

WHAT KEPT THE TANK FROM BEING THE DECISIVE WEAPON
OF WORLD WAR ONE?

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Military History

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ABSTRACT

WHAT KEPT THE TANK FROM BEING THE DECISIVE WEAPON OF WORLD WAR ONE? by Brian A. Pedersen, 95 pages.

The modern tank was invented in 1916 as a means to mechanically overcome the stalemate of trench warfare brought on by the increased lethality of fires employed during World War I. Its introduction received mixed reviews among British leaders. Some advocated its continued role supporting infantry and artillery attacks. Others envisioned it as a revolutionary weapon with the potential to effect decisive results at an operational and strategic level. Still others viewed it as a useless and unnecessary drain on already-scarce resources of men and materiel. Ultimately, the tank was an ancillary sideshow and failed to produce a decisive knock-out punch leading to Allied victory in World War I. The purpose of this paper is to examine the reasons why the tank failed to become the decisive weapon of World War I. It specifically focuses on the genesis of logistics, maintenance, training, and production infrastructure, studying the interaction of development, employment, acceptance or lack thereof, and subsequent frictions which negatively influenced the ascent of tanks as the decisive weapon of World War I. By examining the British efforts to design support systems while simultaneously producing, fielding and employing multiple iterations of the tank, this paper seeks to promote a deeper understanding of the potential challenges facing other armed forces that are rapidly upgrading or replacing combat systems in the midst of the Global War on Terror.

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ACRONYMS

ASC	Army Service Corps
FCS	Future Combat System
FSR	Field Service Regulation
GHQ	General Headquarters
MT	Mechanical Transport
R.A.S.C.	Royal Army Service Corps
US	United States

CHAPTER 1

INTRODUCTION

Enter the Landship

The Great War introduced the world to the horrors of modern conflict on a scale then unimaginable. Trench warfare added a new dimension as it robbed all the pugilists of decisive offensive maneuver, forcing armies to dig expansive complexes, turning virtually every mile of defended line into strongholds. Great Britain, embroiled in the quagmire on the Western Front for nearly two years and unable to generate successes on other fronts, made the first substantive contribution to the Allies in breaking the stalemate. Having tried and failed to overcome the problem with new techniques, changing tactics and massed manpower, the British turned to technology as a solution. As early as December 1914, British ministers, soldiers, and scientists began the critical process of combining available technologies in a novel. In 1915, the British unveiled the results of their labors: a revolutionary new device bearing the innocuous moniker “tank” to confuse would-be spies.¹

The name persevered and still commonly evokes a vision of clanking steel and thundering cannon. The tank’s initial capabilities comprised the mechanical means to defeat the static and impregnable trench defenses on the Western Front: a mobile and armored firepower platform able to defeat German machine gun nests, allowing allied forces to penetrate and engage in offensive maneuver warfare.²

After a rapid prototype development and testing program, the first tanks made their appearance in 1916 on the French fields of Flanders. Over the next two years, tanks would see action up and down the Western Front, never providing the decisive blow for

victory, but nearly always showing a glimmer of what might be possible. Eventually, the capabilities exhibited by the tank would usher in a new era of ground combat, with machine versus machine in an unmerciful clash on the battlefield, each posturing for the upper hand. However, in 1916, another clash was already underway, between conflicting ideologies of how tanks would be deployed on the battlefield, and how they fit in with the large infantry-based armies of the early 20th century. This clash became epic as well, lasting for over twenty years until the Germans resolved it, leaving little room for doubt with their lightning tank offensives at the outset of World War II.

First introduced at the Battle of Flers-Courcellette on 15 September, 1916, the tank made an inauspicious start as reliability and mobility issues plagued early tank models. Of the forty-nine tanks originally slated for the attack, seventeen suffered mechanical failure enroute to the front lines and another fifteen broke down or were abandoned before departing the launching point. The tanks that did enter the fight made a somewhat successful, although localized impact on the battle, striking fear in the enemy and allowing the Allies to advance over 2 kilometers, an impressive gain at the time.³

The Battle of Flers-Courcellette exposed a number of other drawbacks beyond reliability and mobility. These include survivability, visibility, speed, and ease of operation. Later tank versions produced before the end of World War I would address these technical issues.

The next major use of the tank came at the Third Battle of Ypres (Passchendaele), beginning on 31 July 1917. After unseasonably rainy weather and ten days of preparatory artillery bombardment (which subsequently destroyed area drainage control), the terrain became impossible for the tanks to cross, marginalizing their usefulness in the battle.

Troubles with maintenance and mobility persisted. While the sheer number of tanks at the battle reflected an overt commitment to the development and continued use of the tank, covertly a lack of faith in its usefulness plagued many elements of the allied leadership. The results at Passchendaele merely confirmed what many already believed to be true: The tank was a secondary weapon at best, until further technological advances might enhance performance and relevance. The Germans quickly identified the tank's shock value, but also recognized the substantial weaknesses they could readily exploit. Heavy rifles, massed indirect- and direct-fire artillery, and tank ditches all proved capable of disabling or destroying the tank. Additionally, the lack of wireless capability or external field telephone inhibited flexibility, initiative and often the most basic command, control, and coordination. Because of these perceived weaknesses, the Germans grew to despise the tank, failing to realize its worth until very late in the war, when their own mechanized development program had fallen too far behind to make an impact.

Action at Cambrai in November 1917, marked the first time where tanks were massed as a pure fighting element, not subjugated to the role of providing support to enable infantry maneuver. Later successes in battles at Le Hamel and Amiens prompted a more vigorous review of the expanded possibilities of tank and armored warfare.

Foreword-thinking officers began to envision how tanks, armor, and mechanization en masse might manifest themselves in future wars. Yet, that "future" had many different meanings to each of the officers, depending upon their predispositions, country, their military education, and upbringing. Some saw it merely as a tool to break the stalemate so the infantry-centric armies could get back to the business of maneuver warfare. Others saw it as a way to operationally extend the battle space vertically, creating chaos and

confusion in depth while disrupting synchronization. Still others saw it as a way to larger and decisive strategic engagements, striking deep at the heart of their enemies for a rapid and glorious victory. In those formative early years of the tank, many opportunities arose for innovation, free thinking, and adaptation. France, Great Britain, and the United States all took a turn at making the leap into modern warfare. Adaptation and improvisation occurred during the latter years of the war but their impact on the war's outcome is highly questionable at best.

The introduction of the tank at this seminal moment was supposed to have led to a decisive victory on the battlefield, thus shortening the war. Yet it did not. In retrospect, and under the right conditions, this revolutionary weapon should have provided an insurmountable technological overmatch against the Germans. What kept the tank from being the decisive weapon of World War I?

Many factors contribute to the successful development, fielding, and employment of a new weapon. Systems or programs to provide the infrastructure, equipment, manpower, training, maintenance, and logistical needs for organizations are prerequisites for such success. Much the same in 1915 as in 2007, armies and their civilian enablers must have a common vision in order to implement change. For various military and civilian enablers, the list of potential obstacles was long: the tank was complex, expensive and revolutionary, in a time of relative simplicity, war-induced economic crisis and cultural narrow-mindedness. Where did its production fit into the overall war plan? What would be the resulting friction points regarding resources and priorities? What forethought did developers give to creating a maintenance program capable of sustaining tank use? How did they derive the factors for materials, mechanics, and repair facilities?

How would the tank be integrated into the order of battle to ensure its mobility and survivability? Would it be equally accepted across the commands? What would be the methodology for commanding and controlling tanks--both within their own formations and as part of the total battle? How did training evolve to suit the unique needs of the tank corps? Who would take the lead? What would be the personnel and manning challenges, and how would they be overcome in the face of personnel demands across all the fronts? How much thought and constructive energy was placed in developing a logistics program for the tank? How would it be deconflicted with other force logistic requirements? What would tank doctrine and tactics look like on the battlefield? Would the Royal Navy, the proponent and bill payer for most of the tank program, have a significant part to play in determining the tank's battlefield role? Finally, had planners prepared for rapid adaptation and escalation of tank production based on what would undoubtedly be learned from each successive battle?

