artillery Programme

While armaments production continued to progress at an encouraging rate, as the army's doctrinal approach developed, so did its requirements in terms of artillery. Until sufficient tanks and planes could be produced, the heavy artillery would take the main responsibility in the preparation of an attack, and greater numbers were required to ensure that the length of the preparatory bombardment could be decreased to return the element of surprise to the attack.⁷¹⁹

On becoming commander-in-chief, Pétain ordered his general staff to conduct a review of the tactical and operational approaches of the army. This entailed a detailed analysis of the Nivelle offensive and the reasons for its failure, with a particular focus on the performance of the artillery in comparison with previous offensives in Champagne on 25 September 1915 and the Somme on 1 July 1916.⁷²⁰ On the basis of the information received, Pétain sought to introduce a new armament programme that placed even greater emphasis on materiel than Joffre's 1916 programmes. He pushed the production of heavy artillery, aircraft, tanks and chemicals, stressing the importance of achieving the targets laid out in the 30 May 1916 programme and focusing attention on 155mm short-range howitzers, for which production increased from 82 on 31 May to 180 on 31 August. The production of 75mm field guns was reduced from an average output of 316 in the first quarter of 1917 to 241 in the third quarter and 150 in the fourth quarter, as Pétain emphasised the need for

⁷¹⁸ SHAT 16 N 1751, CCA, Procès-verbal de la réunion du 6 Juin 1917 de la CCA, 1.

⁷¹⁹ Pedroncini, *Pétain*, 131.

⁷²⁰ Le général commandant en chef à M. le Ministre de la guerre, 3 July 1917, cited in Doughty, 369.

mobile heavy artillery units.⁷²¹ Nivelle had attempted to establish a larger reserve of artillery made up of tractor-drawn regiments in January 1917 which suited Pétain's 'operational concept of moving artillery quickly and easily and catching the enemy by surprise with a strong but limited attack.'⁷²² He therefore pushed for ten regiments of tractor-drawn 155mm pieces to form the general artillery reserve, along with large numbers of gas and smoke shells to be used in neutralisation fire.⁷²³

In addition, Pétain pressed for the production of long-range heavy artillery (*artillerie lourde à grande portée* or *ALGP*), particularly 220mm TR and 280mm, in response to the German withdrawal to the stronger defences of the Hindenburg Line. The ALGP was more powerful and fired at a much greater range than more traditional heavy artillery and would be granted greater freedom of action at the front lines. Pétain also insisted on hastening the production programme of heavy rail-mounted guns (*artillerie lourde sur voie ferrée* or *ALVF*).

The 280mm production target from the 30 May 1916 programme was increased from 80 to 120, with the aim to equip each battery with three pieces instead of two, and Pétain demanded an additional 120 guns, effectively tripling the request for guns of this calibre. He also doubled the target for 220 TR from 320 to 640, and extended the production of 155mm LTR guns, intended for counterbattery fire, from 1,440 to 1,920. Finally, he examined the possibility of asking the British government to put a contingent of eight-pounder mortars at the disposal of the French army. Pétain targeted delivery by 1 February 1918 so that they would be available for potential spring operations. However, this was unlikely to be achieved considering the rate of production at the time.

⁷²¹ Doughty, *Pyrrhic Victory*, 369.

⁷²² *Ibid.*, 370.

⁷²³ *Ibid.*

Table 30 Modifications to 30 May 1916 Programme and Production Plan

Calibre	105L	155 CTR	155 LTR	220 TR	280 TR
Existing 1 June 1917	273	615	160	40	24
30 May 1916 Programme	960	2,160	1,440	320	80
Increases on 25 June 1917	-	-	420	320	160
Target 1 Feb 1918	960	2,160	1,920	640	240
Deliveries by 1 Feb 1918	304	1,400	744 ⁷²⁴	140	23
Monthly Output ⁷²⁵	60	250	123	24	6
Max available by 1 Feb 1918	577	2,015	904	180	47

Source: SHAT 10 N 12, Programme du 30 May 1916 modifié par letter du 25 June 1917.

Such was Pétain's desire for heavier matériel that he decided that manpower and resources could be diverted from the production of 155C pieces in order to accelerate the production of higher calibre pieces.⁷²⁶

Unfortunately, despite improvements in output, the intensification of manufacturing in one area still meant that other areas suffered, as limitations on manpower and raw materials still applied. The acceleration of the 220mm programme brought forward the delivery date of the 320 guns from September 1918 to July 1918, but the *Service technique* declared that the time taken to install the new machinery for the production of ALGP would cause significant disruption and output would only reach the desired forty pieces per month for the 220mm in May 1918 and ten per month for the 280mm in July 1918. Furthermore, to accommodate this, the output of 155C pieces would have to be reduced to around one hundred pieces per month.

At the start of 1918, a report on the state of the artillery at that time painted a rosy picture, with a lot of the targets for artillery production appearing to have been achieved. The forecasts in July 1917 had been for at least two-thirds of the 1916 programme to be

⁷²⁴ Deduction of 246 155 CTR for those to be delivered to the American army.

⁷²⁵ Total monthly output foreseen for December 1917.

⁷²⁶ SHAT 10 N 12, Pétain to Painlevé, 25 June 1917.

completed.⁷²⁷ In reality, however, the figures were somewhat manipulated. The report claimed that for field artillery on both the Western and Eastern fronts, the army possessed eighteen more batteries than were required by the production programme. However, hidden within these figures were 126 batteries that were still in the process of being modified. Only thirteen of the required thirty tractor-drawn corps artillery were ready, with eight being converted in the rear and nine still incomplete. The story was similar for heavy artillery. The intermediary programme called for 180 105mm batteries, 180 modern 155L batteries and 390 modern 155C batteries. The report claimed that the army was only short by 13 batteries for the 105mm, 33 batteries for the 155L and 20 batteries for the 155C. However, these figures included 44 120L batteries, 105 1877 model 155L batteries and 28 1912 model 155C batteries. Such models did not have the same rate of fire or range as the newer versions and could not be said to have the same offensive capacity. It was therefore somewhat optimistic to try to claim that they could count towards the achievement of Pétain's artillery programme.⁷²⁸

Despite continued shortages, Pétain was able to achieve success in restructuring the artillery so as to provide a greater degree of flexibility and mobility. During the winter, he increased the number of emplacements where the heavy artillery could be rapidly installed and fired, while he kept thirty out of sixty artillery regiments to form an artillery reserve under his command and did the same for the field artillery, so that he was able to create a large mass of artillery that could be easily manoeuvred and that proved critical to stopping the German breakthroughs of the spring.⁷²⁹

⁷²⁷ SHAT 10 N 1, Note sur l'organisation de l'artillerie, July 1917.

⁷²⁸ Ibid., Situation de l'Artillerie, 1 February 1918.

⁷²⁹ Pedroncini, *Pétain*, 176.

The expansion of artillery production meant that shell production also had to increase. The commander-in-chief requested a daily output of fifteen shells per piece for the 220mm and twenty per piece for the 155mm. Thus, to meet the requirements of the new programme, an additional 4,800 shells per day were needed for the 220mm, 1,800 for the 280mm and 2,800 for the 155mm. Shortages of steel meant that it would be incredibly difficult to achieve such figures. Cast iron shells could be produced in place of steel shells, but even so the *Service technique* 'could not indicate when it might be possible to achieve the targets set by the programme of 25 June 1917.' It was reluctant to push the transformation towards high calibre guns before the supply of 155C howitzers could be provided to the army, lest it disrupt the programme too greatly.⁷³⁰

Pétain progressed from the armaments programmes put in place by Joffre, further refining the artillery's needs and shifting the emphasis away from 155mm howitzers, which had been the focus of 1916 and early 1917, towards even higher calibre and longer-ranged guns. This does not imply that Joffre took the wrong approach. The state of production capabilities and the needs of the army shifted and evolved as the war progressed. In the early months of the war, necessity dictated the reliance on old-fashioned guns already in existence in the forts of the interior, as French industry was incapable of producing modern guns quickly enough. By 1915, the emphasis turned to munitions, as pre-war stocks dwindled. Once this problem became less critical (although it was not solved), the French high command began to explore in more detail the tactical requirements of the front lines beyond mere survival, and recognised the need for heavy medium-ranged howitzers and guns for counter-battery fire and preparatory bombardments. The need for higher-calibre guns such as those ultimately requested by Pétain in 1917 was there in 1916, but this was secondary to the more pressing importance of 155mm models. As production in this area

⁷³⁰ SHAT 10 N 12, Note pour M. le Ministre, 24 July 1917.

picked up speed and as the situation at the front lines changed following the German withdrawal to the Hindenburg line, the requirements of the army developed as well and emphasis could now be placed on forming a more well-rounded, offensively minded artillery that was capable of breaching the enemy defences. Jumping from the demands of 1914 straight to those that were apparent in 1917 was unfeasible and impractical, in terms of both the needs of the army and the capabilities of industry, which lacked both the structures and the technical expertise to produce ALGP guns on such a scale.

