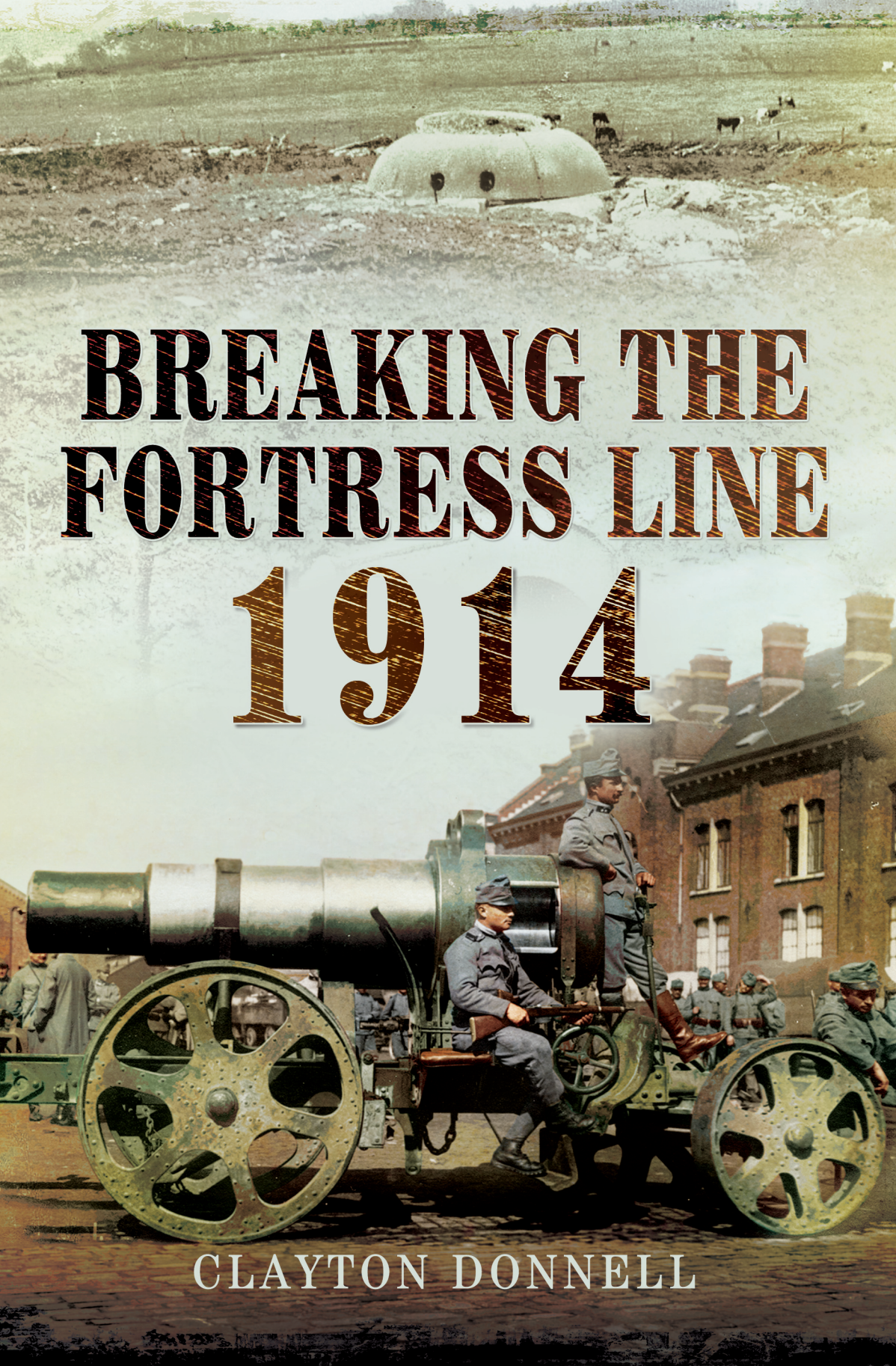
BREAKING THE
FORTRESS LINE
1914
CLAYTON DONNELL

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Contents

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Chapter One

An Introduction

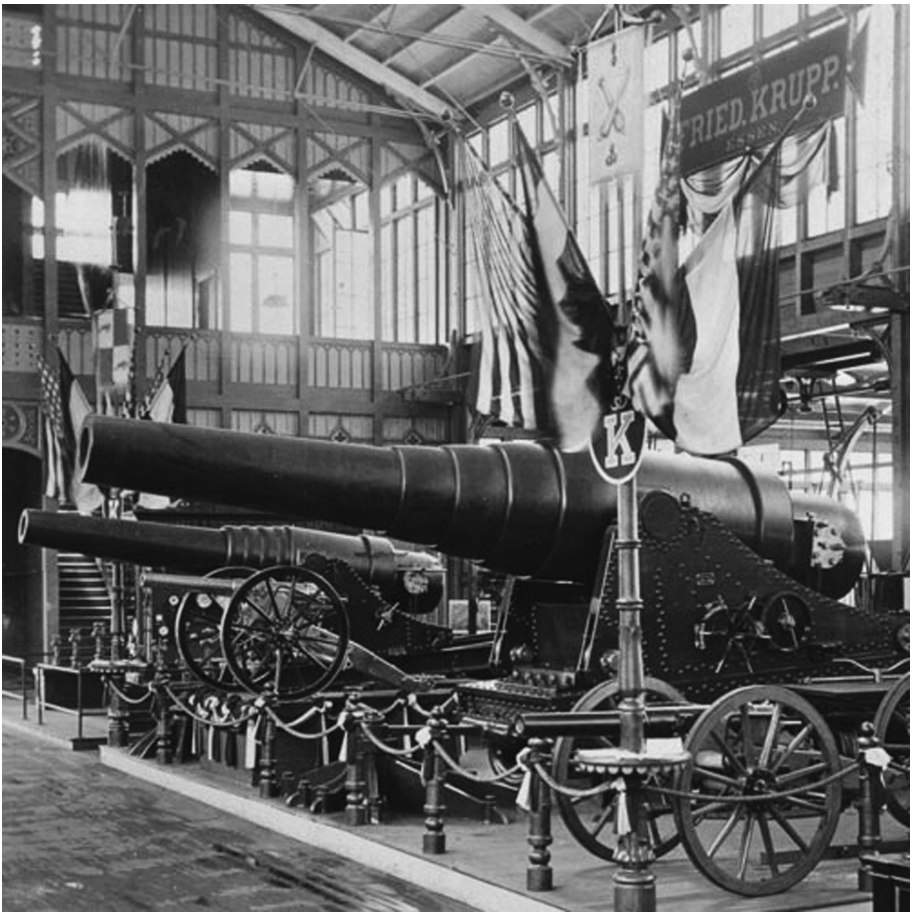
The first International Exhibition was held in London's Crystal Palace in 1851 and was meant to showcase science and technology from countries around the world. Arthur Goodrich, in *The World's Work*, written in 1902, commented, 'The general lessons of the mechanical exhibits are these – that machinery is making rapidly what hands used to make slowly; that electricity instead of steam is operating machinery, and that faster trains and boats, together with new electrical inventions, are constantly increasing channels of communication.'