The main purpose of this study is to provide a better understanding of how the prerequisites--training, maintenance, and logistics--were addressed by the enablers and if their development or lack thereof subsequently prevented the tank from being the decisive weapon of World War I. The study moves chronologically with each chapter exploring the tank's evolution over a finite period. Chapter 2 covers the inception of the tank from notion to testing, production, initial doctrinal concepts, and concludes with its opening performance at the Battle of Flers.

Chapter 3 picks up immediately following the British Army's first swing at mobile warfare. It covers the first major design revisions based on actual battle performance. Feedback from the army is reviewed to determine what if any changes were

implemented to facilitate logistical support. Doctrine and tactics are tracked for significant changes in employment as well as changes in leader attitudes. The Battle of Cambrai provides a good point of summary for allied accomplishments, as innovators continue to work at making the tank decisive for overall victory.

Chapter 4 tracks progress of the tanks in light of significant German offensives in spring 1918. It reviews the lessons learned from Cambrai and how they affected all further tank developments through the end of the war.

Chapter 5 sums key points as well as providing retrospective overview and analysis of J. F. C. Fuller's concept for a massive tank raid into Germany, Plan 1919, in relation to the condition of the prerequisites (maintenance, logistics, and training) at war's end. Was his lightning strike into Germany feasible? Would it have presaged the successive knock-out punches that Adolf Hitler's Panzer Divisions executed in 1939 and 1940?

Review of Major Literature

Development and use of the tank in World War I is a much debated subject in scholarly literature, specifically among those who closely study the British Army of the period. Most often debated among historians is whether individual personalities, civilian attitudes, military cultures, political realities, elitism, or some combination is the key factor determining the development and application of new technologies, doctrine, and tactics during World War I. Bookshelves are filled with analyses of the how's, why's and when's of these factors, each author proclaiming their specific codification of factors most strongly influencing the military technology advances of World War I, their employment and subsequent adaptations. In *The Killing Ground* (1987), Tim Travers

sums up the various schools of thought aptly.⁴ Those who view critically the performance of allied military leadership during the War favor the internal factors of incompetence, arrogance, inflexibility, or cowardice within the senior officer ranks. The perception of cowardice is still widely circulated even in the face of evidence showing the high casualty figures for senior allied officers during the war. Military historians such as B. H. Liddell Hart ascribe to the school of flawed personalities and attitudes. Within *Reputations: Ten Years Later* (1928), Hart describes General Sir Douglas Haig, Commander of British Expeditionary Forces for most of the war, as being far from genius, lacking vision, unreceptive to ideas (novel or otherwise) and obstinate.⁵ Historian J. P. Harris states in *Men, Ideas and Tanks: British Military Thought and Armoured Forces, 1903-1939* (1995), military culture is the root cause of opposition to the tank.⁶ He cites numerous high-ranking officers within General Headquarters of the British Expeditionary Forces who actively opposed through words and actions the development and expansion of mechanical warfare, either as a threat to the traditional branches' (Infantry, Artillery and Cavalry) resources, role, or prestige.

The second school of thought, emerging primarily through the British military's official collection of war history serves to absolve allied leaders for the carnage, citing external factors as the culprit. Inexperience among staff officers, the failure of new technology to provide its promised results, German fighting acumen and political interference are the leading reasons listed in this school of thought. British Chief official historian Brigadier General Sir James Edmonds was the key advocate of this school, and has gathered a large contemporary following. In agreement is historian David J. Childs, *A Peripheral Weapon* (1999).⁷ He makes a compelling argument for widespread military

and political support for the tank program, with the weak link being the technology itself. Most other historians fall somewhere in the middle of the two schools. Travers ascribes to a combination of personalities, social conservatism, and political culture. Robert H. Larson, *The British Army and the Theory of Armored Warfare, 1918-1940* (1984) points to outdated views on strategy crippling British tank development, and alludes to causes somewhere between the two schools.⁸ The truth as I see it lies as always somewhere between the seams of each major school of thought. Attitudes and culture had major effects on decisions. Poor staff training crippled situational understanding and decision making at the highest levels. Technology, or actually lack thereof with communications and mechanics in the face of advances in firepower and lethality left a dangerous void within command and control.

The introduction of the tank at this crucial moment could have led to a decisive victory on the battlefield, if not for a myriad of variables, controllable or otherwise, standing in the way. In retrospect, and under certain conditions, this revolutionary weapon might have been the modern warfare parallel to the invention of gunpowder. However, in Great Britain of the early 20th century, the vision was not quite as clear as it is today, and the millions of lives lost in the last two years of the Great War are a solemn testament to the failed vision.

¹J. P. Harris, *Men, Ideas and Tanks: British Military Thought and Armoured Forces, 1903-1939* (Manchester: Manchester University Press, 1995), 51.

²Kenneth Macksey, *Tank Warfare: A History of Tanks in Battle* (New York: Stein and Day, 1971), 27-8.

³*Ibid.*, 35.

⁴Tim Travers, *The Killing Ground: The British Army, the Western Front and the Emergence of Modern Warfare, 1900-1918* (London: Allen and Unwin, 1987), 130-5.

⁵B. H. Liddell Hart, *Reputations: Ten Years Later* (New York: Books for Libraries Press, 1928), 103, 124-7.

⁶Harris, 159-163.

⁷David J. Childs, *A Peripheral Weapon? The Production and Employment of British Tanks in the First World War* (London: Greenwood Press, 1999), 5-6.

⁸Robert H. Larson, *The British Army and the Theory of Armored Warfare, 1918-1940* (Newark: University of Delaware Press, 1984), 20-32.

CHAPTER 2

EVOLUTION OF THE TANK THROUGH SEPTEMBER 1916

To truly understand the tank's failure in bringing about decisive victory, one must know how and why the tank came into existence, as the process directly affected its lack of success. It not only began inauspiciously, but very nearly failed to launch. Only through the concerted efforts of determined visionaries did the tank make it from science fiction to operational fact. These visionaries had to work within the existing cultural and societal constraints of early 20th Century Great Britain with its often rigid Edwardian mind-set. Yet, the visionaries brought with them experiences from other military branches, prior wars, and civilian services which allowed them to see the problem in a slightly different light than those immersed in the daily strife of trench battles. Near-heroic efforts enabled production, but could not overcome the early training, maintenance, and supply issues. Moreover, infighting over control of the tank which, once endemic, was difficult to overcome. Likewise, tank doctrine and tactics suffered from the same infighting, leaving the tank on a dense intellectual battlefield as it rolled across the line of departure for the very first time on 15 September 1916, in Flers-Courcelette.

A working background of tank genesis is necessary in order to fully analyze the support systems that influenced the tank's performance. Though keeping track of significant dates and activities during this stage lends additional reference, of greater importance is understanding the mindset of key players and the organizational frictions which directly affected decisions regarding tank support infrastructures. Indeed, many great men contributed thoughts, imagination, and improvements to what eventually

became the tank. However, five men stand out above all others for their contribution in visualization, action, and tenacity to bring the tank to fruition. They were the pioneers: Major General Sir Ernest D. Swinton, Sir Winston Churchill, Mr. Eustace Tennyson-d'Eyncourt, Squadron Commander Thomas Hetherington and Lieutenant Colonel Sir Albert Stern.