Foch

The arrival of Ferdinand Foch as Supreme Commander of the Allied Armies, coupled with the increasing availability of matériel, brought a new offensive operational approach. Once the German spring offensives had been halted, Foch sought to implement his concept of *bataille générale*, which united four operational principles: tempo, attrition, manoeuvre and matériel superiority. The Allied armies would strike the German line in successive blows at different points along the front, slowly weakening the enemy by forcing it to plug an increasing number of holes. Rather than distinct tactical battles, this would be a coordinated operational approach, with little respite between attacks in which the enemy could recover and strengthen its position. Foch laid out his approach as follows:

Although we wished to attack at the outset at one point only, our successive enterprises ought to be prepared as a part of one and the same series, so that each of them could, without delay, take advantage of the moral ascendancy gained by the previous one and the disorder brought about in the enemy's dispositions. Also the direction to be given to each must be fixed in such a manner as to arrive at one single end.⁷³¹

Unfortunately, the focus on detailed operational thinking, the constant flow of information between the front and high command, and the emphasis on training did

⁷³¹ Foch, *Memoirs*, cited in Philpott, *Bloody Victory*, 515.

not persist after the end of the war, as the financial constraints of the 1920s meant that the army slipped back into its pre-war ways, the levels of instruction declined and the gap between a coherent doctrine and the ability to implement it in practice re-emerged.⁷³²

Industry

The creation of the Ministry of Armaments in December 1916 brought a different approach to industrial management as Louis Loucheur took Albert Thomas's position as *Sous-Secrétaire d'Etat à l'Artillerie et aux Munitions*. With Thomas dispatched on a mission to Russia for the majority of the rest of his time in office, Loucheur controlled production and ultimately replaced Thomas as Minister of Armaments in September 1917.

Loucheur was a technocrat, part of the new managerial-technical class that began to emerge during the war. He had a number of ideas focused on improving efficiency, business colonisation, vigorous economic expansion, increased involvement of technical experts in government, mass production, and economic modernisation, all designed to enable France to compete on an international level. He was also committed to economic liberalism. By the end of the war he was convinced of the need to fuse this with modernising concepts and approaches in order to assure France's industrial future, such as limited state participation in particular industries.⁷³³

Before the war, Loucheur had founded the Girolou firm with Alexandre Giros in 1899, before forming the Société Générale d'Entreprises, which became the top company in France for the construction of coal-fired power stations in 1913. His experience in the

⁷³² Goya, "Le Processus d'Evolution," 492.

⁷³³ Carls, *Louis Loucheur*, xii-xiii.

rapidly growing electricity industry exposed him to modern methods and processes, particularly the mechanisation of construction, the use of specialist manpower, and the rigorous study of how to ensure the greatest profit. He immersed himself in innovation, emerging before the war as an energetic and forward-thinking manager.⁷³⁴

In August 1914, Loucheur was mobilised as a lieutenant attached to the artillery, but he soon returned to his position as the head of the Société Générale des Entreprises and started to construct armament factories, building two in cooperation with Schneider et Cie. for the production of 155mm and 220mm guns. Loucheur was quick to recognise the need to incorporate female labour in war production and adopted the assembly line to ease manpower pressures. In July 1915, he formed a partnership with Louis Renault to produce shells and began to carry out research into the use of poison gas. Éclairage Électrique, a subsidiary company of the Société Générale des Entreprises, specialised in armaments production and made vast profits as a result, particularly during Albert Thomas's time as *Sous-Secrétaire d'Etat*.⁷³⁵

In November 1915, Loucheur became an advisor to Albert Thomas and accompanied the *Sous-Secrétaire* on a visit to Russia in April 1916 to advise on industrial mobilisation.⁷³⁶ He was instrumental in the formation of a consortium for the production of heavy artillery on 4 September 1916 called the *Participation Usines Artillerie Lourde* (PUAL), which received an order for 150 155L guns and 110 220mm howitzers subcontracted from Schneider et Cie. The group united many of the largest armaments manufacturers, such as Chatillon-Commentry and l'Éclairage Électrique, and swiftly produced large quantities of artillery.⁷³⁷

⁷³⁴ Comité pour l'histoire économique et financière de la France, "Etudes et documents" (Comité pour l'histoire économique et financière de la France, 1989), 299.

⁷³⁵ Godfrey, *Capitalism at War*, 195.

⁷³⁶ Comité pour l'histoire économique et financière de la France, "Etudes et documents," 301.

⁷³⁷ Barjot, "La grande entreprise," 780.

When he was approached by Briand on 7 December 1916 about becoming more involved in the government, Loucheur was able to negotiate from a position of strength: 'I presented my conditions: as a bare minimum, I wished to the *Sous-Secrétaire d'Etat*, with absolute and complete powers and a purely nominal dependence on the Minister of Armament.'⁷³⁸ Following his appointment, his main focus was on heavy artillery, with which he was most familiar. He quickly began work on intensifying production and was already meeting aides, Schneider and the artillery services on 18 December 1916. He drew up a new heavy artillery programme on 24 December 1916. He pushed for expansion of state-run operations and sought to aid Schneider in its execution of its order for 155mm howitzers through the state taking responsibility for the purchase and transport of tooling machines for Schneider's subsidiary firm, the *Société d'Outillage Mécanique et d'Usinage d'Artillerie*. The government would also supply some of the funds for the expansion of factories. Albert Thomas, with the benefit of two years of experience trying to increasing production, was quick to warn his optimistic successor that his grand plans were likely to prove more complicated and harder to execute than he might hope.⁷³⁹

Unlike Thomas, Loucheur did not have obligations to any political party, and he was able to run the Ministry of Armaments like a large company. He was authoritative in his approach. Despite being a proponent of economic liberalism, he was quick to advocate state intervention to a much greater extent than his predecessor. Henry Hauser, a chief collaborator of Clémentel, remarked in 1918: 'We appointed a very big industrialist to be the head of these great services of the state and people said that state intervention was at an end. But what did this big industrialist do as soon as he became minister? Immediately, in the interests of the nation, he imposed a discipline on French industry which was

⁷³⁸ Ibid., 785.

⁷³⁹ Carls, *Louis Loucheur*, 25.

infinitely more severe than the timid parliamentarians of the previous regime would have dared imagine.⁷⁴⁰

Loucheur and Clémentel shared the opinion that ‘the government should tell each industrialist exactly what he was to do and the industrialist should be allowed to do nothing other than this one specific task. This was *dirigisme* with a vengeance.’⁷⁴¹ Loucheur applied modern approaches to his Ministry, introducing cost analysis drawn from his experience in manufacturing. By comparing the costs of various products manufactured by the Société de l’Éclairage de Lyon, and Thomas-Houston, two of his former firms, he was able to reduce the prices charged by factories for armaments. While this did not make him popular with industrialists, it served to lower prices to the benefit of the government. He also took a firm stance towards workers, viewing them as performing a duty to their nation and therefore being forbidden to strike, provided they were paid reasonable salaries.⁷⁴²

Loucheur brought in his own men, whose background and education were very different from those who had worked under Thomas. The outgoing undersecretary had worked with men who had graduated from the *École Normale Supérieure*. Loucheur’s men were technocrats; engineers, bankers, and industrialists from the private sector with experience of the environment in which they were working. Loucheur’s cabinet chief, Xavier Loisy, had graduated from the *École Polytechnique* while Edmond Philippart and Paul Munich, Loucheur’s adjunct cabinet chief and assistant cabinet chief respectively, were also graduates of engineering schools. These men had a much greater understanding of industry

⁷⁴⁰ *Le Musée sociale*, no. 3, 1 May 1918, cited in Godfrey, *Capitalism at War*, 197.

⁷⁴¹ *Ibid.*, 198.

⁷⁴² *Ibid.*; Barjot, “La grande entreprise,” 792.

and particularly industrialists. They knew their interests, their demands, and how to secure the maximum output from the factories.⁷⁴³

Rather than relying on the structures already put in place by Thomas, he approached industrial management in his own way. He recognised the confusion and considerable overlap of the numerous committees and commissions that had been created in the first three years of the war and therefore sought to establish a clearer division of tasks, for instance relying heavily on the *Commission Interministérielle des Métaux et Fabrications* (CIMF) to determine the priority given to orders from the Ministry of War, the Ministry of Armament, and other ministries and industrialists.⁷⁴⁴

He continued with the approach to modernisation that had served him well in his own firms, encouraging the expansion of existing establishments and the purchase of new machinery. A sub-commission attached to the CIMF was entrusted with the examination of requests from industrialists for the construction of new factories, exploring whether they would prove useful to the development of domestic raw materials or armaments production. Metallurgy and energy projects were prioritised, representing 58 percent of the new projects that were approved.⁷⁴⁵

According to Reboul, 1917 marked the beginning of the third phase of industrial mobilisation, which saw the creation of specialised factories focusing on the production of single items, such as at Grand Couronne. By the end of the war, the total number of factories had fallen from over 20,000 to around 15,000 as a more coordinated and efficient

⁷⁴³ Carls, *Louis Loucheur*, 24.

⁷⁴⁴ Barjot, "La grande entreprise," 790.

⁷⁴⁵ *Ibid.*, 793.

structure began to emerge.⁷⁴⁶ The creation of specialised factories allowed the lowering of the cost price. At the same time, the government sought to impose specialisation on smaller firms that were subcontracted by larger companies. André Citroen was particularly active in promoting this approach. He felt that, 'we have to move towards standardisation according to ability, the large factories making the larger pieces, the smaller ones producing the smaller parts, but in very large quantities.'⁷⁴⁷ It is likely that Citroen's interests were not entirely altruistic, as the proposed changes would reduce the cost of production and thus result in larger profits. Nevertheless, a system that was more efficient for the entrepreneur was also likely to be more efficient for the state as well. For instance, it was the success of Louis Loucheur's innovative methods in his armaments factory that drew the attention of government and led to his rise to Minister of Armaments. Excessive war profits stoked the ire of the press, but the government's first priority was increasing output, and therefore any measures that facilitated this were to be encouraged.