'The Great Exhibition', as it was called, featured Frederick Blakewell's facsimile machine, Mathew Brady's daguerreotypes and a number of revolvers manufactured by Colt. The exposition returned to London in 1862 and displayed naval engines, the first household gadgets and an exhibition of the Bessemer process for manufacturing steel from molten pig-iron. These new inventions were viewed by millions of visitors and brought about the realization of how the world was changing in the second half of the nineteenth century.

The Centennial International Exhibition of 1876 was the first 'World's Fair' held in the United States. Philadelphia was the location, in celebration of a hundred years of American Independence. One of the most talked about and anticipated exhibits came from the Alfred Krupp armaments works in Essen, Germany. 'Not twenty yards from the main entrance of Machinery Hall stand two monsters,' wrote the *New York Times* correspondent in the edition of 28 June 1876, speaking of two giant Krupp coastal defence guns. Krupp was being compared to England's Sir Joseph Whitworth and William Armstrong and America's Thomas Jackson Rodman as a builder of 'rifled ordnance which shall defy armour-plated leviathans and put the most powerful land batteries to confusion'.

The Krupp guns were indeed monsters but in relation to similar heavy armament, they turned out to be not so extraordinary. The Krupp coastal defence gun was made of cast steel, with a 35.5cm diameter barrel, an 800cm long tube and a hydraulic recoil brake, the ensemble weighing 56kg. Tests showed it was able to penetrate the armour plating of British battleships from a distance of nearly a mile. It was larger than the Rodman but smaller than the Whitworth guns also on display in the hall.[1] What made the Krupp guns extraordinary was the mystery surrounding them. They were described as 'monsters', to be used against 'Leviathans', but they also demonstrated the might of the new German empire and represented one element of the new military technology that would change the face of warfare in the next century.

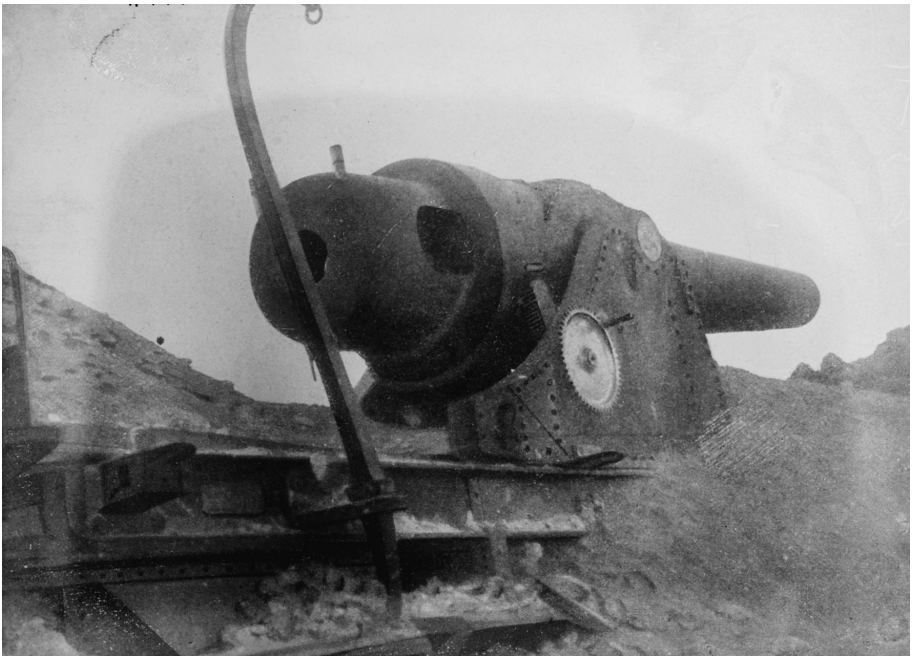
A year later an obscure article appeared in the *New York Times* on 21 May 1877 comparing Krupp's 'latest 80,000kg gun[2], of a marvelous and interesting



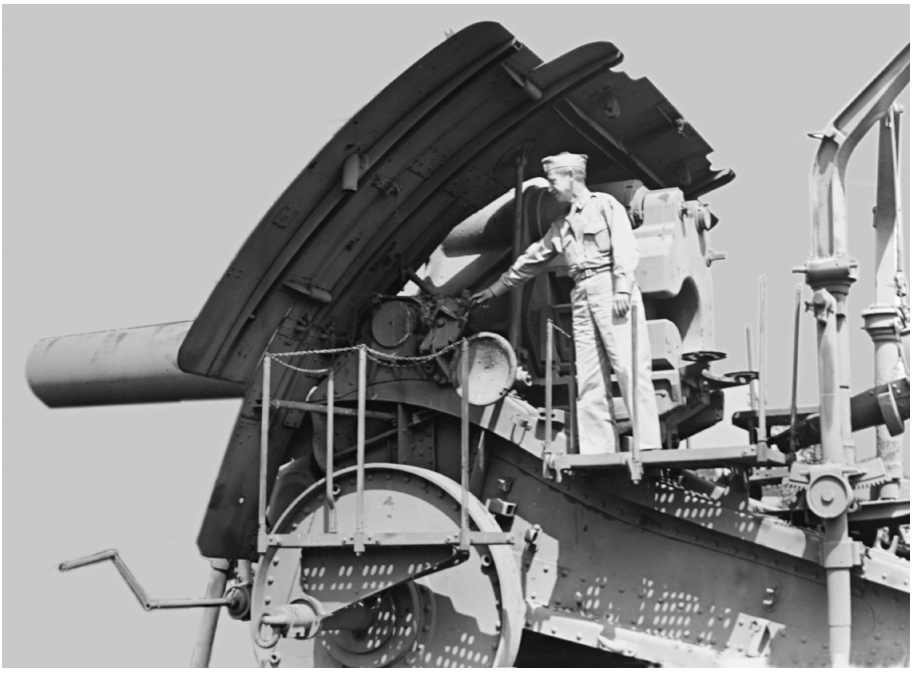
Krupp guns on display at the Centennial Exposition, Philadelphia, 1876. (*LOC*)