Pioneers

Arguably, the tank was the brainchild of Swinton, the first acknowledged champion of tank development. As a pioneer (combat engineer) officer during the Boer War at the turn of the century, Swinton witnessed first hand the destructive capability of a well-managed machine gun. This experience became a preoccupation, causing him to measure all subsequent warfare against it:

So far as I was concerned in this growth, the conception of the Tank was the direct result of the association of a particular piece of knowledge with a particular frame of mind. This frame of mind was a mild form of obsession which had come upon me years before the Great War and had been intensified shortly before it broke out.¹

After the general mobilization in 1914, then Colonel Swinton found himself as the Deputy Director of Railroads. Closely following the onset of hostilities, the War Office selected Swinton, an accomplished author, to go forward and report on activities from the Western Front. Plagued by negative press accounts and growing discontent in England, Secretary of War Lord Horatio Kitchener needed more favorable news coverage of actions from the front. Upon Winston Churchill's personal recommendation, Kitchener requested Swinton to act as Britain's official press representative. Swinton's observations of wholesale slaughter caused in large part by concentrated machine gun and small-arms fire reinforced his experiences from the Boer War. More importantly, by the first week of

October 1914, Swinton began to formulate a concept for overcoming the tactical stalemate. He envisioned a vehicle with caterpillar tracks capable of moving across broken terrain, crossing ditches, crushing obstacles, and defeating machine gun nests. Several times over the next eight months, Swinton promoted his idea among various factions within the British military establishment. His ideas met no immediate success though he did plant seeds in the minds of enough key people that eventually sprouted when the conditions were right. Knowing the Royal Artillery had ordered caterpillar-tracked general purpose Holt tractors to test as artillery tow vehicles, on 1 June 1915 Swinton drafted a concept paper entitled “Armoured Machine Gun Destroyers (General Description)” which laid out the capabilities, general specifications, and possible application based on the Holt chassis.² After several false starts at presenting his concept to higher officials and initially being turned down by Kitchener,³ Swinton finally received fair hearing, and the tank was born.

The concept of mobile armored machines was not new to war. The Italians had adopted armored cars as early as 1911, and had used them during the Turko-Italian War. Early in World War I, the Admiralty formed the Royal Naval Armoured Car Division around the Rolls Royce Silver Ghost Chassis. Its squadrons were to protect friendly airfields from attack and rescue downed fliers.⁴ During their initial push through France, the Germans constantly demolished roads to hamper wheeled vehicle movement. Unknown to Colonel Swinton on the Western Front, Winston Churchill, then 1st Lord of the Admiralty, was concurrently exploring ways of overcoming the demolished roads plaguing his armored car squadrons.⁵ Having observed large caterpillar tractors tow heavy artillery across broken terrain, Churchill formulated a grand idea. He worked with

Admiral Reginald Bacon, general manager of Coventry Ordnance Works, a naval gun contractor, to develop plans for a large armored vehicle on caterpillar tracks capable of deploying and recovering its own bridge apparatus.⁶ This early attempt at building a kind of tank failed due to the prototype's inability to meet mobility requirements (trench-crossing and water-fording), but failure did little to dampen Churchill's spirit for innovation. After reading a paper drafted by Swinton's immediate supervisor, Colonel Maurice Hankey, Churchill wrote his own letter to Prime Minister Herbert Asquith extolling Swinton's ideas for the machine gun destroyer. Asquith forwarded the idea to Lord Kitchener with a request for favorable consideration. Despite his earlier reservations, Kitchener allowed the concept to move forward to the Ordnance Office for review. However, initial review by "experts" in the Office of the Master General of Ordnance severely criticized the idea. Churchill, believing strongly in the concept, formed his own organization, called the Landship Committee, to pursue research and development for the new weapon. He directed Eustace Tennyson-d'Eyncourt, Chief Constructor of the Navy, to run the committee and its tests. The committee began testing on eighteen experimental vehicles. Six of the vehicles were wheeled, representing evolutionary progress from the existing armored cars. Twelve of the vehicles were tracked variants, representing a revolutionary leap forward in battlefield technology. The Landship Committee worked with both concepts not knowing exactly where they would lead but believing in the dire necessity to succeed.⁷

Churchill chose a long-time acquaintance, then Lieutenant Albert Stern, to assist the Landship Committee. Stern worked in private industry prior to general mobilization and was one of the leading minds in the development of armored cars used to secure

Royal Naval Air Force airfields. He too saw the drawbacks of his lightly-armored wheeled cars and lorries and thought a better way must exist for armored cross country travel.⁸

What followed next defined the tank's early production phase. The War Office engaged in an ongoing battle to wrest control of the tank from the Ministry of Munitions. In typical Edwardian fashion, the War Office held that established lines of authority could not be crossed. The Ministry countered that, as the originators, its personnel should continue oversight and production until a completed vehicle could be supplied en masse to the army. It took the direct intervention of Sir Lloyd George, then Chancellor of the Exchequer responsible for financial and economic matters of the state, and the newly appointed Minister of Munitions, to resolve the dispute.⁹ Even so, many more seemingly trivial issues, such as infighting within the Ministry itself, plagued the process. It was only through the combined efforts of Stern, Swinton, and Churchill, that they were able to overcome the deeply entrenched cultural biases and societal affectations preventing manpower, resources, funding, and government support from flowing to the tank development project.

Societal and Cultural

One of the most pervasive challenges faced by the champions of the tank was the deeply ingrained cultural and societal biases. British commanders, being officers of the line (infantry or cavalry) did not attend technical schools; nor did they normally hold degrees in science. They were raised in the British Army's regimental system which rewarded duty, honor and, above all, loyalty, though not necessarily brainpower.¹⁰ These

“old school” types feared technology and loathed officers not from their branch and regiment, or who proposed change to the status quo.

[T]echnical organizations in the armies were not held in high esteem and their activities tended to be emasculated or ignored by conventional General Staff Officers who believed in the sanctity of personal combat. In most armies the ruling clique were cavalry or infantrymen while the technologists were drawn from the artillery, the engineers and the random handful who had become involved with mechanized transport vehicles. The former were out of their depth in technology and mistrusted the technologists, who, frequently in desperation, were impelled to cause friction with a ‘hard sell’ for their wares.¹¹

As neither Swinton, Churchill, nor the other pioneers fit into a well-defined military clique, they found it very difficult to advance the idea of the tank. Not only was it a challenge to the resources available for other war fighting necessities, it also challenged the very importance of the cavalry and infantry branches in war.

Additionally, individual personalities, social conservatism, political realities, and elitism stood in the way of the tank making its launch, thereby influencing its eventual success or failure. Turning a blind eye to advances in technology, British Army commanders refused to see that “for some time, warfare had been assuming quantitative aspects, but in the period 1900-14 most British senior staff and officers still conceived war to be essentially qualitative, i.e. human centered.”¹² This refusal to grapple with modernization spawned an entire generation of officers unwilling to seek any alternative to massed infantry attack supported by artillery. The general lack of trust and adherence to tradition crippled even non-technical efforts at modernization. One example was the British Army’s conversion to the khaki uniform in 1902, decades after its origin in India, but now unsuited to the changing nature of battle.