The start of 1917 saw Albert Thomas seeking to expand heavy artillery output wherever possible and particularly the production of 155C Schneider howitzers. In December 1916, he introduced a plan to more than double the output from Le Creusot from forty in January 1917 to ninety by June 1917. Citroen was expanding its factories and machinery, while orders were placed in the United States for parts for older materiel such as the 120mm L and 155mm L, which meant that French factories, and particularly the *Construction Navales*, could devote themselves to producing more 155C Schneider parts. Finally, Schneider et Cie planned to increase activity in their factories and promised to work in closer cooperation with its sub-contractors in order to hasten manufacturing. All this gave

⁷⁴⁶ Reboul, *Mobilisation industrielle*, 159.

⁷⁴⁷ André Citroen, *La Vie Féminine*, 9 June 1918, cited in Hatry, *Renault, usine de guerre 1914-1918*, 33.

Thomas hope that production would reach three hundred 155mm pieces per month by December 1917.⁷⁴⁸

However, the transition to the manufacturing of heavy artillery had not been smooth and production was considerably behind schedule. Although Thomas recognised that there had been a number of difficulties putting the machinery and structures in place for heavy artillery production, he felt that the setbacks were temporary and that once manufacturing was underway, industry would be able to catch up with the programme's targets. He therefore expressed surprise when, at a meeting with Schneider on 11 January, he saw that considerable reductions had been made in the forecast output. On every calibre, apart from the 155C, whose production had been modified in December, reductions had been made as follows:

Table 31 Schneider Group production forecasts, January - June 1917

Calibre	Increase in forecast	Decrease in forecast
155 C	140	
105mm		78
155L		30
220mm		36
280mm		16

Source: SHAT 10 N 12, Thomas to Loucheur, 28 January 1917.

To summarise the relative importance of these increases and reductions from the point of view of production, Thomas sought to formulate a proportional coefficient for the manpower devoted to artillery production, which was as follows:

Table 32 Thomas's coefficient for artillery production

Calibre	105mm	155C	155L	220mm	280mm
Coefficient	1	1.05	1.6	2.3	5.7

Source: SHAT 10 N 12, Thomas to Loucheur, 28 January 1917.

⁷⁴⁸ SHAT 10 N 11, Letter to Paul Doumer, 12 January 1917.

For instance, Thomas estimated that the production of 280mm pieces required the use of 5.7 times as many workers or working hours as the 105mm. Applying these coefficients to the forecasts supplied by Loucheur and the proposal of 11 January raised a number of questions. First, provided Thomas's calculations were accurate, Thomas found that the proposal of 11 January represented an overall reduction of 153 units of production, a significant fall in the total manufacturing work. It was therefore necessary to revise how manpower was being utilised to ensure that the maximum levels of production were being achieved. In addition to repeated demands for the return of more specialists and mobilised manpower from the front lines, further investigation should be conducted into ensuring that the current workers were being employed as efficiently as possible. Second, Thomas asked what new issues had arisen that had not been foreseen in July and November 1916, and could they explain these further reductions in output? Thomas had seen first-hand the number of men returned from the front to the factories, and over the past few months supplies of raw material had been relatively consistent. So why had forecasts fallen? Third, while a great effort had been made to increase the production of 155 C howitzers, if this was having such a serious effect on the production of other materiel then it should be communicated to the French high command, who could decide whether the supply of howitzers was worth the reduction in output of other calibres.⁷⁴⁹

The production problems could not be resolved simply by assigning more men or resources and Thomas's coefficient formula was flawed. There is little information on what Thomas based his calculations, and the intricacies of production involved numerous variables, particularly the supply of raw materials, the workers' levels of expertise, and the machines available for manufacturing. On 8 March 1917, Louis Loucheur remarked to Albert Thomas that the intensification of the production of 155mm pieces was not taking place at the

⁷⁴⁹ SHAT 10 N 12, Note, Le Ministre de l'Armement et des Fabrications de Guerre à M. le Sous-Secrétaire d'Etat des Fabrications de Guerre, 28 January 1917.

expense of the production of other calibres. Indeed, Loucheur had not modified anything regarding the production of other pieces, and moreover he wanted to increase their output as well. The limiting factor was the number of machines available since, provided there was sufficient manpower, it was not possible to increase production beyond their maximum capacity. The large delays in the completion of the artillery programme were a result of multiple causes but often were cases of *force majeure* that were out of the control of the industrialists, particularly arising from supply problems.

Unlike the first three years of the war, increased production was no longer achieved by reducing production in other areas, as supplies of manpower and raw materials remained relatively constant. Instead, Loucheur proposed that new means and methods should be put in place. Industry would not be able to claw back the time that had been lost, they could merely maximise potential production. For instance, a factory that was capable of producing eight guns could not produce twelve even if its guns were prioritised over other models or manufacturing elsewhere was reduced. Therefore, it was necessary to push the production of machinery in order to increase output and it was these delays that hampered the intensification of production.⁷⁵⁰

Munitions

The growing strength of the French munitions industry by 1917 was illustrated in a meeting held at the Ministry of Armament on 1 April 1917 to assess the state of shell production. Albert Thomas declared that he had decided to fix the production target for 75mm shells at 280,000 per day (30,000 of which would be delivered to allies), despite the fact that Nivelle had only asked for 200,000 per day. Thomas felt that 'it is necessary to always be ahead of

⁷⁵⁰ AN 94 AP 63, Note, Loucheur to Thomas, 8 March 1917, 2.

the high command.’ The ability of Thomas to push production beyond the needs of the generals for the first time demonstrates how far the munitions industry had developed from a period when it was being asked to produce all that it could in order to meet lofty targets demanded from the front. Nevertheless, not all problems had been overcome and shortages of steel meant that reductions were required for other calibres, with the output of 105mm shells reduced from 16,000 to 10,000 per day, 220mm shells reduced from 3,400 to 3,000 per day, and 270mm shells reduced from 600 to 500 per day.⁷⁵¹

The state of production of steel shells was as follows:

Table 33 Daily production of steel shells, March 1917

Calibre	Minimum target	Daily output in March 1917	Maximum target
75mm	150,000	210,680	250,000
75mm (allies)	32,000	28,765	32,000
105mm	10,000	11,443	14,000
105mm (allies)	600	962	720
120mm	5,000	11,065	8,900
145-155mm	28,000	13,462	28,000
220mm	3,000	2,929	3,200
270mm	500	624	600
280mm	200	10	300
370mm	50	-	50

Source: AN 94 AP 63, Réunion tenue chez M. le Ministre de l’Armement, 1 April 1917.

The table shows that for the most part industry was exceeding the minimum production target, particularly for 75mm, 105mm and 120mm shells. The production of 155mm shells posed some concerns throughout 1917, however, as the lack of steel threatened potential output.

However, the period of comfort was only temporary. The deteriorating supply of steel continued to hamper the production of munitions throughout 1917. A report from

⁷⁵¹ Ibid., Procès-verbal d’une réunion tenue chez M. le Ministre de l’Armement le 1 avril 1917 à l’occasion de la révision du rendement journalier des fabrications de munitions, 3 April 1917.

Clémenceau, the President of the *Commission de l'Armée*, on 3 August 1917 blamed the lack of raw materials for the poor quality of the shells arriving at the front lines. The production of French steel had remained relatively stationary for many months at around 200,000 tons per month, which was roughly half of what was required. Clémenceau called for 'greater energy' to be applied to production but did not offer any concrete solutions to the problem. Munitions production had also failed to progress as the *Commission* would have liked, with output falling below the minimum levels fixed by the high command once more. However, it was the dip in quality rather than quantity that was especially worrying. Increasingly, steel shells were being replaced by cast iron shells, with the latter increasing to around half of all 155mm and 220mm shells produced. Clémenceau believed that this reduced the effectiveness of the artillery by almost 75 percent, although it is unclear on what basis he arrived at such a calculation.⁷⁵²

The state of munitions during the previous month, July, had been as follows:

⁷⁵² SHAT 10 N 85, Note sur la marche des fabrications du matériel d'artillerie et des munitions, 3 August 1917.

Table 34 Shell production, July 1917

Calibre	Type	Minimum Output Target	Actual average daily output
75mm	Expl. Steel	146,000	156,057
	Shrapnel	34,000	20,199
	Special	10,000	9,637
	<i>Total</i>	<i>190,000</i>	<i>185,893</i>
105mm	Steel	11,500	6,927
	Shrapnel	50	429
	<i>Total</i>	<i>12,000</i>	<i>7,356</i>
120mm	Steel	5,000	8,133
	Cast iron	11,500	6,909
	Shrapnel	500	29
	Special	1,000	2,557
	<i>Total</i>	<i>18,000</i>	<i>17,619</i>
145&155mm	Steel	19,000	16,264
	Cast iron	17,500	17,572
	Shrapnel	500	62
	Special	1,000	1,272
	145 steel	1,000	693
	145 cast iron	1,000	751
	145 shrapnel	-	101
	<i>Total</i>	<i>40,000</i>	<i>36,715</i>
220mm	Steel	2,000	2,263
	Cast iron	1,500	833
	<i>Total</i>	<i>3,500</i>	<i>3,096</i>
270mm	Steel	250	430
	Cast iron	250	317
	<i>Total</i>	<i>500</i>	<i>747</i>
370mm	Steel	50	-
	Cast iron	17	25
	<i>Total</i>	<i>67</i>	<i>25</i>

Source: SHAT 10 N 85, Note sur la marche des fabrications du matériel, 19 August 1917.