character', to the British models. The most interesting part of the article was the mention of a 'design by Herr Krupp of a 126-ton model with an 18-inch diameter bore, or approximately 45cm'. Enemy naval vessels would certainly avoid going near a coastal battery equipped with a gun of this calibre, but a coastal defence gun was of no concern to fortress engineers in France and Belgium, because it could not be moved inland to fire on the forts. Unknown to the London *Times* and *New York Times* reporters who were writing about coastal guns at that time, Krupp would soon begin to develop large calibre siege guns that would result in the fielding of a massive 42cm gun.

As late as 1890 the military engineers working on the new defences of eastern France and Belgium built their forts to resist a shell no larger than 21cm – the largest known gun that could be transported by an army. Krupp might be developing very large coastal guns, but the Belgian forts at Liège and the French fortifications in Lorraine were 400km and 700km respectively from the closest



A Krupp gun like those at the exhibition at a Turkish fort in Libya. (*LOC*)

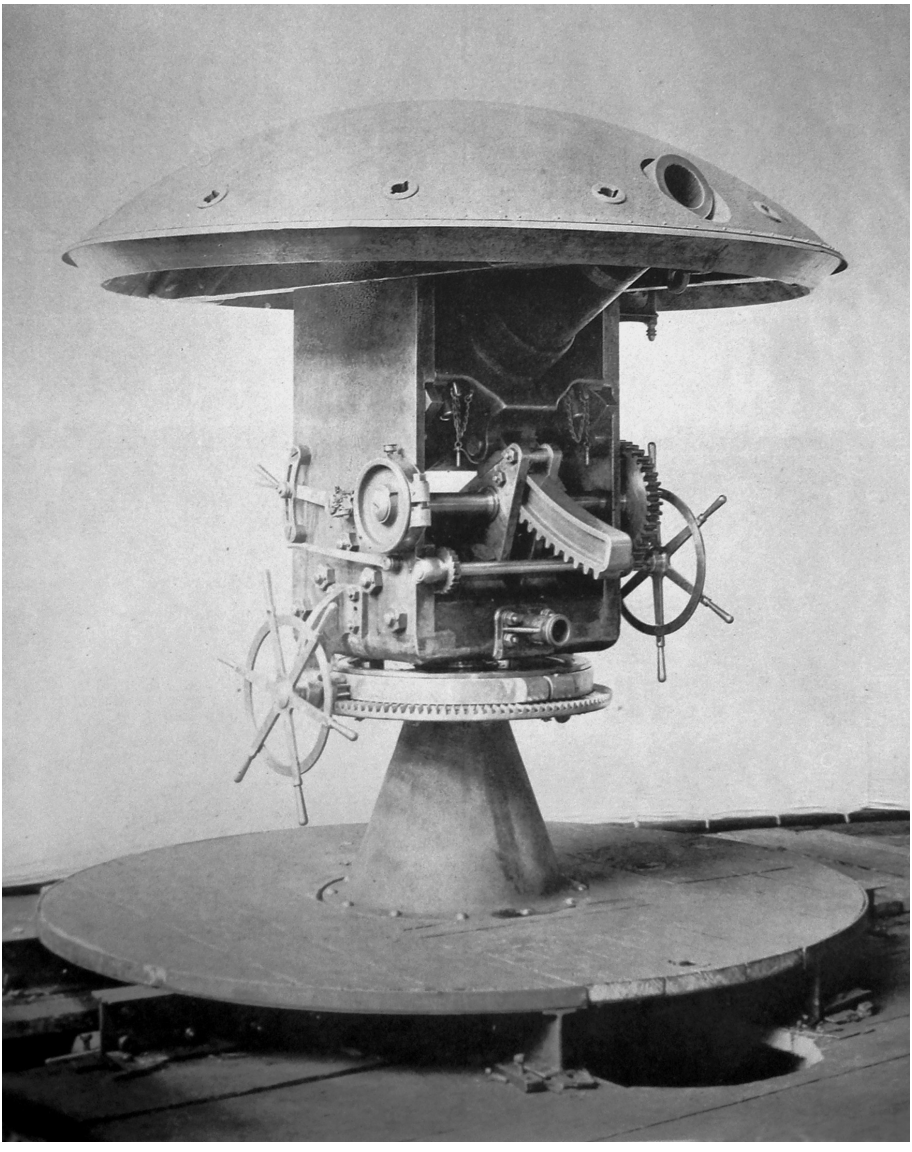


The 42cm mortar at Aberdeen; it was scrapped in 1943. (*NARA*)

German coastal battery and thus were not threatened at all by these monster artillery pieces. Not, that is, until they were designed to be disassembled and moved overland by train or mechanized tractor and set up to bombard the forts. They had no idea that Krupp's designer, Professor Fritz Rausenberger, was working on a rail-transportable 42cm heavy mortar known as the Beta model. This would eventually lead to the development, in 1911, of a mobile, short-barrelled 42cm howitzer, the *Kurz Marine Kanonen M-Gerät*. They used the label 'marine' because it was an offshoot of the Krupp coastal defence gun and the term could disguise the fact of its development for land warfare.

In 1901 the chilled cast-iron gun turret, manufactured by Grusonwerk and designed to protect artillerymen and fortress guns from increasingly powerful enemy artillery, made an appearance at the Pan-American exhibition in Buffalo, New York. It is interesting that, although it was described as a 'coastal defence turret[3] for 12-inch guns', it would not be used in coastal fortifications in the United States[4] in the future.[5] Dozens of armoured turrets like the Gruson model were, however, installed in land fortifications throughout Europe. Some would be manufactured by Krupp-Gruson, others by French and Belgian companies such as Schneider-Creusot, St Chamond and Ateliers de la Meuse.