Unfortunately, it proved difficult for the “technologists” to overcome biases and gain favor for developing the tank. Lord Kitchener, Chief of British Forces, was still

wedded to 19th century tactics. He did not see a need for a machine to overcome battlefield stalemate and dismissed the idea when posed to him.¹³ Colonel Swinton, while promoting his original ideas with superiors, was once advised to “descend from the realms of imagination to solid facts.”¹⁴ This criticism characterized the common perception that technology had little to add to an army manned with well-trained infantry and equipped with an unbreakable will. Indeed, even at the highest levels, technology was still discounted as leaders learned the wrong lessons from successive battles. General Sir Douglas Haig, Commander of the British Expeditionary Forces in France, while discussing the outcomes of various battles had the following comment:

In short, the longer the war has lasted, the more emphatically has it been realized that our original organization and training (focused on musketry and bayonet skills) were based on correct principles. The danger of altering them too much, to deal with some temporary phase, has been greater than the risk of adjusting them too little.¹⁵

Sir Ian Hamilton, Commander-in-Chief of the Mediterranean Expeditionary Forces, provided his assessment on the stalemate of trench warfare by saying:

for this trench warfare no great technical knowledge is required. A high moral standard and a healthy stomach--these are best.¹⁶

Even with these firmly ensconced attitudes to battle, Churchill continued his crusade. After the War Office refused to fund and support his so-called folly, Churchill ordered independent procurement, production, and testing of a prototype, fully manned and paid for by the Admiralty. His continued efforts to push for tank development were the primary impetus which led to the War Office finally signing on to the project.¹⁷

Simultaneously, the War Office focused its attention on the machine gun. Supporters of the machine gun claimed it could have maximum effectiveness only by being removed from general purpose troops, namely the Cavalry and Infantry, and being

consolidated in a specialized organization controlled at division and brigade level. General Headquarters' focus on the new machine gun formations diverted much attention from talk of a machine gun destroyer that had been raised by "technologists" in the rear. Ironically, this new Machine Gun Corps, formed over the strident objections of the two aforementioned branches, and posing a risk to funding and resources for the tank project, eventually became the tank's parent organization.¹⁸ The unique organizational construct that isolated the Machine Gun Corps and its tanks from units of the line proved crucial. In conjunction with the collaboration of army and navy technical experts, separate evolution allowed tank units to take on their own persona and develop an atmosphere receptive to technology, adaptation and innovation.

Naval Influence

Churchill not only provided the political push to enable tank development, he also provided the initial planning staff, funding, facilities, contractors, and manpower. Squadron 20 of the Royal Naval Armored Car Division was deactivated as the War Office assumed total control of all land operations and initiatives. Sailors from the division were scheduled for transfer to the Army or Air Force in support of general combat. Churchill fought to maintain the division's sailors under his control as a testing and evaluation unit for the tank.¹⁹ The War Office approved his request in July 1915, allowing Churchill to continue dabbling in land warfare experimentation. The armored car units provided more than just raw manpower to the tank effort. They also provided intelligent, imaginative leaders able to provide substantive input to the direction of the tank. Already imbued with wartime armored car experience, Squadron Commander, and later Major, Thomas Hetherington provided the giant-wheeled land cruiser concept--a

virtual battleship on wheels--capable of traversing rivers, trenches, and demolished roads while simultaneously taking out enemy railways, strong points, and artillery. The tank eventually seen on the World War I battlefield possessed many of the capabilities envisioned by Hetherington.

In July 1915, as the War Office saw the fruit born of Churchill's project, it enacted a power play. All land warfare inventions (most notably the tank) and ownership of Squadron 20 were taken over by the War Office. Churchill again played a crucial part in negotiating his Landship Committee into the mix as the primary action committee. With personnel, plans, and activities intact, the Committee maintained momentum in moving a product closer to combat deployment, now with full support and coordination of the War Office.²⁰ Intuitively, one might believe this continuity would assist the tank in meeting its full potential. In one way, design benefitted, for testing and early production left intact key players and supporting agencies. However, constant bickering over control potentially caused the committee to "lose the bubble" on some of the other supporting infrastructure requirements of a complex mechanical system. With heavy emphasis on production, early planners neglected key elements of sustaining the tank force such as maintenance, logistics, and training.

Early Production

By early 1915, Churchill had started most steps for experimentation and evaluation. He actively worked to consolidate efforts with the War Office, both for gaining a wider acceptance of the tank as a viable weapon, and for priority of funding and resources. Meanwhile, Colonel Swinton was appointed as the Deputy Secretary to the Committee of Imperial Defense. By December 1915, Swinton pushed for and secured

from the Imperial Defense Committee a commitment for future tank production. He was given authority to effect direct coordination with industry and other governmental agencies as well as locate and secure a number of able-bodied troops to crew and test the tanks. Concerned with manpower and industrial capabilities, in January 1916, Tennyson d'Eyncourt recommended a full complement of prototypes be ordered "as is" in order to keep production moving forward.²¹ Following several successful demonstrations to highly placed military and civilian officials, the War Office agreed to the production of one hundred tanks. Even in its infancy, the tank garnered rave reviews, such as those from Third Sea Lord, Rear Admiral Tudor, that there was "no limit to the development . . . except the cost."²² Unfortunately Tudor's prescient statement became a recurring theme as other wartime issues such as raw materials, manpower, and weapons shortages continued to relegate tanks to the bottom of the pecking order.

Meanwhile, Churchill and his subordinates continued to consolidate gains in favor of tank development. He convinced the War Office to allow the Admiralty continued oversight over tank development to ensure continuity. However, the Minister of Munitions would retain responsibility for supply, materials, and infrastructure for production. This situation quickly led to a variety of frictions. First, Churchill's project was a close-held secret within the British government. Very few officials knew of its existence. On more than one occasion secrecy led to mix-ups where the Landship Committee, now known as the Tank Supply Committee, would be directed by government officials to move out of their facilities, have their material orders cancelled, or be asked to provide services they did not perform. Moreover, since so few knew of the project and even fewer were willing to support it openly, aircraft and rail truck

production both earned higher priorities than tanks, stripping off valuable resources like aluminum and tempered steel.²³ Again, fate intervened on behalf of the project. In March 1916, Colonel Swinton's appointment as head of the newly formed Heavy Section, Machine Gun Corps, later to become the Tank Corps, allowed him to address and overcome the priority problems, materiel shortfalls, and infrastructure support issues.²⁴ His efforts proved vital in moving the tank closer to actual employment in combat. Still, Swinton faced serious hurdles, including ongoing technical challenges, infrastructure requirements, and tactical integration questions.

Training

Early on, the pioneers recognized the need for well-trained, capable troops to man and fight the tanks. Churchill's initial solution was to draft Squadron 20 in totality to provide the manpower necessary for testing and evaluation. In coordination with Churchill, Colonel Swinton pursued a corresponding initiative in December 1915. Its approval gave Colonel Swinton the ability to "raise a body of suitable men to crew the tanks."²⁵ During that same month, Tennyson d'Eyncourt pleaded with the War Office to order an additional ten tanks for training purposes.²⁶ This action shows a realization among the development team that the tank was a complex system and would require a new methodology--a paradigm shift--in training, manning, and support. Swinton further explained the need to exercise freedom in locating and hand-picking officers and soldiers with exemplary leadership capabilities and pronounced mechanical skills.²⁷ These men would become the nucleus of the new Tank Corps, defined by innovation, technical adaptation and panache.

Swinton and his cadre of like-minded officers actively sought officer cadets with mechanical aptitudes, specifically from the 18th, 19th and 21st Royal Fusiliers, for grooming into the ranks. Swinton personally interviewed young officers prior to their acceptance into what they believed to be a new armored car section of the Motor Machine Gun Corps.²⁸ At Bisley, England, Swinton established his new headquarters and began crew and maneuver training, commencing from March through June 1916.

Initially, the training comprised of both individual and collective training and was tied closely to tank production. Without any tanks for training, Swinton became an innovator. He personally designed a specialized tank driver simulator which replicated the challenges of traveling across difficult terrain.²⁹ While the simulator never enjoyed application, its use marked a continued effort to break away from traditional methods and practices such as close order maneuver and bayonet drills and create a unique character for tank units. Swinton also procured machine guns from the Ministry of Munitions and six-pounder naval guns from the Navy. These were in near-constant use by the soldiers, because “with the above exception, physical drill and an occasional route march, no further training of military character was imposed; thus in the early summer of 1916 practically all the personnel of the new branch of the service were efficient in the manipulation of the guns in question.”³⁰

While the training camp began to ramp up for training the expected influx of soldiers, the War Office doubled its original tank order, asking instead for 200 total tanks: 50 for training and 150 for combat. This demand would complicate matters of training proficiency as some young engineering officers, NCOs, and soldiers were pulled out of training to assist with tank production. Additionally, General Haig had pushed hard to

add tanks to his Somme offensive of 1 July 1916. The friction between production and training resulted in personal projections estimated at only seventy-five trained crews ready by 1 August 1916, at the earliest, too late to make the initial push on the Somme.³¹ There is agreement among many historians that Haig's push to include tanks in the Somme Offensive prematurely exposed the Germans to the technology and weakened its effectiveness in later battles.