Although the table shows that output was below the targets set, it was only marginally so for the most important calibres. The Minister of Armaments blamed manpower for the failings, as it was lacking ‘in quantity and above all in quality,’ and while he hoped the situation would improve, workers were lacking everywhere. He disputed that the quality of munitions had not improved since the start of the war. A new 75mm shell was close to being introduced that would use *mélinite* in place of *schneidérite*, was more stable upon

firing, and could be compressed further to produce a greater explosion. Other improvements had been made to increase the range of the shells, with a new 1917 model weighing 6.128 kg and containing 675g of *mélinite*. While the shell was still undergoing tests, it was hoped that it would permit a range of 10,700 metres. Furthermore, André Lefevre was in the process of developing two new cast iron shell designs that would increase the range of the 75mm field gun. The first was drilled from the bar and equipped with a detachable cartridge, while the second was a modification of the 1900 model shell with a modified interior and bevelled around the nose. This would allow a range of 9,800 metres, representing a gain of around 1,200 to 1,300 metres over the regulation shell.⁷⁵³

Discussions taking place in France throughout the war gave a very negative insight into the state of armaments production, as output continually failed to reach the specified targets. However, in comparison to the other belligerents, France was not performing badly. A comparison of charged shells produced during 1916 was as follows:

Table 35 Charged shells produced in 1916

Country	Field Artillery (millions)	Heavy Artillery (millions)	Total (millions)	Daily Production
France	60	18	78	212,000
France (foreign production)	6	1	7	20,000
Britain	35	16	51	140,000
Italy	17	2	19	52,000
Russia	28	4	32	88,000
Total	146	41	187	512,000

Source: AN 94 AP 63, Note pour M. Simiand, 30 June 1917.

It is clear from this table that France was already the key munitions producer on the Allied side, providing 45 percent of field artillery and 44 percent of heavy artillery munitions.⁷⁵⁴

⁷⁵³ Ibid., Note sur la marche des fabrications du matériel. Réponse. 19 August 1917.

⁷⁵⁴ AN 94 AP 63, Note pour M. Simiand sur la production de munitions des belligérants pendant l'année 1916, 30 June 1917.

French production required the consumption of 1,390,000 tons of steel and 620,000 tons of cast iron. The steel tonnage was split roughly evenly between field artillery shells and heavy artillery shells, with the cast iron devoted to heavy artillery. Based on these figures, the Allied armies used around 3,100,000 tons of steel and 1,350,000 tons of cast iron for their munitions production. A study carried out by the general staff estimated that the quantities of steel and iron used by the Central Powers, in comparison to the Allied powers, were as follows:

Table 36 Estimated steel and iron use

Country	Steel	Iron	Total
Germany	2,900,000	500,000	3,400,000
Austria-Hungary	1,200,000	350,000	1,550,000
France	1,390,000	620,000	2,000,000
French Allies	1,700,000	730,000	2,430,000

Source: AN 94 AP 63, Note pour M. Simiand, 30 June 1917.⁷⁵⁵

The same study estimated the daily production of the Central Powers as follows:

Table 37 Estimated daily armaments production by the Central Powers

Country	Field Artillery	Heavy Artillery	Total
Germany	335,000	172,000	507,000
Austria-Hungary	120,000	68,000	188,000
Total	455,000	240,000	695,000

Source: AN 94 AP 63, Note pour M. Simiand, 30 June 1917.

The figure for field gun shells, which for the Central Powers were mainly for the 77mm (Germany) and the 76.5mm (Austria-Hungary), appeared to be greater than in reality. The proportion of light shells received during combat was much less than two-thirds of the total figure. Therefore the estimate of 695,000 shells was largely discounted by the French Ministry of War. They felt that an evaluation of the number of projectiles, supposing that the average weight of the German shell was equal to the average weight of the French shell, was more accurate. This hypothesis revealed a roughly equal production of light and

⁷⁵⁵ The bases for this evaluation are open to some scepticism, and were viewed with hesitancy by the Ministry of War.

heavy shells in the two countries. According to the preceding table, two million tons of metal had been employed for the production of 512,000 shells on the basis of an average weight of 23.5kg for each shell. From this, the Ministry calculated that the munitions production of the Central Powers during 1916 was roughly equal to that of the Allies, at around 212,000,000 or 580,000 shells per day.⁷⁵⁶

The major challenge for the Ministry of War and French industrialists in 1917 was once again implementing the changes desired by the army. Although industry's production capabilities had improved since the start of the war, 1917 saw severe constraints on raw materials and manpower, as has been discussed in Chapters 4 and 5. Continuing problems with shipping affected the import of sufficient quantities of steel, which consequently threatened munitions production. As a result, the *Commission de l'Armée* drew up a report assessing how the manufacturing programme could be modified, and which calibres of shells would be prioritised, if they began to lack raw materials. The Administration de la Guerre and General Nivelle drew up a reduced programme that laid out the minimum output that was deemed indispensable.

Table 38 Minimum shell output deemed necessary by Nivelle

Calibre	Minimum required daily output
75mm	195,000
90mm	1,000
105mm	12,000
120mm	18,000
155mm	40,000
220mm	3,500
270mm	500
280mm	600
320mm	180
370mm	67

Source: SHAT 10 N 11, Note de M. Gervais sur la fabrication des projectiles, 18 May 1917, 2.

⁷⁵⁶ AN 94 AP 63, Note pour M. Simiand sur la production de munitions des belligérants pendant l'année 1916, 30 June 1917.

A further discussion took place at a meeting at the Ministry of Armaments on 31 July 1917. Louis Loucheur envisaged a deficit of around 30,000 tons of steel over the following months. Savings would have to be made in munitions production by producing more cast iron shells rather than the more effective steel shells. The output of steel shells would be reduced as follows:

Table 39 Reductions in steel shells

Calibre	Reduction in steel shells
120mm	4,000
105mm	8,000
220mm	800
270mm	850

Source: SHAT 10 N 12, Réunion du 31 July 1917.

This illustrates the priorities at the time and the emphasis that was placed on higher calibre shells.⁷⁵⁷

The steel supply problems had inevitable consequences for industrialists, which were highlighted by Léon-Lévy at a meeting of steel shell manufacturers on 7 July 1917. He pointed to the reduction that industrialists had been asked to make in the production of steel shells of certain calibres in order to save steel that might be required more urgently elsewhere and asked whether this would be a permanent or temporary situation and what would become of the workers in one case or the other. No allowance had been made for the industrialists, who he felt should be compensated for limiting their production while keeping all of their personnel on the payroll. He asked that the state bear the brunt of the losses that the factories would incur. Thomas was reluctant to provide a concrete answer, as there was little the government could do to avoid the continued fluctuations in both the delivery of raw materials and the requirements of the army. Instead, he drew attention to

⁷⁵⁷ SHAT 10 N 12, Réunion du 31 July 1917.

the fact that many industrialists were still being wasteful and using too much steel, and threatened not to renew the contracts of those that persisted.⁷⁵⁸

Overall, the state of munitions production was becoming increasingly acceptable to the Ministry of Armaments and, while there continued to be difficulties, discussions now focused on providing the army with the maximum tactical flexibility rather than simply preventing the artillery from running out of shells. Despite the fluctuations in the availability of raw materials, the work of the industrialists engaged in shell manufacturing was continually improving. On 3 March 1917, Albert Thomas praised their work, highlighting that, 'thanks to their efforts, it had been possible to provide the French army with an incomparable supply of munitions, almost 50 per cent more than in July 1916. The industrialists should therefore not trouble themselves too much with the current difficulties, but seek to resolve them in cooperation with the Ministry of War.' To facilitate this, Louis Loucheur created the *Services d'informations* to gather information concerning all the daily problems faced by the industrialists and to help them in overcoming these issues. While raw materials remained short, the factory owners were urged once again to do all that they could to push production wherever possible.⁷⁵⁹

The Arsenal of Roanne

Albert Thomas's attempts to improve the output of munitions, establish greater state control over production, and increase the efficiency of the manufacturing process with fewer workers culminated in the creation of the Arsenal of Roanne. Unfortunately, the

⁷⁵⁸ SHAT 10 N 29, Séance des fabricants d'obus en acier, 7 July 1917.

⁷⁵⁹ Ibid., Réunion générale des fabricants d'obus en acier et en fonte aciérée, 3 March 1917.

arsenal was beset by a multitude of problems that ultimately provided those who opposed Thomas with the means to remove him from office.⁷⁶⁰

Louis Loucheur had previously proposed the creation of a national steelworks, along similar lines to the National Dyes Company, with part of the capital provided by private industrialists. However, this idea was scuppered by François de Wendel, who told a member of the *Comité des Forges* that he would use his influence as a deputy in Parliament to prevent it going ahead in order to protect his own interests in steel production. His factories were responsible for the production of 220,000 tons of laminated steel, the majority of which would be used for construction in Paris after the war. A new steelworks close to the capital threatened this market, particularly as it would produce Martin steel, which was of a higher quality than de Wendel's Thomas steel.⁷⁶¹

Impressed by a proposal by a young engineer, Emile Hugoniot, for a new state arsenal, and under pressure from Joffre to increase munitions output to new levels, Thomas approved the construction of a large factory at Roanne that would adopt American production methods and promised to manufacture shells far cheaper than those offered by private industry.⁷⁶²

The factory would cost an enormous 150 million francs and would produce 12,000 155mm shells, 40,000 75mm shells and four heavy guns per day.⁷⁶³ Unfortunately, the management of the project was a disaster. Senator Milliès-Lacroix heavily criticised Albert Thomas and

⁷⁶⁰ The founding of the arsenal is discussed in great depth in Godfrey, 258-84, and will therefore be covered only briefly.

⁷⁶¹ Godfrey, *Capitalism at War*, 257.

⁷⁶² *Ibid.*, 261-2.

⁷⁶³ The 155mm shells would be produced at 75 francs each instead of the cost at the time of 85 francs, and the 75mm shells would be produced at 4.25 francs instead of 7.5 francs, providing a saving of 10.7 million francs per month. The factory would therefore be paid for in just over a year.