A captured 42cm mortar at Aberdeen, Maryland; this was one of only three remaining guns of this type after the war. (*NARA*)



The gun carriage and protective cap for a 15cm Krupp howitzer turret. (*NARA*)

The armoured turret for land fortifications was an offshoot of the steel and cast-iron turrets developed for ships, such as those used on American ironclads during the Civil War. Armour plating was first used in British coastal defences. The armoured gun turret vastly improved the protection for gunners when loading and firing the guns. Without it, there was no overhead protection and the gunners were vulnerable to shrapnel shells and high explosives fired from distant heavy mortars and howitzers.

This was the new age of technology, and it was on public display in exhibition halls in the world's great cities, in the pages of *Harper's Weekly* and *Scientific American*, and in the works of authors such as Jules Verne and H.G. Wells who wrote of submarines that could sink great naval ships and space capsules that could be fired from giant guns to reach the moon. New technological advances were occurring at an ever-increasing pace. Technology designed for use in the civilian world, such as steam and diesel engines, telegraph and telephone communications, and barbed wire to pen in herds of cattle in the west, was being adapted for military use (and military inventions for civilian use). At the same time military technology was developing at the same rapid pace, with the invention of machine guns and smokeless gunpowder, and in the scientific application of developments in ballistics and explosive chemistry.

The opening campaign between the armies of France, Belgium and Germany hinged on speed and manoeuvre. But in the background, overshadowed by the movements of the main armies, a series of small battles took place. They rarely appeared on the front pages of the world's newspapers, nor did they take up many pages of future classics of the First World War. Yet they were in fact no less important, no less critical to the main campaign, because their aim was to eliminate the serious threat posed to the flanks and rear of the German army from the border fortifications of France and Belgium. These relatively obscure battles to subdue the forts pitted one form of modern technology against another in a showdown between the destructive firepower of heavy German siege guns and the concrete and steel of the Allied fortifications.

Throughout the history of siege warfare, offensive and defensive technologies had always progressed hand-in-hand. From ancient times the walls of a fortress were pounded by enemy projectiles designed to smash through them. The fortress walls were then modified to overcome the projectile that had managed to smash its way through. From ancient catapults throwing large stones, to siege mortars casting a huge iron ball; from high, vertical, stone castle walls to low, angular, concrete bastions, artillerymen and military engineers countered and parried each other's latest advancements, thus creating for each other a new set of challenges.

In the last half of the nineteenth century siege artillery underwent monumental changes in a very short period of time. In the 1850s rifled artillery first appeared in Prussian and American arsenals. The Krupp armaments works in Germany designed a new type of gun barrel with a set of parallel grooves etched in a spiral pattern on the inside surface of the barrel. This etching process was called 'rifling' and the spiral grooves in the barrel's inner surface caused the shell, now in the shape of a bullet (or 'torpedo'), to spin as it left the barrel. It now soared for a longer distance, with greater accuracy, enabling it to reach the centre point of a fortress from a greater distance, beyond the range of the fortress's guns. The fortress was now placed in check and it was the turn of the fortress engineer to counter the move. In America rifled guns, such as the Phoenix 3-inch, the James and the Parrott, were introduced to Federal arsenals and used in the American Civil War.

The engineers needed to devise a way to keep the enemy guns out of the range of the centre of the fortress, city or defended area. It was far too expensive to build solid fortress walls along the entire perimeter, which might be as much as 80km in circumference; multiplied by the number of cities that would have to be defended; such an endeavour would bankrupt the wealthiest nation. The solution was to build detached forts in a ring 3–4km from the centre. These were independent forts, but close enough to one another to provide mutual support and to cover the ground between them.

The most popular type of detached fort was in the shape of a polygon, a design adopted by all of the European engineering schools in the nineteenth century. Beginning in the first half of the 1800s, German, Austrian, Belgian, Dutch and English engineers incorporated the polygon into their designs, followed in 1870 by the French. Many of Europe's cities, including those in France, were surrounded by fortifications built in the 1600s. In fact, in 1914 the Germans would lay siege to the Vauban-era fortresses of Longwy, Montmedy and Givet, and encounter other places where ancient bastions remained an integral part of the defences, such as Verdun and Maubeuge. (Sébastien le Prestre de Vauban, field marshal and military engineer (1633–1707), developed the French line of defences for Louis XIV. The foremost military engineer of his time, his work included the development and improvement of the bastioned fortification system and the adoption of techniques to lay siege to enemy fortified cities. Between 1667 and 1707 Vauban improved the defences of approximately 300 French cities and directed the construction of thirty-seven new fortresses along France's borders and coasts. Most of his works survive to this day.)

Beginning in the 1850s, hundreds of new, detached, polygonal forts were built in rings surrounding entrenched camps, or in belts to defend the area between them. The Belgian army engineer General Henri Brialmont, France's chief engineer General Séré de Rivières and the German engineer Eduard Todleben were given the opportunity to become the Vaubans of their era. Brialmont and Séré de Rivières were responsible for the planning and construction of fortress lines in their respective countries. In 1914 these two systems provided the first test for the German siege techniques.

The single most important event that changed the nature of siege warfare was the improvement in the chemistry of the explosive placed inside artillery shells. In 1885 the French chemist Eugène Turpin, guided by the research of Hermann Sprengel, patented pressed and cast picric acid, a volatile material that could be placed inside artillery shells. In 1887 this high explosive was adopted by the French government and mixed with guncotton[6] to form a substance called melinite. Its explosive power was tremendous. The use of time-delay fuses in the nosecone of the projectile prevented the chemicals inside the steel casing from exploding until it had penetrated through the earth covering and reached the masonry vaulting, causing severe and often fatal damage to the structure. The shells used for the German 30.5cm and 42cm guns were armoured for better penetration. Their mass and armoured tips enabled them to penetrate armour plate and concrete.

Thousands of new and more powerful shells were tested against materials used in the existing forts and the engineers came to only one conclusion: all the permanent fortifications in Europe, and especially in France, were now obsolete. This precipitated the 'Torpedo Shell Crisis', and an immediate solution was needed. As they had since ancient times, the fortress engineers looked for new ways to protect the forts and their garrisons from the destructive power of the new shells. The answer was found in modern technology, ushering in a new age of armoured concrete protection.