Swinton established new tank training and proving grounds in Elveden near Thetford Woods, where more maneuver space and a more secret atmosphere could be maintained. Drivers now focused their training more on the actual conditions they might face on the battlefield. Soldiers began using luminous tape as a method to mark nighttime tank positions. Tank ground guides now wore electric lights on their backs to help signal drivers under low visibility conditions.³² Tank instructors combined with the tank designers to resource and prepare more realistic training with a twofold purpose: better preparing the crews for eventual combat, and identifying necessary tank modifications for future production runs. Without the tank ever being used in combat, this task would prove difficult and lead understandably to technical and tactical changes following Flers. However, there was a reasonable idea what conditions might be and instructors worked to replicate them as closely as possible. A great example was meticulous work under the direction of then Captain Martel.³³ He and his team of pioneers constructed an exact replica of a French trench complex on Lord Iveagh's estate grounds outside Elveden to enable crews to conduct realistic training.³⁴ Other training events over this same period included tank camouflaging and signaling. Swinton enlisted the aid of experts within the army to teach his troops these as well as other critical tasks. While this training

undoubtedly helped prepare crews for basic firing and maneuver, it could not replicate actual combat. Early crews likely had little idea what to expect when they first attacked at Flers. Likewise, from the number of tanks abandoned in early battles, a certain mindset probably existed where some tank crews felt more affinity to their local infantry than the Tank Corps, and were more willing to fight a familiar battle on the ground than try to repair their tanks. However, Swinton worked to minimize this phenomenon at every turn.

The challenge of meeting now burgeoning manpower requirements was not lost on Colonel Swinton. Realizing the enormity of his manpower and training problems, he looked to alternative solutions. One such solution was to transfer entire units of Royal Marine Artillery into the Heavy Branch, Machine Gun Corps. The rationale was that they were comfortable with heavy machinery and more mechanically inclined. They could be trained more quickly than the average soldier or new recruit, allowing them to be fielded in combat more quickly. To be sure, they were not being fully utilized in their current capacity. It is difficult to ascertain how effective this measure was, considering the competing issue of tank production. Some evidence shows tank crew members taking complete ownership over their tank's maintenance and upkeep, not allowing anyone else to perform repairs or conduct operations on it. One might conclude the hand-picked soldiers and leaders generally enhanced the speediness of employment. Regardless, forty-nine of fifty available tanks departed for combat on the morning 15 September 1916, fully manned and ready.

In June 1916, the Heavy Branch, Machine Gun Corps, consolidated its training efforts at a new facility in Bovington, southwest of London. Bovington Camp would grow and eventually become the British Army's permanent armor center, training many

of the thousands of soldiers who manned and supported the tanks during World War I. It is tempting to limit the scope of training to tank crews and their mundane tasks of driving, gunnery, maintenance, and the like. However, of equal importance was the coordinated training between the tanks and the supported (or supporting) infantry and cavalry. General HQs believed this as shown below:

GHQ's 'Preliminary Notes' on the use of Tanks issued in mid-August 1916, stressed the vital importance of such training. In what appears to have been a covering letter to these 'Notes' General L.E. Kiggell, Chief of the General Staff, made it clear that he understood the limitation of the Tank and the importance of combined training. The objectives of the Tanks must be clearly stated and as simple as possible, as it is difficult for the Tanks to maneuver...It will be necessary to specifically train the divisions who may be earmarked to work with the Tanks.³⁵

Although commanders realized the value of this training and earnestly believed all efforts should be made to conduct it, the reality was very little training between infantry and tanks prior to the battle at Flers-Courcelette. Time constraints, lagging production, and the emphasis on secrecy precluded any comprehensive training events.

As one of the new tank commanders noted:

The Tanks did not arrive till the last minute, and I and my crew did not have a Tank of our own the whole time we were in England...as our Tank went wrong the day it arrived...Again we had no reconnaissance or map reading, no practices or lectures on the compass. We had no signaling and no practice in considering orders...We had no knowledge of where to look for information that would be necessary for us as Tank Commanders, nor did we know what information we should be likely to require.³⁶

Surely, this set of circumstances must have lessened the effectiveness of the tanks in that first foray. Further, the tanks' relatively minimal impact on battle outcome may very well have "poisoned the well" with many influential figures in the government and General Headquarters (GHQ), with the result that tanks never received the full measure of across-the-board support necessary to establish supporting infrastructure for sustained combat.

The subsequent cascading effect on maintenance, logistics, and tactics might well have been the essential mechanism in the undoing of the tank as the decisive weapon of World War I.

Maintenance

The 1915 Army motorized vehicle maintenance system involved three major sub-categories: recovery of inoperable or incapacitated vehicles; repairs made forward by skilled workmen; and the availability of spare parts. The concept for all three sub-categories was not new in the British Army. Assets and systems for each area existed long before the beginning of the war. Conversion to meet the challenges presented by the tank involved efforts of scope and scale.

The Army Service Corps (ASC), Mechanical Transport (MT), owned all motorized land transports and their operators in the army. Established in 1902, the ASC MT of World War I had conducted efficient mechanized maintenance operations for years. The ASC MT was well-equipped and trained to conduct vigorous recovery operations. Assets included lorries equipped with boom cranes and winches to extricate mired vehicles and tow broken-down vehicles to maintenance collection areas. Maintenance lorries carried extensive tool sets, raw materials, and some spare parts. Personnel manning the lorries could both manufacture a wide variety of spare parts and repair damaged components sufficiently to continue operations.

In light of the wide variety of civilian transports in use, the ASC MT employed scores of civilian mechanics who moved forward in maintenance the lorries. Every motorized unit had its own mechanic who, owing to the shortage of spare parts (again, due to wide variety of vehicle makes in use) would hand-make replacement parts on the

spot. At the time, this approach worked well for the ASC MT as vehicles were reasonably primitive and skilled civilian mechanics were readily available. As the tank evolved, the ASC MT naturally remained in the process because the organization had already fielded thousands of vehicles and drivers, and were familiar with motorized movement around the battle area. This ongoing influence, while necessary, also led to many of the problems later faced by the tank:

When the first units were formed there was little time to train tank drivers and R.A.S.C. (Royal Army Service Corps) drivers were employed to drive the tank, and the R.A.S.C. officers naturally initiated the system of workshops and repairs for the first tank units on the lines of R.A.S.C. units.³⁷

Initially the concept was welcomed enthusiastically by the ASC MT and the Tank Corps. Mechanics were able to pore laboriously over each tank, unconcerned by having unskilled tank crewman causing additional harm. Early on, tank commanders were more than happy to ignore the technical aspects of their new war wagon and leave the tinkering to the engineers. Commanders much preferred concentrating efforts on crew tasks, gunnery, and tactical deployment. However, officials were quick to realize that as the Tank Corps ballooned in size, it would rapidly outstrip Great Britain's capacity to provide skilled workmen while meeting other technological priorities.

Spare parts also caused much consternation for tank developers and the War Office. It was clearly understood that there was "no limit to the development . . . except the cost," and that cost was measured in manning, raw materials and official support, as well as funding. Officials saw the efficiencies that could be gained with an integrated spare parts and repair system. With only minor differences in the three major tank types fielded, the tank readily offered itself to mass-production of spares. At the time, developers and GHQ had difficulty resolving the balance between tank production versus

production of spare parts. As the initial concept waned of a tank being a type of a one-time use weapon akin to an artillery round, concept designers were forced to look at tank sustainability in the long run. Obvious facts quickly presented themselves, the first being a need for some, as yet unknown, number of spare parts to keep a tank running.