Hugoniot in the Senate in March 1917 for their failure to establish a clear administrative plan, for the abandonment of two of the four plants intended for the manufacturing of steel and artillery, and for the considerable financial problems, the result of large orders for machinery which had been delivered before warehouses had been constructed or the credits had been approved by Parliament. By June 1918, almost two years since its conception, the arsenal was producing just 1,170 shells per month, instead of the intended 50,000. By September, it had cost the country 203 million francs and produced materials worth just 15 million francs. Ultimately, Hugoniot's estimates on prices and the length of time required to amortize costs were wildly inaccurate, and the construction of the Arsenal came too late to prove economically viable. Furthermore, the lack of a clear plan compounded the organisational and financial errors. Finally, Thomas and Hugoniot drew the wrath of Milliès-Lacroix and the Senate Finance Commission by proceeding with the construction of the plant without the prior approval of the Ministry of Finance, having viewed their approval as a *fait accompli*.⁷⁶⁴

Public opinion quickly turned against Thomas, attacking his socialist leanings and the profit-sharing contract that suggested that Hugoniot would benefit greatly from the factory.⁷⁶⁵ There was also considerable opposition from industrialists, despite the fact that many of them profited through supplying the factory with machinery. Thomas believed that much of the intense criticism of the Roanne affair from the press stemmed from private industry. Once again, the key opposition came from metallurgists, who strongly opposed the appointment of Hugoniot as director, preferring someone with greater experience. It appeared that de Wendel had exerted pressure to protect his own interests. Godfrey also suggests that Louis Loucheur was actively working to undermine the project in order to further his own ambition of replacing Albert Thomas, although the evidence for this is

⁷⁶⁴ Godfrey, *Capitalism at War*, 270–282.

⁷⁶⁵ *Ibid.*, 264.

entirely circumstantial. After staking his reputation on the success of the factory and the modern methods that it would employ, the huge financial losses and ultimate failure contributed significantly to Thomas's fall from power.

The Roanne affair encapsulated the power struggles that ran under the surface throughout the war, with private industry running up against the state, the Ministry of Finance against the Ministry of Armaments, and bureaucrats against bureaucrats. According to Godfrey, 'the motive common to all parties was self-interest,' while 'the question of the... fate of France... seemed to interest none of the participants except Thomas and Hugoniot.' Private industrialists were concerned not just about protecting their monopoly of the market but also the increasing state interference in the economy. The affair is a key example of the wide-ranging implications that the Ministry of Armaments had to take into account when seeking to mobilise for war production and the importance of maintaining strong relationships between the government, Parliament and industry. Even in the attempt to build a new plant to ease the armaments and raw materials situation, the interests of industrialists had to be balanced with the interests of the nation and the two rarely matched.⁷⁶⁶

Replacement of Thomas

In the wake of the Roanne affair, Louis Loucheur replaced Albert Thomas as Minister of Armaments in September 1917, as the *union sacrée* became increasingly fragile and Thomas's socialist affiliations finally made his position untenable. Following his promotion, Louis Loucheur was able to act with much greater freedom, benefiting from his lack of

⁷⁶⁶ Ibid., 283–4.

obvious political allegiances, his proven record as an industrialist and the fact that he was able to pin many of the failings of the Ministry on his predecessor.⁷⁶⁷

Criticisms of Charles Humbert

Throughout 1917, Charles Humbert continued his campaign against the Ministry of War and the general staff and their management of the production of artillery. However in light of the continued improvement in the output of both matériel and munitions, his criticisms sounded increasingly hollow and lacked substance. He declared in April 1917 that the state of the artillery 'in the thirty-second month of the war is a scandal.' While he recognised that serious artillery output was starting to be achieved, Humbert used this apparent success to lambast the mistakes that had previously been made, particularly the lack of recognition of his calls for increased artillery production: 'The results that are beginning to materialise condemn the negligence, the lack of conviction, and the stupid stubbornness that have delayed the achievement of production more severely than all our previous criticisms. They provide the highest justification for our persistence. The war would have finished long ago if we had been listened to straight away.'⁷⁶⁸

Humbert recognised that the new *Sous-Secrétaire d'Etat des Fabrications*, Louis Loucheur, had provided a considerable impulsion to artillery production, and improved results were promised. Thus, 'we will have a heavy artillery. We will probably have it the day after the war ends.' Once again, Humbert's bitterness comes through:

If it does not serve much in the fighting, at least it will be there to prove the criminal negligence and the blind obstinacy of the technical services that refused to fulfil their duty for two years. Up until today, we could believe that if the necessary work had not been carried out, it was because it had met

⁷⁶⁷ Ibid., 62.

⁷⁶⁸ SHAT 10 N 4, Rapport fait à la Commission de l'Armée sur un prochain matériel d'artillerie, par Charles Humbert, 7 April 1917, 2.

insurmountable obstacles, as a consequence of our lack of pre-war preparation. We can no longer believe this. The work of Louis Loucheur on war production shows that if we have done nothing before, it is because we did not want to do anything. That which is possible in December 1916 and January 1917 was possible in December 1914 and January 1915. If we had listened from the first day, we would have had an artillery for a year already that we will only have at the end of 1917. Our heroic armies would have won. France would be free.

Loucheur's new approach focused industry's efforts on a small number of models: 105L, 155C and L, 220C and L and 280mm, pieces that had proved particularly effective at the front. Instead of perpetual trial and error that resulted in the accumulation of numerous models and tests, limiting work to a small number of pieces produced a homogenous artillery quickly and efficiently.

While Humbert made some cogent points, he allowed himself to get carried away and contradicted himself in some areas. Although mistakes had been made along the way in setting up the production of matériel, he ignored practicalities: the need for haste, the uncertainty about the length of the war, and the lack of preparedness of industry. Furthermore, he argued that the present programme could have been put in place towards the end of 1914 but stated that the focus of production was on those pieces that had proven themselves at the front, and that it was only from these lessons that the new programme could be focused on the most effective models. Humbert focused too closely on the front lines and the army. He had little appreciation of the complexities faced by the Ministry of War in mobilising industry.⁷⁶⁹ The Ministry was forced to make decisions that focused primarily on the short-term in order to ensure the army's continued ability to

⁷⁶⁹ Ibid., Rapport fait à la Commission de l'Armée sur un prochain matériel d'artillerie, par Charles Humbert, 7 April 1917, 9.

remain in the war. Putting long-term programmes in place at the start of the war that did not prioritise short-term expediency would have been just as imprudent.⁷⁷⁰

Humbert's story took a turn at the end of the year, when, on 13 November 1917, he was arrested on suspicion of spying, supplying information on armaments production to Germany, and promoting overproduction to benefit his backers within the *Comité des Forges*.⁷⁷¹ Four others were also arrested and shot for conspiring to sell Humbert's mouthpiece, the newspaper *Le Journal*, to the Germans. The Senator had been a persistent thorn in the side of the Ministry of War, and his removal, coupled with the suppression of the parliamentary commissions, resulted in a much calmer and more positive working environment.⁷⁷²

The day-to-day challenges of the Ministry of War also became considerably easier in 1918 following the appointment of Georges Clemenceau as Prime Minister on 16 November 1917, marking a shift in the management of the war and the relationship between Parliament and the government. The lower levels of Clemenceau's ministry were made up of a high proportion of businessmen and technocrats, experienced in the key areas of economic management, and he paid less regard to the political orientation of his ministers. Clemenceau stopped secret sessions in Parliament and the parliamentary commissions were blunted, particularly since Clemenceau was no longer a part of the Senate Army Commission. His government operated by executive power, with a reversion to the widespread use of decrees that had characterised the initial months of the war. Loucheur

⁷⁷⁰ Ibid., Rapport fait à la Commission de l'Armée sur un prochain matériel d'artillerie, par Charles Humbert, 7 April 1917, 18-19.

⁷⁷¹ Jean-Baptiste Duroselle, *Clemenceau* (Paris: Fayard, 1988), 594.

⁷⁷² Francis Martel, *Pétain : Verdun to Vichy* (New York: EPDutton & Company, 1943), 70.

and Clémentel enjoyed far greater freedom and far less scrutiny as Clemenceau stressed that from now on, the priority was 'the war. Nothing but the war.'⁷⁷³

Supplying the American Army

The clearest indication of the expansion of French industry and the confidence that the government had in its capabilities was the agreement to supply the arriving American army with artillery and munitions. The United States entered the war on 6 April 1917, but a preliminary calculation of the requirements of an army of 500,000 men revealed the need for 2,524 artillery pieces, which American industry was entirely incapable of supplying.⁷⁷⁴ At the time, the army possessed just 400 field guns and 150 heavy pieces of antiquated design, and the Chief of Ordnance, William Corzier, estimated that the country would require fifty to one hundred times the capacity of the Frankford Arsenal, which was the main manufacturer of artillery munitions.⁷⁷⁵ On 22 May, Albert Thomas cabled the French Mission in the United States to offer French artillery and munitions to the American Expeditionary Force. He agreed to provide five 75mm field guns per day from August 1917 with 1,000,000 shells along with two 155mm howitzers with 100,000 shells. By the armistice, French industry had provided the American army with 3,532 artillery pieces and almost nine million shells. Only 130 American-made pieces were used in combat. Stocks of 155mm howitzers had increased to such an extent by June 1918 that the Ministry of War

⁷⁷³ Chambre des députés, 20 November 1917, cited in Godfrey, *Capitalism at War*, 60–1.

⁷⁷⁴ John J. Pershing, *My Experiences in the World War* (London: Hodder and Stoughton, 1931), 105; SHAT 10 N 4, Rapport fait au nom de la Commission de l'Armée sur la situation des munitions en septembre 1917 par Charles Humbert, 28 November 1917.