Concrete was invented in England in the early nineteenth century. It was made by mixing the chemical compound cement with sand, coarse gravel and water to form a hardened, durable surface. Concrete has an infinitely greater resistance to steel projectiles containing melinite than ordinary stone and brick. Tests were conducted throughout Europe using various thicknesses and densities of concrete until the right formula was found that could resist bombardment by the heaviest siege guns of the time, using high explosive shells.[7]

French engineers, having recently completed Séré de Rivières's 'Line of Steel' along France's borders and coastline, at a cost of hundreds of millions of francs, now had to determine if these forts could be modified or if they would have to be abandoned or declassified[8] and used for lesser purposes. Fortunately, tests showed that the engineers could modify the existing forts by adding a layer of concrete to the outer surface. It was expensive but better than tearing down the forts and starting from scratch. The engineers could also build bombproof shelters underneath and adjacent to the existing structures. Modernization of the French forts began in 1887. However, due to budget constraints and differing theories about the exact nature of a future German attack, some forts were left untouched; others underwent only minor modifications or were declassified. Some of these decisions would have serious consequences in 1914.

The Belgians were more fortunate than the French. They did not start to build the forts of the Meuse until 1888, by which time they had extensive knowledge of the capabilities of high explosive shells. General Brialmont, their designer and builder, conducted tests at Fort Brasschaat at Antwerp using various calibres of artillery shells against various types and thicknesses of concrete and armour. The tests revealed the ideal mix of concrete needed to withstand 21cm shells. The Belgians started from a level playing field, with all the advantages of being able to use the latest technology in the construction of their new forts. That would have been sufficient if the status quo had been maintained in the coming years.

The Germans were quite aware of what their neighbours were doing across the border. Thousands of labourers were employed to build the forts of Belgium and France, and it would be naive to believe there were no German spies among them. Therefore, while the Belgians and French were laying concrete and forging steel armour plating, Krupp was developing his 'monster' siege guns for the German army to haul across the border, with the necessary size and power to obliterate the forts.

In the 1880s the Germans were participating in the 'fortress arms race' on their borders with France and Belgium (and also in Russia). The Chief of the General

Staff, Helmuth von Moltke, realized he would need heavy guns to destroy the fortifications in order to break through the line. Let us not forget that Krupp was building powerful coastal guns that were appearing at exhibition halls throughout the world. At the time the 21cm and 15cm were the largest guns available to the foot artillery regiments. The current range of heavy siege guns would not be powerful enough to do the job and von Moltke asked the *Artillerie-Prüfungskommission* (APK) – Artillery Test Commission – to design and construct a weapon powerful enough to destroy the concrete forts. The APK first developed the 30.5cm mortar and followed it up with a 42cm model. The German army now had the sledgehammer it needed to smash the forts. The Allies remained completely unaware of this development until 11 August 1914, when the first 42cm shell flew through the air and landed in a field near Fort de Pontisse in Belgium.

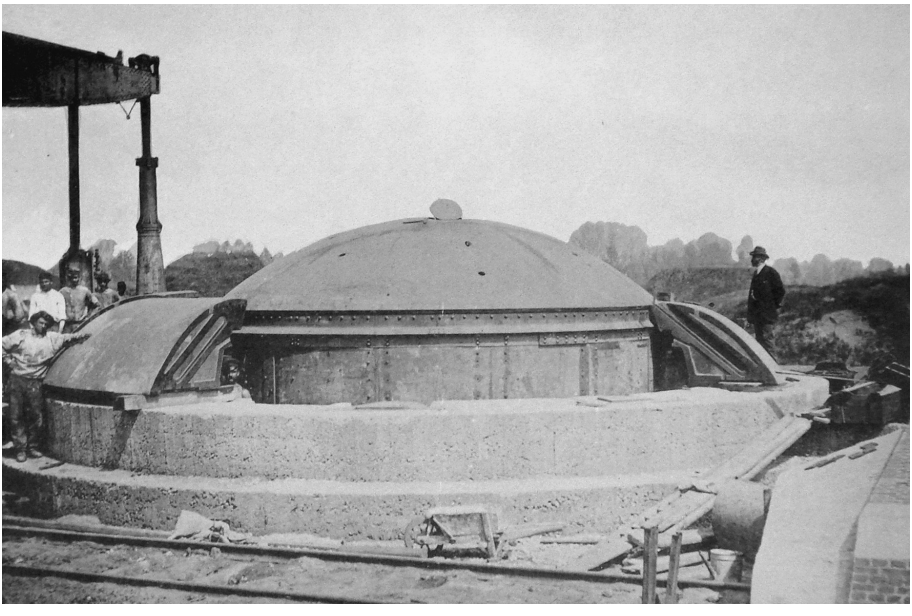
As previously mentioned, the open ramparts on the forts were exceptionally deadly places for artillery units. The same highly explosive chemicals that were used to break up the masonry could also be utilised in shrapnel shells with time-delay fuses set to explode directly over the gunners' heads. Beginning in France in 1887, the long-range guns were removed from the open ramparts and placed in open batteries between the forts. Moving the guns out of the forts dispersed them but the external batteries were no less vulnerable to enemy shelling. A more effective solution was needed and this led to the development of armour plating for the protection of the guns and their crews in the forts.