Simultaneously, Colonel Swinton began expanding ancillary services (maintenance and repair sections) as early as July 1916 because he realized, “the importance of which we are only just beginning to be in a position to gauge.”³⁸

Further maintenance challenges stemmed from basic equipment characteristics. The heaviest recovery lorry available in late 1915 and early 1916 had a laden weight of approximately eight tons.³⁹ At thirty tons, the tank posed the difficulty with recovery services as described below:

Tank recovery presented tremendous problems. A sound tank could tow another on firm level ground, which was practical in the workshop area but rarely so on the battlefield, where most tanks became casualties. Here was an unending panorama of trenches and shell holes, often a sea of mud. In these circumstances, towing was almost impossible: sound tanks had to be dug out and damaged ones repaired *in situ* or cannibalized and abandoned.⁴⁰

Daily journals, diaries, and unit after action reports all illustrate this difficulty, with numerous accounts of crews being forced to ditch their tanks and retreat after encountering impassible terrain, suffering a debilitating but non-lethal hit, or experiencing mechanical difficulties. Slowly, officials realized all aspects of Britain’s existing maintenance program were unsuited for the tank. It would take nearly another full year after Flers-Courcellette before the ASC MT would implement a useful change in tank maintenance methodology. Meanwhile, the Royal Army Service Corps, parent to the ASC MT, struggled with massive supply responsibilities at the Western Front.

Supporting the tank in battle would soon pose still another test.

Logistics

Prior to Flers-Courcelette, with secrecy shrouding the tank project, little information exists on the development of supporting logistics. This lacuna might be a function of secrecy alone, or it might point to either an oversight by the committee or a continuing belief in the one-time use philosophy of tank employment to break the stalemate. Regardless, after Flers, leaders began considering logistics, which resulted in some innovations as well as deficiencies. A brief history and operational review of the Army Service Corps serves as an appropriate stage setter for later discussions on tank logistics.

The ASC--“royal” was added in 1918--evolved from the Royal Waggoners of 1794 through the Wagon and Land Transport Corps to become the ASC in 1888. Due to continued functionality and adaptation to motor vehicles, the ASC remained virtually unchanged organizationally and by 1914, it was generally considered the most capable military logistics organization in all of Europe, earning accolades through support of overseas wars in India and Africa.⁴¹ However, in August 1914, a reorganization shifted control of all support for mechanical transport except petrol from the Department of Transport and Movements to the Mechanical Transport Branch. This change likely had a positive effect on tank operations as it combined maintenance and supply functions under a single office.

Important actions of the ASC included creating a civilian owned and operated fleet of automobiles at its disposal, part of the Special Reserve, and requisitioning the entire output of British automotive manufacturers.⁴² Although these changes gave the ASC a tremendous edge in vehicles and operators, the result was a logistical nightmare in

supplying petrol and spare parts. Enlisting the aid of civilian and commercial mechanics and technicians, the ASC kept the fleet and its supplies moving steadily in theater, and doing so arguably with lesser quality officers than in front line units.

Allowing for the fact that most officers desired glory as officers of the line while technically skilled and educated officers gravitated to the Artillery and Engineers, a common misperception is that the poorest-quality officers landed by default in the ASC. While some unworthy officers likely ended up in the ASC, many wartime ASC officers had been civilian engineers, accountants, or otherwise highly educated. These officers provided a level of analysis and coordination which brought together the vast resources, competing requirements and dissimilar systems for unprecedented support, as evidenced by the following comments from an ASC soldier:

As a fairly large employer of labor I often wondered, before volunteering my services and joining His Majesty's Forces as a Tommy, whether the Army methods were as up-to-date and efficient as the average commercial firm, and I am afraid that I had what is probably the prevailing opinion that the comparison would not be favorable to the Army. However, after going through the evolutions necessary to be placed in the position for which a man is most fitted, I can assure the taxpayer that I have been astonished at the extraordinary efficient method they have in the MT of placing the right man in the right place . . . it is the question of organization that will appeal to the business man, and when I see, as I do daily, the large numbers joining up as drivers of light cars, heavy lorries, and steam wagons, mechanics, turners, fitters, electricians, coppersmiths, blacksmiths, body builders, and numbers of other tradesmen, all sorted out for their various tests on the day of their arrival. . . . I marvel that more is not allowed to be written so that every resident in this country may realize what is being done.⁴³

The drive for efficiency appeared to work in traditional types of combat. The ASC established ammunition depots, fuel depots, and even manpower depots for rapid replenishment of the resource-intensive operations at the front. Unfortunately, the technical nature of the tank and its direct employment on the battlefield would render useless many of the logistics fundamentals operating elsewhere. Although logisticians

worked to bring efficiency to their trade, Army leaders pondered over how best to use the tank once it transitioned from concept to combat.

Doctrine and Tactics

Each visionary who contributed to the tank harbored a slightly different idea of its use in combat. Churchill envisioned his cross-country capable armored cars destroying railway lines in the enemy's rear area; fording rivers and great trenches; and destroying lightly fortified and lightly armed enemy.⁴⁴ Hetherington envisioned both a giant land cruiser maneuvering as if a naval battleship on land, and as a vehicle for transporting upwards of fifty soldiers under armor forward to disembark and attack German trenches. He even posed the possibility of the vehicle constructing its own trench and defilade position.⁴⁵ Colonel Swinton's memorandum "Armoured Machine Gun Destroyers" detailed specific ways for the tank to be used for break-in and break-out actions in trench warfare. Tanks would: be able to cross a four foot trench and climb obstacles; be armed with two machine guns and a heavy gun to suppress or destroy enemy machine gun nests; travel three to four miles per hour across broken terrain; possess a twenty mile operating range and be able to exploit and then hold a penetration so infantry could move forward en masse.⁴⁶ Swinton saw tanks in large numbers spread across a vast frontage, moving forward simultaneously to crush enemy resistance and prevent the German counterattacks so prevalent and effective on the Western Front. This basic concept of tactical employment became the accepted method by which the tanks would be used. However, each of the early concepts failed to capture the essence of the true combined arms warfare that the Germans were master during World War II. Instead, theorists viewed the tank as an evolutionary tool of maneuver designed to reestablish the superiority of traditional

infantry fire and maneuver. Even so, had they stuck to the concept of the tank as an enabler for assuring fire and maneuver, commanders might have succeeded in a decisive breakout prior to the end of 1918. Unfortunately, the first several battles using the tank deviated from the principle of mass, resulting in limited successes.

Battle Test

Britain's planning and preparation was put to the test in September 1915 at Flers-Courcellette. Such was the initial widespread optimism by the tank champions that until after Flers, they refused to take serious and necessary steps to sustain the tanks long-term. Arguably, the speed at which tanks were rushed from experimentation to execution led to many mechanical defects which became apparent under combat conditions. The tanks were hot--sometimes so unbearably hot that crew members passed out from heat exhaustion. Artillery pieces destroyed or disabled tanks in great numbers. Ricochets and spalling⁴⁷ occurred around the poorly sealed plate armor, resulting in a great many more crew casualties from small-arms fire than necessary. Mobility concerns raised by developers were not heeded by frontline commanders resulting in a number of ditched tanks. Secrecy precluded most necessary training among the infantry, cavalry, and tank crews. Maintenance systems, patterned on the MT model, would prove ineffective and drive substantial changes following the battle at Flers. Tank recovery on the battlefield would have to wait until a larger driving force provided the impetus for further innovation. Overall, the Battle of Flers-Courcellette was not a great victory for the tank, nor was it a humiliating defeat. By pushing hard to increase production and place more tanks sooner on the battlefield, the War Office in retrospect seemed willing to mortgage future tank sustainability for a decisive blow at the Somme in 1916. Some have argued

that early commitment was a political move by General Haig. Others say it was a necessary test of the tank's technical and tactical concept. Regardless, those developers who had spent months bringing the tank to fruition in order to mass them in a huge attack for a decisive victory had the following response:

As regards the claim that no commander would have been justified in risking the use of these machines in the manner proposed by Colonel Swinton without a preliminary trial, this is, of course, purely a matter of opinion. Such risks have been taken in the past with overwhelming success, and it is now tolerable certain that a great success would have been attained if the risk had been taken in this case. Possibly the duration of the war might have been shortened by over a year.⁴⁸

In the absence of thorough training and testing of crews, equipment, and doctrine, the case for a preliminary trial commitment has some merit.