⁷⁷⁵ Harvey A. DeWeerd, *President Wilson Fights His War: World War I and the American Intervention* (New York: Macmillan, 1968), 206–7.

was able to devote the totality of French production to supplying the American army, providing a battery of four pieces per day.⁷⁷⁶

The supply of the American army, which totalled twenty-nine divisions by November 1918, was a considerable undertaking, particularly when the supply of the French army had only just begun to reach levels acceptable to the high command. While summer 1917 saw a shift towards the increasing reliance on firepower under the influence of Philippe Pétain, the agreement suggests that improving the numerical strength of the forces at the front remained a top priority. General Pershing reveals that in the early discussions about the American entry into the war in May 1917, both the French and British Missions desired the incorporation of American soldiers into the ranks of their respective armies. The French offered two proposals, with the first suggesting ‘voluntary enlistment in French armies... [to] utilise men with the least delay..., which has the advantage of furnishing us immediate aid and of hastening victory.’ Recognising American reluctance, a second proposal, dubbed the “General Nivelle Scheme”, requested sending 80,000 men to perform various kinds of work in the interior. The French government clearly encouraged haste: ‘we cannot expect to see American armies before the expiration of a period of preparation the duration of which it is impossible to estimate. On the other hand it seems possible to obtain... within a brief period of time a portion of the great resources of that nation in combatant and non-combatant personnel.’⁷⁷⁷

France sought to employ American manpower not just in the trenches but also in the interior as the availability of French labour became perilously low due to rising casualties, the poor harvest and the continued demands of industry. Furthermore, the high command

⁷⁷⁶ Ibid., 207; Robert B. Bruce, *A Fraternity of Arms: America and France in the Great War* (Lawrence: University Press of Kansas, 2003), 105; SHAT 10 N 11, Note pour M. le Ministre, 6 July 1918. France also supplied 237 trench mortars, 40,884 machineguns and 4,878 aircraft.

⁷⁷⁷ Pershing, *My Experiences*, 39–40; AFGG, 521-458, Joffre to Minister of War, 8 June 1917.

recognised the morale boost that the arrival of American troops would provide to the mutinous French infantry.

Arming the American army also had practical benefits, as it freed up shipping space for the continued supply of raw materials from the United States to French factories. It also secured a firm obligation from the American government, as the provision of artillery was predicated on the assurance of steel deliveries.⁷⁷⁸

The decision to supply the United States with artillery seems to have stemmed from Thomas at the Ministry of Armaments and the French mission led by Joffre, Viviani and André Tardieu. Pétain, as commander-in-chief, was less enthusiastic about diverting materiel from the French army. In September 1917, he insisted that priority continued to be given to the needs of French troops if the situation was urgent. Furthermore, when asked about the requirements of the army for spring 1918, Pétain was quick to emphasise the extent to which the artillery still lacked over a thousand 75mm field guns, although it appears that he overestimated his figures to ensure that the French artillery did not suffer at the expense of arriving American forces.⁷⁷⁹

Not strengthening French materiel appears to deviate from the direction of strategic thinking in 1917. However, securing the arrival of American manpower as quickly as possible presented a larger and longer-term goal that offered greater assurances both for keeping the French army in the field in the short-term, and ultimately securing victory either in 1918 or 1919. The fact that French industry was capable of doing so was an

⁷⁷⁸ AFGG, 52, 244.

⁷⁷⁹ SHAT 10 N 12, Loucheur to Painlevé, 29 September 1917; SHAT 6 N 297, Pétain to Loucheur, 29 October 1917.

astonishing accomplishment and a huge statement considering the relative pre-war strengths of the French and American economies.

Overall, 1917 was a year of transition, both at the front lines and domestically. The failure of the Nivelle offensive prompted a reassessment of the French high command's conduct of operations and the accession of Pétain to commander-in-chief finally allowed him to introduce the artillery-dependent and patient tactics that he had advocated since the start of the war. While French industry was still attempting to catch up with Joffre's 1916 heavy artillery programme, the focus shifted even further towards large calibre pieces and quality became more important as the quantities produced began to reach acceptable levels. Munitions production was in full swing but was hampered now by shortages of raw materials rather than the capabilities of the factories. Ultimately the increased levels of output enabled the large, materiel-intensive offensives at Verdun and Malmaison, which saw intensive bombardments with high density of fire, rolling barrages, and widespread use of gas shells for neutralisation, resulting in the most significant successes of the war to date. Despite the increasingly mobile tactical situation at the front lines in 1918, the final year represented a period of stability and continuity, with industry continuing to facilitate the materiel-intensive battles. Although not perfect, the structures of industrial production had long been in place, and, provided sufficient raw materials were supplied, output was largely acceptable from a military perspective. Furthermore, it is likely that the production of higher calibre pieces deemed most suitable for operations at the front would have continued to grow throughout 1919, swinging the balance of power in terms of industrial might significantly towards the Allied powers.

Conclusion

The development of the French war machine can be viewed from two perspectives: first, the high levels of production achieved during the war, and second, the consequences of the events of 1914-18 on post-war France. The strength of French industry by 1918 must be viewed as a considerable success. It provided large numbers of modern artillery pieces and munitions, allowing the army to act with considerable freedom on the battlefield, while also supplying the arriving American army. Almost all French problems stemmed from the lack of foresight and preparation before the war, which left both the army and industry unable to meet the requirements of a modern conflict. Under extreme pressure, the government's response was *ad hoc* and reactive as it sought to keep the army supplied. It was only in spring 1916 that serious thought was applied to a longer-term production strategy that closely matched the tactical requirements of the army. After the armistice, industry quickly recoiled from the state intervention that it had tolerated during the war, but a more modern, technologically minded approach continued. However, the military was unable to maintain the progress made since 1914, and once again doctrinal stagnation left the army outmatched in the early engagements of the Second World War, with disastrous consequences.

Transformation of the artillery

By 1918, French industry was finally producing modern artillery in large quantities, facilitating the unconstrained action of the army at the front lines. Targets were being achieved if not surpassed. In January, the numbers received by the army largely exceeded their forecasts, particularly for the key pieces such as the 75mm field gun and the 155C howitzer.

Table 40 Artillery production, January 1918

Calibre	Forecast	Number received	Difference
75mm	560	592	32
85mm	30	27	-3
105mm	52	36	-16
145mm	24	11	-13
155C	180	199	19
155L 1917	32	38	6
155GPF	60	57	-3
220mm	16	17	1
280mm	6	8	2

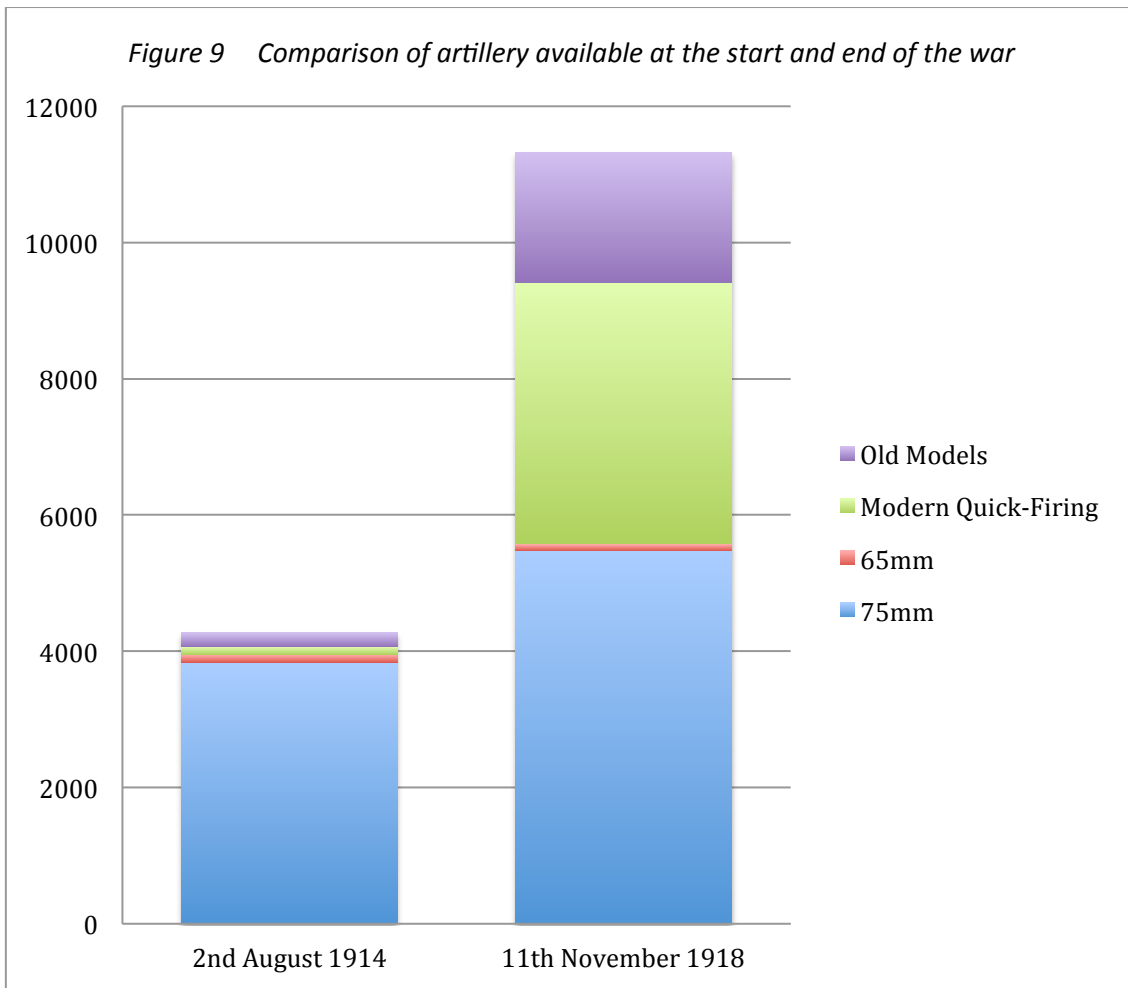
Source: SHAT 10 N 4, Rapport de M. Lucien Humbert, 16 January 1918, 20.