Results of artillery tests at Fort de Malmaison in 1866. (*LOC*)

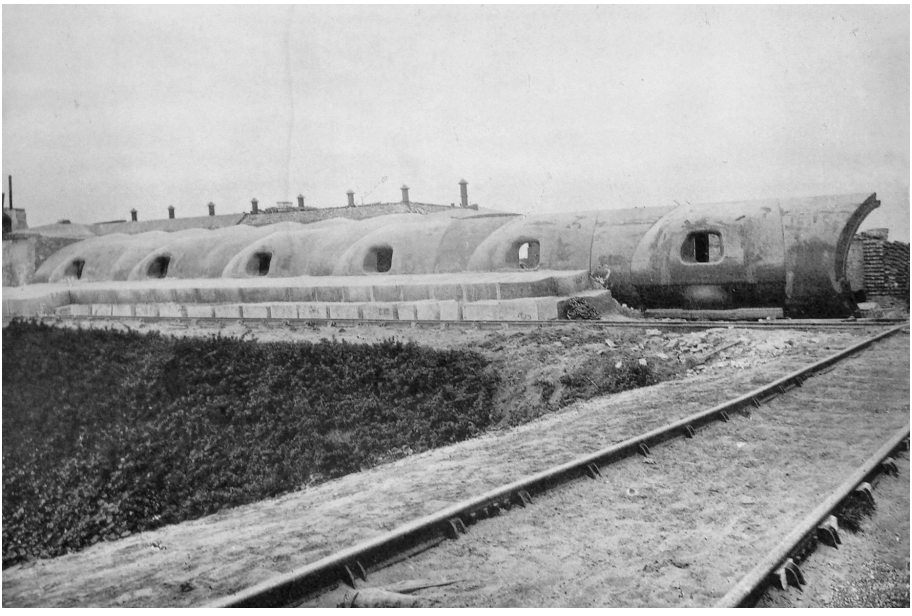
The German firm Gruson conducted tests to determine the type of iron or steel, or a combination of both, that could best withstand the effects of modern shells. Gruson developed a series of thick, rounded, cast-iron, wedge-shaped armour plates that were connected together and topped with a thick cap to form an armoured casemate. Captain Maximilian Schumann, a Prussian army engineer, used this technology to develop a circular, revolving turret for two 15cm guns for use in land-based gun batteries.

Meanwhile, Commandant Mougin, a French engineer, designed a revolving turret for two 15.5cm cannon. The Mougin turret, like the Schumann turret, was built by connecting curved steel plates to form a circular protective cap that was placed inside a concrete well. The turret rested and moved on wheeled tracks or ball-bearings that allowed the cylinder to be turned through 360 degrees to fire in any direction. The guns inside the steel capsule could be raised or lowered to fire at various angles. Later models, like the one first built by the French artillery engineer Colonel Bussières, were 'eclipsable', meaning they could be raised up to fire and lowered below the concrete surface to protect the guns and the crew during bombardment. They used a counterweight system to raise and lower the turret inside the concrete housing. The Mougin turret was adopted for use in early Séré de Rivières fortifications. Schumann's turret design only appeared in a test model in the Metz fort of Kameke.

The turret was developed along with the fortifications in which it would be installed. Several models, including one submitted by Schumann, were considered and tested. In 1887 Commandant Mougin developed the designs for what



A Grusonwerk armoured turret for two 15cm cannon, 1889. Note the visor port at top centre. (*NARA*)

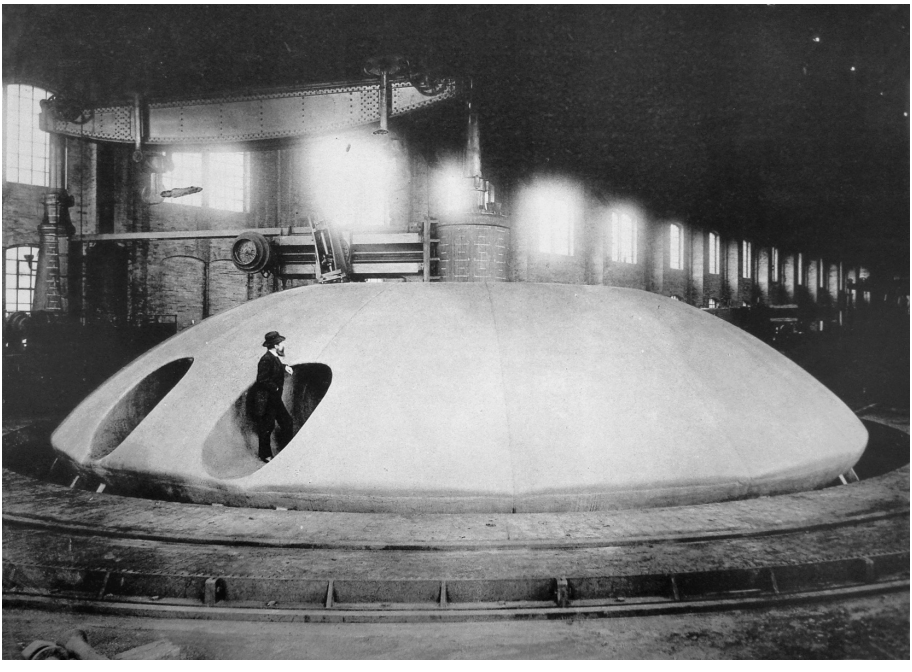


Cast-iron casemates for the 24cm experimental coastal emplacement made by Grusonwerk in 1878. (*NARA*)

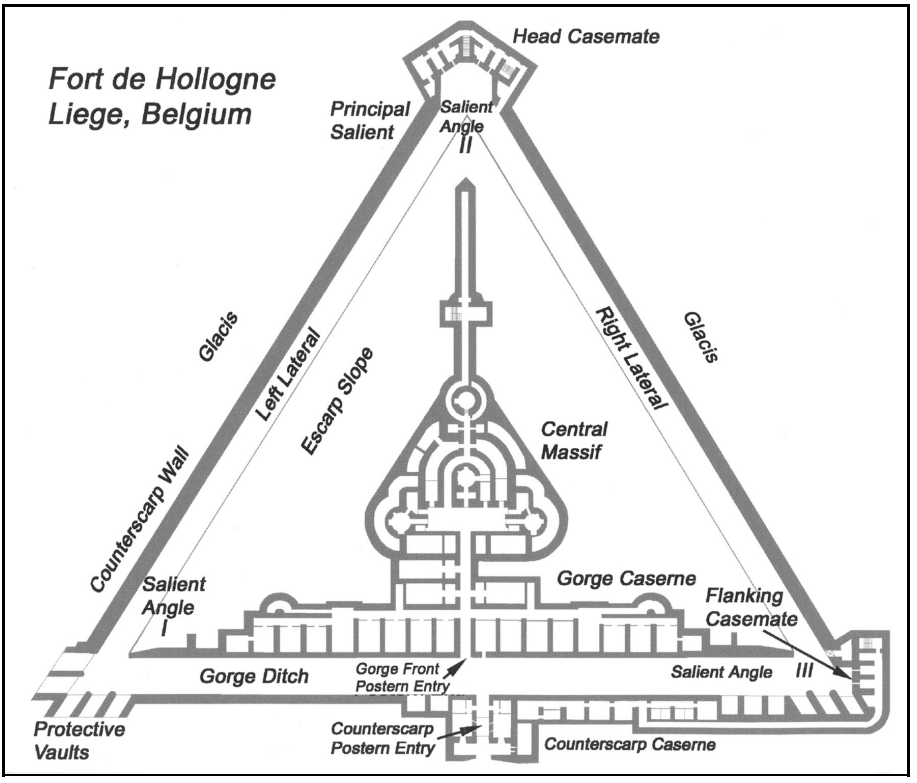
A 28cm experimental coastal battery by Grusonwerk, 1877. (*NARA*)