¹Ernest Swinton, *Eyewitness: Being Personal Reminiscences of Certain Phases of the Great War, Including the Genesis of the Tank* (London: Hodder and Stoughton Ltd., 1932), 23-4.

²Swinton, 129-130.

³*Ibid.*, 94. At the time, Kitchener still believed massed artillery and the spirit of the offensive could break the stalemate.

⁴Albert Stern, *Tanks 1914-1918: Log Book of a Pioneer* (London: Hodder and Stoughton Ltd., 1919), 8.

⁵Winston Churchill, *The World Crisis* (New York: Scribner's, 1923), 63.

⁶*Ibid.*, 63-4.

⁷Churchill, 69.

⁸Stern, 22.

⁹Childs, 16.

¹⁰Ian M. Brown, *British Logistics on the Western Front: 1914-1919* (Westport: Praeger, 1998), 26.

¹¹Macksey, *Tank Warfare*, 25.

- ¹²Tim Travers, *The Killing Ground*, 77.
- ¹³Swinton, 96.
- ¹⁴*Ibid.*, 134.
- ¹⁵J. H. Boraston, *Sir Douglas Haig's Despatches, December 1915-April 1919* (London: J. M. Dent and Sons Ltd., 1979), 345.
- ¹⁶Timothy Travers, British Army Command and Leadership Styles, *Journal of Contemporary History* 29, no. 3 (July 1994): 403-442.
- ¹⁷Stern, 12.
- ¹⁸Kenneth Macksey. *A History of the Royal Armoured Corps and its Predecessors, 1914 to 1975* (Beaminster: Newtown Publications, 1983), 14.
- ¹⁹Stern, 27.
- ²⁰*Ibid.*, 38.
- ²¹*Ibid.*, 54.
- ²²*Ibid.*, 60.
- ²³*Ibid.*, 123.
- ²⁴*Ibid.*, 73.
- ²⁵*Ibid.*, 48.
- ²⁶*Ibid.*, 58.
- ²⁷*Ibid.*, 74.
- ²⁸Clough Williams-Ellis and Amabel Williams-Ellis, *The Tank Corps* (New York: Doran, 1919), 46.
- ²⁹*Ibid.*, 76.
- ³⁰*Ibid.*, 47.
- ³¹Stern, 78.
- ³²*Ibid.*, 79.

³³G. Le Q Martel, *In the Wake of the Tank: The First Eighteen Years of Mechanization in the British Army* (London: Sifton, Praed and Co., Ltd., 1935), 6.

³⁴Stern, 80.

³⁵Childs, 132.

³⁶Williams-Ellis, 52.

³⁷Martel, 58.

³⁸Stern, 85.

³⁹Brian S. Baxter, *Breakdown: A History of Recovery Vehicles in the British Army* (London: Her Majesty's Stationary Office, 1989), 4.

⁴⁰*Ibid.*, 7.

⁴¹R. H. Beadon, *The Royal Army Service Corps: A History of Transport and Supply in the British Army*, vol 2 (Cambridge: Cambridge University Press, 1931), 84.

⁴²The Times History of the War, vol 10 (London: The Times Printing House, 1917), 284-286.

⁴³*Ibid.*, 302.

⁴⁴Stern, 10.

⁴⁵*Ibid.*, 17.

⁴⁶Swinton, 96.

⁴⁷Spall is created when material behind the point of impact is dislodged, taking on the properties of the projectile even without the projectile's penetration; ricochets often skipped along the plate armor, entering the crew compartment through porous seams.

⁴⁸Martel, 11.

CHAPTER 3

EMERGENCE OF THE TANK: FLERS TO CAMBRAI

The period up to and immediately following the tank's appearance at the Battle of Flers-Courcelette in September 1916, saw many changes in Great Britain. The collective pain from the Somme's staggering casualties still reverberated through British society. Soldiers were weary of the brutal grind associated with trench warfare and, most importantly, secrecy for the tank project was out the window. Great Britain understood German productivity and adaptability, and the British were now vested in following through with advancing tank production and employment before they were forced to face German tanks in great numbers.

With the failure of Haig's 1916 Somme offensive in knocking a hole in the German defenses and tanks no longer having the element of surprise, the tank pioneers and newly converted believers began reassessing the utility of the tank. Thoughts now turned to the longevity and sustainability of tanks as a useful alternative to direct frontal attacks with infantry, while tacticians worked out the details for how and when to make the tank the decisive weapon initially envisioned.

During this timeframe, the British learned a great deal regarding the capabilities, weaknesses, and challenges of the tank as a weapon. Further, they realized its shortfalls as a combat system and began incorporating changes in training, maintenance, logistics, and finally tactics. Leaders realized the need for more robust logistical support forward. Units formed tank supply sections which provided all classes of supply to the fighting tanks. Maintenance efforts were pushed down to the individual crew level as mechanics and engineers were in short supply. Recovery became more specialized using tank

chassis as the basis for improved capability. Each of these evolutionary improvements resulted in a more robust tank force. However, success on the battlefield was elusive.

The timeframe and major shaping events analyzed begins as the tanks rolled across the line of departure on 15 September 1916, through the swamps of Passchendale in the spring of 1917 where the tank's reputation was dangerously marred, and ends with the success at the Battle of Cambrai in November 1917, setting the stage for the great battles of 1918.

Flers-Courcelette

General Haig insisted he have tanks for his summer offensive of 1916. His vision for the tank was as a machine gun destroyer, providing valuable suppressive support to enable the massed infantry assault.¹ Production and training shortfalls denied him of their timely use, and his attack along the Somme went as scheduled on 1 July 1916, without tanks. By September 1916, allied casualties were mounting at a high rate, while allied successes were few and limited in scope. With two of the four tank companies, a total of fifty tanks and their crews equipped and trained, Haig elected to employ the available tanks with his upcoming attack near the villages of Flers and Courcelette. Winston Churchill, an advocate of massing hundreds of tanks for one dramatic, surprise attack, responded strongly to what he felt was a premature application of the tank to solving the trench stalemate, stating, "my poor 'land battleships' have been let off prematurely on a petty scale."²

The tanks and crews were hurried into theater and rushed to the front, some arriving just prior to launch of the attack. Of the fifty tanks allocated to the attack, only thirty-two crossed the line of attack and entered No Man's Land. Results varied along the

lines where the tanks attacked. British reports showed major collapses in German morale as entire units threw down their arms and fled from the tanks, or surrendered en masse.³ A German account disputed the British reports, claiming the Germans not only had some prior knowledge the British planned to employ a new type of armored machine but that the Germans were somewhat prepared to conduct a defense against it in certain sectors using field artillery pieces in direct-fire mode.⁴ Regardless, both versions offered some truths to the tanks' effectiveness on that first day.