However, France's slow start and its struggles in the first three years of the war meant that the number of pieces available was not significantly greater than in 1914. The key difference, though, was in the type of matériel.

Table 41 Comparison of artillery available at the start and end of the war

	Light pieces		Heavy Pieces	
2 August 1914	75mm	3,840	155CTR	112
	65M	120	Other	204
	Total	3,960	Total	316
11 November 1918	75mm	5,484	Modern Quick-Firing	3,840
	65M	96	Old models	1,900
	Total	5,580	Total	5,740

Source: Aublet, "L'Artillerie Française de 1914 à 1918", 243.



The table shows a 40 percent increase in field artillery but a 1,817 percent increase in heavy artillery, with a heavy emphasis on modern, rapid-firing pieces. The table is somewhat misleading, as it does not take into account the artillery available in forts and attached to the navy in 1914. If the figures in 1918 are compared to Lucien Humbert's breakdown of the artillery in existence in 1914, there was a 15 percent increase in field artillery. While the same approach reveals an 11.5 percent fall in the total number of heavy artillery pieces available at the end of the war, the total number of modern, quick-firing heavy artillery had risen by 3,329 percent.⁷⁸⁰

⁷⁸⁰ SHAT 10 N 4, Rapport fait à la Commission de l'Armée sur la Situation du matériel d'artillerie et des munitions, par Lucien Humbert, 16 January 1918, 9-12.

The French army finished the war with 1,463 heavy batteries compared to 2,063 possessed by the German army, but this represented a much greater proportion of the nation's total military capacity.⁷⁸¹ France also had significantly more heavy batteries than the other Allied armies on the Western Front: Britain had 885, the United States had 210, and Belgium had 54, with the latter two armies equipped almost entirely with French-produced models. In addition, France was the only army to have more heavy batteries than light batteries, with 1,290 of the latter at its disposal. French batteries were also more mobile, with a higher proportion of the batteries drawn by tractors. Goya highlights that, although the German army outnumbered the French in numbers of batteries 4,649 to 2,753 in 1918, the French were able to fire almost as many shells. Indeed, the success of the French artillery was symbolic of the improvement in the army as a whole: it was capable of adapting to the tactical requirements of the war by transforming itself successively over the course of a few months, but it was unable to anticipate these changes, and therefore always had to respond.⁷⁸²

Over the course of the entire war, French industry produced 252,034,000 field gun shells and 79,506,700 heavy artillery shells: a total of 331,540,700 shells. While industry rarely met the targets set by the Ministry of War, its ability to produce on such a scale was highly impressive, particularly given the state of industry at the start of the war. Nevertheless, the Ministry of Armaments stopped short of taking shell production to a higher level of sophistication by planning output around the specific operational needs of the army or seasonal fluctuations in requirements. Modifications and reductions to output were made in response to shortages of raw materials, but the emphasis on maximising production persisted until the end of the war.

⁷⁸¹ Goya, "Le Processus d'Evolution," 477.

⁷⁸² Ibid.

While the figures themselves are laudable, the most important development was the effect that the new artillery pieces had on the battlefield, particularly with the transition to quick-firing, heavy artillery following Joffre's production programmes of May and July 1916:

Table 42 Proportion of rapid-fire heavy artillery possessed by the army

Date	Percent
August 1914	3.1
June 1916	5.7
June 1917	21
December 1917	36
April 1918	49

Source: SHAT 10 N 4, Rapport de Lucien Humbert, 16 January 1918.

The transformation in both the heavy and field artillery is clear. At the start of the war, 48 percent of the field artillery was rapid-firing. By December 1917, this had risen to 76 percent, for a roughly similar total number of guns available. Similarly, for heavy artillery, in 1914, just 3.1 percent of the available matériel was quick firing. By December 1917 this had risen to 36 percent and was expected to reach 49 percent by April 1918 for an artillery possessing around 500 more pieces than at the start of the war, with an additional 744 pieces of ALGP not included in these figures.⁷⁸³

Therefore, while the overall quantity of matériel remained roughly similar, the total weight of shells that could be fired had increased dramatically. Modern artillery pieces possessed further advantages over their older predecessors: they were more mobile, required fewer men to move and to operate them, and were much more accurate.⁷⁸⁴

⁷⁸³ SHAT 10 N 4, Rapport fait à la Commission de l'Armée sur la Situation du matériel d'artillerie et des munitions, par Lucien Humbert, 16 January 1918, 7-8. Field artillery: 1914: 5260 slow firing, 4836 rapid firing. December 1917: 2452 slow firing, 7737 rapid firing. Heavy artillery: 1914: 6374 slow firing, 212 rapid firing. December 1917: 3808 slow firing, 2127 rapid firing, 420 ALGP.

⁷⁸⁴ Ibid., Rapport fait à la Commission de l'Armée sur la Situation du matériel d'artillerie et des munitions, par Lucien Humbert, 16 January 1918, 6.

The weight of fire that the artillery was capable of firing in one minute demonstrates the true extent of industrial progress:

Table 43 Weight of fire (kg) capable of being fired in a minute

		Artillery with the army		
	Calibre	2 August 1914	1 December 1917	1 April 1918
Field artillery	75mm	334,304	484,179	496,000
Heavy long-barrelled artillery	105L	-	32,960	44,000
	120L	2,400	20,300	20,000
	155L	-	9,761	9,315
	155 LTR	-	42,572	77,400
Heavy short-barrelled artillery	155C 1904 TR	17,888	4,300	3,440
	155C Sch. And St-Ch.	-	173,548	275,200
	220mm old model	-	6,035	6,670
	220 TR	-	14,000	30,000
	280 TR	-	13,117	20,000
ALGP	19cm	-	5,644	9,960
	24 and 240	-	13,935	32,400
	274 and 285	-	800	5,200
	320mm	-	5,865	5,735
	340mm	-	670	3,335
	370mm	-	0	800
Total		354,592	827,686	1,039,455

Source: SHAT 10 N 4, Rapport de Lucien Humbert, 16 January 1918, 9-12.

At the outbreak of the war, the artillery could fire 354,592kg of projectiles per minute. By December 1917, this figure reached 827,686kg and was expected to rise to 1,039,455kg by 1 April 1918. While such a weight of fire was theoretical, it shows the vast improvement in the firepower of the French artillery, enabling it to compete with and overwhelm its German counterpart.

The modern matériel significantly increased the range of the artillery:

Table 44 Improvements in the range of artillery

1914		1918		Improvement
Calibre	Max range (m)	Calibre	Max range (m)	
75 mod. 1897	8,000	75 mod. 1897	11,400	42.5%
155C de Bange/Rimailho	6,300	155C Schneider	11,900	89%
155L de Bange	10,900	155L de Bange barrel	13,600	22%
		155L mod. 1917	15,400	41%
		155L GPF	16,300	49.5%
		145 mod. 1916	17,600	61%
220M de Bange	7,100	220M Schneider	10,800	52%
270M	7,900	280M Schneider	10,950	39%

Source: Aublet, "L'Artillerie Française," 234.

These improvements were achieved through either modifications made to existing models or the introduction of new, modern pieces. The extended range put the French artillery roughly on a par with the German army and was particularly important for counter-battery fire and for increasing the depth that the infantry could advance with artillery support without having to wait for it to displace and move forwards.

The key development was therefore not just the quantity of artillery supplied to the army but the quality. The pre-war faith in the 75mm field gun had shifted to faith in firepower in general. By the final year of the war, large-scale industrial output granted mobility and speed of fire, and facilitated and drove doctrine, granting commanders the flexibility to deploy artillery units quickly to where they were needed most before concentrating heavy fire in a short space of time. The army was able to be increasingly creative with its methods, rather than relying on rigidly planned artillery bombardments that still pervaded even in 1916 and 1917.

French industry's ability to supply the arriving American Expeditionary Force while providing its own army with modern artillery in such quantities makes its achievements even more impressive. Discussions surrounding the provision of French matériel and

munitions to the United States reveal an interesting shift in the Ministry of War's approach. Although the events of 1917 suggested that the army wished to prioritise firepower and amass artillery along key sections of the front, the practical considerations of morale, manpower, and the supply of raw materials took priority over immediate tactical goals in order to ensure an overwhelming superiority over the German army in 1918 and potentially 1919. Considering the criticism aimed at the Ministries of War and Armaments during the first three years of the war for their short-sighted and reactionary response, this represented a pragmatic and rationalised approach, and a sign of growing confidence in the French army's strengths.

Flaws stem from the pre-war period

France's position as the arsenal for the Allied powers in 1918 is particularly astonishing considering the numerous structural issues that had to be overcome, particularly in terms of the lack of raw materials and manpower, and the planned reliance on state arsenals in 1914. These problems all stemmed from the failure of the high command and the government to prepare adequately for war. They underestimated the scale, style, and length of the conflict to such an extent that both the army and industry were caught completely off guard, resulting in munitions shortages at the front lines and severe disruption on the home front. The army was severely constrained by shell restrictions and incapable of matching the more powerful and more mobile German artillery. Workers were recruited from factories before the Ministry of War realised that they would be needed to produce armaments, while the invasion of northern France left the country woefully low on raw materials.