he called the *Fort de l'Avenir* – a 'fort of the future'. At the time it was as much fiction as Captain Nemo's 'Nautilus' or Cavor's bullet ship to the moon: a concrete monolith sunk into or under the ground, embedded with steel gun turrets and observation cupolas, all connected by underground tunnels. A prototype of Mougin's fort had been built by the Swiss at Fort Airolo, the Saint-Gothard fortified position. Photographs and plans of this fort reveal its stark similarities to Mougin's ideas, although the French did not adopt the model because they preferred not to mix their long-range and short-range guns. However, the French war minister authorized a study of the fort by the *Compagnie des Aciéries de la Marine* (St Chamond). The decision was made to go ahead with a construction prototype at the French testing grounds but then a new war minister was appointed and the scheme was shelved.

General Brialmont may not have been a reader of Jules Verne or H.G. Wells but it is very likely he was privy to Mougin's design; the basis of his central massif, as used in the forts of Liège and Namur, was a concrete monolith embedded with armoured steel gun turrets, connected by underground tunnels. But Brialmont looked for a shape other than the polygon that would optimize the ability of a turret to fire in all directions. His choice was a triangle and that was the basic shape he used for his Forts of the Meuse. It should also be noted that these underground forts resembled landlocked naval vessels and used the latest diesel motors to generate electricity to power the lighting and ventilators and to operate some of the rotating turrets.



A Grusonwerk cast-iron experimental turret for two 40cm cannon. (*NARA*)



Plan of Fort de Hollogne, a small triangular Brialmont fort. (*Author*)

Concrete fortress design was not limited to Mougin and Brialmont. Major Schumann also presented a circular model of a battery for long- and short-range guns, but problems with firing angles along the flanks persuaded him to abandon the idea. Instead he began work on a system that combined a limited number of armoured guns in small batteries, laid out in lines, each battery equipped with guns of varying calibres. A similar system was applied in Romania on the Sereth Line facing the Russian border. Schumann died before his concept could be used closer to home but it was the foundation for the type of fortification built at Metz, consisting of fortified groups of dispersed infantry defensive positions and armoured gun batteries of various calibres. It included mobile 5.7cm gun turrets that could be moved along a trench line to a critical point as needed.

As war approached, the fuse lit in 1870 hissed towards the powder keg of 1914. Whether it was eventually detonated by the assassination of the Archduke in Sarajevo, by the crisis in Morocco or through a naval arms race is not important to this story. What is important is that, even before the Franco-Prussian War was over, the Germans were planning and building for the next campaign, and the French and Belgians soon followed. They built powerful fortress lines, adapted to crises as they arose, and adopted new technologies offered to them. The French

Schumann's design for the 21cm howitzer armoured battery at Feste Manstein, Metz. (*NARA*)

tried to guess where the Germans would attack and, because funds were not endless and doctrines changed with the winds, to decide which forts to modernize and which ones to shut down. All the pieces were in place and the world would soon find out the effects of the struggle for technological supremacy that had taken place over the preceding forty-four years.

The major battles of the opening days of the war in the west fell under the larger heading of the 'Battle of the Frontiers'. This included the Battle of Lorraine on the right, the Battle of the Ardennes in the centre and the Battle of Belgium on the left flank of the Allied lines. In each case the Germans won the initial battle and pursued the retreating Allies over the border into France, and then further and further south until they reached the Marne. In doing so, they came into direct contact with the border forts; garrisoned with a large number of infantry troops and equipped with arsenals of long-range guns, these forts were a dangerous and significant threat and could not simply be bypassed. In every case it was necessary for the German commanders to leave behind a sizeable siege corps to reduce the forts. In the critical early days of September a large number of men and the most powerful guns in the army inventory assigned to the siege corps were occupied with the time-consuming task of compelling the surprisingly stubborn French fortress commanders to surrender, instead of being where they were needed most – on the Marne.

When the French retreated from their failed invasion of German Lorraine in late August, the Germans pursued them and ran into the guns of Fort Manonviller. After the French lost the Battle of the Ardennes, the Germans pursued them past the fortresses of Longwy and Montmedy. On the far left the siege of Maubeuge took place after the French and British retreated from Belgium on their way to the Marne, this coming quickly after the fall of the Belgian fortresses

of Liège and Namur. In late September General Falkenhayn, the new German Chief of Staff, perhaps beginning what would become his obsession with Verdun, ordered an attack on the forts along the Heights of Meuse and the seizure of Fort Camp des Romains at St Mihiel in order to surround and capture Verdun, and to perhaps open up a new eastern doorway to Paris.

In late September the German siege guns, including the 30.5cm and 42cm monsters, headed north to Antwerp and systematically reduced fort after fort to punch a hole in the Belgian fortress ring. Yet even at Antwerp, despite the presence of the heavy guns, the Germans lost men in infantry attacks on well defended positions, just as they had at Liège in the beginning.

Liège, scene of the first siege, would prove to be the most difficult and the most costly test of the German siege strategy. The fortress of Liège had to be quickly reduced in order for the main armies to move out into the open plain of Belgium. The Germans set aside a large besieging army with six brigades and two cavalry divisions to make a surprise attack and quickly capture the city and its ring of forts. They hardly anticipated that the siege of Liège would become a twelve-day ordeal that would cost the lives of thousands of men and delay their march by an undetermined but substantial length of time – a delay that may have cost them the momentum they needed for the ultimate victory in the west.

Belgium, a small country with a small army, saw the opening and closing scenes of the German campaign to eliminate the threats to the rear of their armies as they moved across the country towards France. The struggle started at Liège on 4 August 1914 and ended at Antwerp on 7 October. Both cities would be the undoing of their dual strategies, first to conquer France, and, when that failed, to seize the channel ports in order to gain an advantage out of the ruins of their failure on the Marne. The German high command, both before and during the first weeks of the war, underestimated the will, bravery and sense of duty of the commanders and men who defended 'their' forts and refused to give them up until, in many cases, they no longer had the capability to continue the struggle.

The following inscription was carved in various locations in the forts of Verdun and nearby. It was written by General Michel Coutanceau, the military governor of Verdun from 1912 to 1915, and exemplifies not so much what every member of a fortress garrison actually believed, but the way they would fight to hold on to their position until the end. Unbeknownst to Coutanceau, it applied not only to Verdun (a place that would be severely tested in 1916), but also to the forts of Liège, Namur, Longwy, Maubeuge and Antwerp, to name but a few. It was not so much a suggestion from the general as a definite command:

S'ensevelir sous les ruines du fort, plutôt qu de se render
(Be buried under the ruins of the fort rather than surrender.)

Chapter Two

War Plan Development

There is insufficient space in this volume to address all of the reasons that led to the European conflagration labelled the Great War. But the cause of the war is not the issue; rather this book seeks to understand the reasons why the Germans chose to attack France and Belgium precisely where they did, and how, in doing so, they came into conflict with the French and Belgian fortress lines. We should, however, look briefly at two treaties that steered the French, German and Belgian governments towards the clash that took place in August 1914: the Treaty of London (1839) and the Treaty of Frankfurt (1871).

The Treaty of London was signed on 19 April 1839. It granted independence to Belgium from the Netherlands. Article VII of the treaty required Belgium to remain neutral in any future conflicts. That neutrality was to be guaranteed by the powers that signed the treaty, including France, Germany and Great Britain. Should one of those nations go to war against Belgium, the others guaranteed they would come to Belgium's aid. Seventy-five years later Germany broke the treaty obligations and marched on Belgium. As we will see, when Germany chose to go to war with France, the geography and defences of France and Belgium gave the German planners no other choice but to violate Belgian neutrality.

The Treaty of Frankfurt was signed on 10 May 1871, a few months after William I of Prussia was crowned Emperor of the new German Empire in the Hall of Mirrors at Versailles. Not only had the French been overwhelmed by the German armies on the battlefield, but they were further humiliated by the German declaration of the new empire and the coronation of its Emperor beneath portraits of French kings marching on the Rhine. The final humiliation for France was the loss of a portion of the eastern, partly German-speaking, territories, disputed between the two countries for centuries, and its incorporation into the new German Empire. In Alsace France lost the departments of Bas-Rhin and Haut-Rhin (on the eastern side of the Vosges adjacent to the Rhine Plain), except for the city of Belfort. In Lorraine the French lost the departments of Moselle and one-third of Meurthe, including the cities of Château-Salins and Sarrebourg, and the subdivisions of Saales and Schirmeck from the department of the Vosges.

The new borders pushed the French back from the Rhine and the Saar region. Undoubtedly German memories of the French general Frossard's forces overlooking the city of Saarbrücken from the Spicheren Heights, and of MacMahon's forces at Froeschwiller in 1870, influenced the decision to push the French border to a more defensible position. The French would not be allowed to bring an army that close to a major German city again.

The plain of the Woëvre separated Metz from Verdun, and the Vosges mountains protected Strasbourg and the Rhine plain. Both sides built powerful fortresses to defend the new border. The French forts were strictly defensive, yet, as we will see, the French plan allowed for the flexibility to launch an attack if the opportunity presented itself. The German fortresses were designed to contain the French, while serving as a pivot point around which they would launch their invasion of France.

The Germans were more secure within their new borders, but the French also benefited from the geography of the western side of the Vosges and the Woëvre plain. Paris lay within the watershed of the Marne, Seine, Aisne and Oise rivers that flowed through deep valleys. Further east, the Meuse and Moselle rivers flowed from eastern France into Belgium and Germany. The plateaux to the east of Paris were made of limestone, creating a series of steep escarpments through which the major rivers flowed towards the lowlands in the north. The steeper faces of the escarpments looked towards Germany, creating a series of natural walls that dominated the broad, flat lowlands such as the Woëvre plain. The western faces were gentle slopes extending in the direction of Paris. The crests that rose up from the plateaux provided perfect defensive positions. The French chose to build their fortress lines along the crests to the east of the Meuse and Moselle rivers between Verdun, Toul, Épinal and Belfort. These fortresses defended the roads and railway lines that ran through gaps in the crests.

The Germans had a choice of four possible invasion routes into France. The first option was an attack from Alsace and Lorraine south of Metz, but this was a highly impractical and difficult route. An army crossing into France between Strasbourg and Mulhouse would first encounter the Vosges mountain range with its narrow, twisting roads, steep slopes and easily defended passes, and beyond the Vosges range was the entrenched camp of Belfort, defended by a powerful ring of eleven modern forts. Some 70km north of Belfort was the fortified city of Épinal, surrounded by a dozen forts. At the northern end of French Lorraine lay the fortress of Toul, with a ring of twelve forts, and Verdun, the most powerful entrenched camp in the French system with twenty forts. The defences of these four places also included dozens of interval infantry positions, shelters and gun batteries; twelve additional forts linking the four entrenched camps and defending their intervals were placed along the crests of the Meuse and Moselle escarpments between Belfort and Verdun. Four of these forts rested on the Haute Moselle and seven on the Heights of the Meuse.

The town of Charmes occupied the centre of a gap between the fortifications of Toul and Épinal. The 70km gap was a strategic, rather than a geographic, feature. Its role was to lure the enemy into a lightly defended area, where their flanks could then be attacked from both north and south. Fort Manonviller was the only fort in the undefended zone. The forts of Épinal to the south and Toul to the north, including Fort de Bourlemont southwest of Toul, prevented the encirclement of Toul and drove the attackers towards the defences of Langres. To the east of Toul were the Heights of the Grand Couronné of Nancy, a ridge defended by Fort de Frouard and the Batterie de l'Éperon. The Grand Couronné