Although the debates on the *Loi des trois ans* in 1913 and the state of French armaments in July 1914 reveal that a number of key individuals were becoming increasingly worried about French deficiencies in heavy artillery and production capacity, change took far too long to implement.

The Ministry of War, led by Alexandre Millerand, scrambled to respond. Millerand's initial actions, particularly his recruitment of private industry, hint at pre-war recognition of the flaws in Plan XVII. The outbreak of war removed parliamentary constraints and he was able to take decisive action. Nevertheless, it was impossible for the Ministry to ignore the importance of short-term necessities, and although this led to inefficiency, excessive bureaucracy, and vehement criticism from the *Commission de l'Armée*, the army received sufficient munitions to keep the artillery firing.

After the war, Paul Painlevé asked, 'at what price had this industrial miracle been accomplished?' answering: 'at the price of murderous delays, bought with the blood of our soldiers, at the price of waste..., at the price... of the scandalous enrichment of some that must never be repeated.'⁷⁸⁵ If the government had known in advance that the war would last four years, then it might have acted differently. However there were periods during 1914, 1915, and even 1916 when defeat seemed imminent due to the paucity of resources at the front lines. Thus, the Ministry of War had to do everything within its power to keep the army supplied. It was only in spring 1916 that serious thought was put towards a longer-term production strategy that yielded such impressive results in the final two years of the war. The structures put in place in 1914 and 1915, while not perfect, ultimately put French industry on the track to large-scale production. The Bordeaux Conference in September 1914, the creation of the *Sous-Secrétariat d'Etat* under Albert Thomas, and the

⁷⁸⁵ Speech on 4 March 1927, cited in Eugenia C. Kiesling, *Arming against Hitler: France and the Limits of Military Planning* (Lawrence: University Press of Kansas, 1996), 13.

transition to the Ministry of Armaments under Louis Loucheur in 1917, allowed the rapid expansion of armaments manufacture that proved crucial to the strength of the French army in 1918. Consequently, despite the problems along the way, the process must be viewed as a success.

Post-war industry

The war had a profound effect on the state of French industry, promoting growth in new areas and shifting the focus of heavy industry away from the north-east. Metallurgy developed in the south-west in particular, and those firms involved in war production became 'the backbone of technologically advanced industry.' Modernisation catalysed by the war 'undoubtedly did much to help break down old habits and rigidities in industry and in business methods generally. In this sense the war helped to drag the French economy into the twentieth century faster than might otherwise have occurred.' Smaller companies were squeezed out, as the loss of manpower, the mobilisation of owners and important personnel, and the lack of financial reserves hit them hardest. Conversely, the larger companies were able to expand rapidly by taking advantage of government contracts, resulting in industrial concentration that continued into the 1920s.⁷⁸⁶

With the widespread involvement of major industrialists such as Louis Renault and Robert Pinot on governmental committees, the war saw the birth of a 'military-industrial complex', and even a 'politico-industrial complex', in which the government and industry worked in close harmony to achieve the goals of the army.⁷⁸⁷ During the war, the French government was forced to play a far greater role in the management of industry than it had before 1914. It exercised control over manpower, armaments production, and particularly the

⁷⁸⁶ Kemp, *The French Economy, 1913-39*, 54.

⁷⁸⁷ Fridenson, *Histoire Des Usines Renault*, 91.

import and distribution of raw materials, which were governed by a number of different consortia and committees. However, this was not an ideologically driven attempt to introduce a form of *étatisme*. Rather it was merely a pragmatic response to the circumstances and pressures of war.⁷⁸⁸

After the armistice, France sought to build on the progress made during the war. The government realised that the threat of future war remained, and therefore it was vitally important that the country was in a much stronger economic position from which to respond. The industrial expansion that had invigorated the French economy had to continue, and therefore the Ministry of Armaments renamed the Ministry of Industrial Reconstruction just two weeks after peace arrived. However, the lessons of the First World War were soon forgotten.⁷⁸⁹

The task of overseeing the reconstruction of the French economy was entrusted to Louis Loucheur. He was keen to encourage industrial growth but sought to move away from the levels of state intervention seen during the war.⁷⁹⁰ Loucheur was critical of the weaknesses of the pre-war French economy, which saw a preponderance of small, poorly structured businesses, economic individualism and an overdependence on other countries for both finished goods and resources. Building on his work at the Ministry of Armaments, he sought to continue the modernisation and specialisation of business practices in the post-war period, particularly with a transition towards American methods of mass production.⁷⁹¹

⁷⁸⁸ Godfrey, *Capitalism at War*, 289.

⁷⁸⁹ Porte, "Mobilisation industrielle et guerre totale," 34; Robert A. Doughty, *The Seeds of Disaster: The Development of French Army Doctrine, 1919-1939* (Hamden, Conn: Archon Books, 1985).

⁷⁹⁰ Kuisel, *Capitalism and the State*, 50.

⁷⁹¹ Carls, *Louis Loucheur*, 129.

Although industrialists accepted government intervention during the war, they recognised that it stemmed from the need to defend the country. They still sought to preserve their own interests, negotiating favourable contracts and ultimately making large profits. They remained suspicious of the state's ambitions and were quick to seek a return to pre-war practices after the Armistice. While the concentration of contracts in the hands of the larger private industrialists during the war had favoured their development at the expense of smaller firms, they now wanted to be let off the leash and given the freedom to expand as they wished. Some still favoured collective forms of action, but the majority preferred to return to the pursuit of individual initiative and economic freedom.⁷⁹²

While the civil service grew from 800,000 in 1914 to 1.25 million in 1926, and significant social legislation governing workers' rights and wages was introduced, the removal of inter-allied economic cooperation at the end of the war dismantled the structure that provided the foundation for state control over the economy. The government had little justification to continue with its reliance on consortia, and relations with industry quickly returned to a system similar to that existing before the war. Still, the 1920s saw greater consultation between industrialists and the government, with increased involvement of unions in the decision-making process.

The law of 11 July 1938 established a plan for the organisation of the state in wartime and so demonstrates that some lessons had been learnt from France's failure to prepare for the First World War. It gave the government complete control over the economy as well as the ability to requisition private industry if necessary.⁷⁹³ Conversely, one can argue that such a law, coming just months before the outbreak of the Second World War, was far too late, and suggests that the administration was making the same mistakes and hasty attempts to

⁷⁹² Kuisel, *Capitalism and the State*, 50.

⁷⁹³ Godfrey, *Capitalism at War*, 296–9.

recover as characterised the debates of July 1914. Indeed, in 1927, Joseph Paul-Boncour had proposed a law seeking to avoid a repetition of the hasty actions and improvisations of the first few months of the war, but it failed to pass in Parliament.⁷⁹⁴

Post-war military planning

For the military, the high command was keen to ensure that the lessons of the war were not forgotten in the transition to peace and that the army was placed in a better position to prepare for future wars. Chastened by its failure to adopt heavy artillery in time in 1914, it perceived the need to stay abreast of technological developments.

Gilbert Garnier, the head of the *Laboratoire d'Artillerie*, recognised that, although the demands of war meant 'the speed of execution overwhelmed all other considerations', and resulted in 'hurried and temporary' solutions, changes and improvements had occurred quickly. In peacetime, such pressures would be absent, and thus the urgency to improve would also disappear. Without real-world opportunities to challenge the army, Garnier feared that doctrine would stagnate, with the army once again convincing itself of the merits of existing weapons and practices.

A more rational approach to research was required. During the war, studies had frequently been conducted with specific goals in mind, often seeking to decide between two models of artillery or types of fuse or shell to settle which best suited the needs of the moment. Garnier proposed a more patient and methodical approach, building a body of information on all manner of areas relating to the artillery, such as fuses, powders, braking mechanisms and sighting methods. This would produce documentation on the most suitable element for

⁷⁹⁴ Porte, "Mobilisation industrielle et guerre totale," 34.

certain scenarios, from which the general staff could base its future decisions on the adoption of materiel that most suited its doctrinal needs.

Whilst such studies would not warrant widespread production of new pieces or prototypes, the relevant machinery could be developed and perfected so that production could be intensified if necessary and the army would not be caught unprepared, as it had been in 1914.⁷⁹⁵

By 1918, France had reassessed its relationship with industry and the role that the latter played in military planning. The First World War had affirmed the revolutionary approach of the nation in arms, with the entire country mobilised and contributing to the war effort and ultimately to victory. A similar approach, while costly, was deemed necessary to ensure that success was achieved in future conflicts, rather than once again entering a war as unprepared as in 1914. The achievements of French industry by 1918 convinced generals and politicians of the nation's strengths, providing the belief that they could rely on industrial production and materiel might in a future war. However, it also led to their neglect of potential doctrinal developments as technology became more advanced and increased mobility became possible.⁷⁹⁶

France was certainly not unprepared for the Second World War, having spent the previous twenty years laying the foundations for a potential war with Germany. Drawing on experiences in the First World War, tanks, modern artillery and stout defences were at the core of the army's approach, but it was not industrial weakness that led to defeat. French doctrine foresaw methodical, structured battles that favoured the strategic and tactical defensive, but the army was overrun by an extremely mobile and offensive Germany army.

⁷⁹⁵ SHAT 10 N 11, Le Chef d'Escadron Garnier à M. le Colonel Mercier, 18 November 1918.

⁷⁹⁶ Doughty, *The Seeds of Disaster*, 40, 182.

Doughty's criticisms that 'under the pressure of war, France simply could not respond to the type of fighting thrust upon [it]', and 'the complete collapse of the French army in 1940 demonstrated that it had failed to prepare adequately for the demands of modern warfare,' eerily echo the cries of 1914 and 1915.⁷⁹⁷

⁷⁹⁷ Ibid., 4–5.

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