Many German units became demoralized and fled in terror or surrendered. The tanks succeeded in taking Flers, a huge gain of ground not previously seen since the trench stalemate first began, and allied casualties were quite light. One British pilot observing the battle reported on the tanks moving forward in Flers followed by infantry. His report was eventually interpreted famously as "a tank is walking up the High Street of Flers with the British Army cheering behind!"⁵

The tanks proved effective against the German machine guns, destroying many crews while effectively clearing wire obstacles and trench lines. The tanks also showed the many weaknesses inherent in early models. They were mechanically unreliable, difficult to operate, and had difficulty keeping up with the infantry. A number of tanks were "ditched"⁶ during the battle. Still more tanks were destroyed or disabled by artillery, or crews incapacitated by small arms fire. Tank crews unscathed by small arms fire suffered the ill-effects of confinement in a cramped, jostling compartment filled with hot, noxious engine exhaust. Exact accounting for cause of failure by type during this first battle is difficult to ascertain. As many as twenty-three of the thirty-two tanks which

left the start point failed to keep up and make contact with the enemy, with the bulk of the fighting in and around Flers being conducted by nine tanks.⁷

Tank-supported attacks continued throughout the latter part of September 1916. However, with the toll from attrition, lack of reserve crews, and few replacement tanks available, tanks were often employed in what was disparagingly termed “penny packets.”⁸ In this manner, the tanks were sent out in small numbers of one to five tanks to support very limited attacks of individual platoons, companies, or battalions.⁹ The penny packet employment failed to produce any decisive results along the front, and resulted in both a bleeding off of technical resources and crews as well as a dimming view of the tank’s worth by some field commanders.¹⁰ However, many other commanders, most notably General Haig, were enthusiastic of the possibilities offered by the tank.

Production

General Haig praised the tank pioneers in his dispatches following Flers. In one, he reports, “we have had the greatest victory since the Battle of the Marne . . . This is due to the tanks . . . Go back and make as many more as you can.”¹¹ Haig backed up his praise with an immediate request for one thousand tanks to be produced for combat by the spring of 1917.¹² However, resistance to change within GHQ resurfaced several days later when Haig commented to the pioneers, “Go home and build as many tanks as you can, subject to not interfering with the output of aircraft and of railway trucks and locomotives, of which we are in great need.”¹³ Haig had apparently caved to the demands by traditionalists within GHQ who still refused to accept the tank as a possible war winner. Once again, tank developers occupied the awkward position of owning a great idea full of potential, but receiving only lukewarm support from the echelons of

command able to generate the impetus necessary to carry tank production to the required level. Stern and his team worked to overcome the technological, materiel, and leadership challenges over the next year, intent on meeting the production goals outlined by General Haig.

Production dramatically increased in armor plating to meet these requirements. Fortunately, this coincided with the Royal Navy's large drop in demand for armor plate between 1916 and 1917, from nearly 15,000 tons per year down to just over 7,000 tons.¹⁴ Excess plate went directly to tank manufactures to produce combat-ready tanks. Armor plate and steel availability became an issue again in late 1917, when the Navy inexplicably began stockpiling plate as well as ammunition, even though significant naval operations had not occurred since the Battle of Jutland in 1916, and were not expected again. This marked yet one more stumbling block in sustaining rapid production of large numbers of tanks.

Another stumbling block was a need for more power. Engineers modified engines to meet the demand created by heavier tanks such as the MK IV and the planned MK V. In October 1916, the Whippet light tank prototype was approved and ordered by GHQ, driving an overall increase in engine numbers needed.¹⁵

Production and mechanical improvements notwithstanding, managers overseeing the tank building process continued to be hampered by higher authority on two fronts. One was based in legitimate prioritization of resources and skilled workers, a true production and management hurdle. The other was based on provincial thinking.

The first challenge involved resources and workers. The allies suffered from a shortage of raw materials. Most of France's resources existed in the area already captured

by the Germans. Outside of coal, Great Britain had very few natural resources on the Isles, bringing nearly everything used to support their nation by sea from around the Empire. Due to this, the British government devoted an entire cabinet department to managing basic societal resources during the war, including food, fuels, textiles, lumber, and metals.¹⁶ Meanwhile, German submarines took a brutal toll on British shipping, nearly crippling the allied war effort. After they lifted restrictions on sinking merchant vessels in early 1917, German U-boats sank a cumulative of nearly two million tons of shipping from February through April 1917.¹⁷

With such a premium on resources, allied officials prioritized all materials based on their current experience and historical understanding of war. Although some generals and high-ranking officials felt the tank would be highly useful, they still had to deal with the current fight. Artillery shells had to be manufactured and stockpiled. Railroad track had to be laid, and steam locomotives built to carry troops and munitions to the front. Airplanes, vital as the eyes and ears of commanders, needed engines and armament.

The tank was forced to compete against all these other material priorities, as well as compete for the skilled workers already burdened in other areas. There were simply not enough materials, engineers, or manufacturers to produce large quantities of tanks. Not until the Americans chose sides and entered the war as both a fighting force and economic power did this balance of materials shift to one of excess capacity. Even this would not tip the balance as there was a distinct shortfall in manufacturing capacity. One unnamed bureaucrat in the Ministry of Munitions branch recommended against building any new tank manufacturing facilities as it would not have an impact on the outcome of the current war.¹⁸ Although a realistic attitude given the limited resources available for

Britain and the tank's lukewarm results at Flers, the bureaucrat showcased the second aspect hampering production--provincial attitudes and resistance to progress.

High command in Britain consisted primarily of upper-class, privileged, anti-intellectual officers raised in the Edwardian fashion. They proved resistant to change; held an unflinching belief in the dash of the cavalry, the firepower of the artillery, and the perseverance of the infantry. By far, they believed the trench problem to be less a technical and tactical problem and more an issue of character. Sir Ian Hamilton provides an excellent example of this attitude as he explains, "for this trench warfare no great technical knowledge is required. A high moral standard and a healthy stomach--these are the best."¹⁹ Tank pioneers encountered this attitude at nearly every turn. Commanders such as Haig, who initially supported their effort, failed to provide the follow-up needed to jump start the process or reprioritize materials, technicians, and facilities, thus putting the program behind its revised goal of decisive employment by the end of 1917. His ambivalence might have stemmed from true concerns about resources and priorities. It may have resulted from lingering provincialism and resistance to change. Or, Haig may have been overwhelmed by event as the war slogged on unsuccessfully. Had he taken a more vigorous stand with the various ministries and other agencies emplacing stumbling blocks, tank production might have made exponential increases from December 1916 to December 1917. In fact, GHQ placed additional tank orders for 1917, over and above the original 1,150 (150 limited run plus 1,000 after Flers), expanding the program to nearly 5,000 tanks.²⁰ Unfortunately, with a targeted monthly goal of 190 tanks, production through 1917 was 1,277 units, barely over 100 per month average.²¹ Still, the tank program showed signs of life, as pioneers and tank leaders alike fought to bring relevance

to the tank. The losses posted in production would be somewhat offset by improvements in the areas of training, maintenance, and logistics, and after a false start tactically in the spring of 1917, the tanks would again posture themselves for a decisive impact in 1918.

Training

One would expect improvements in the area of training if one understands the nature and history of the British Army. Following the Boer War, the British Army initiated a thorough review of policies and tactics with the intent of standardizing and improving their actions in war.²² These improvements were codified in various manuals, most notably the Field Service Regulation (FSR) series. Officers fostered a culture of internal military review within their individual branches, with each of the arms publishing their own doctrinal publications in the years preceding World War I. The Tank Corps would both benefit and at the same time suffer from the culture of written review. Up until the Somme offensive of 1916, no written doctrine, tactics, or training methodology existed for tanks.

After the Somme, the overall mentality of the Army changed from long artillery preparations and unsupported mass frontal assaults to more refined tactics of creeping barrages and small-unit infiltrations.²³ While the spirit of the offensive was alive and well, changes to application came in the form of a new doctrinal publication for immediate implementation. Titled *Instructions for the Training of Divisions for Offensive Action 1916*, this December 1916 manual went into great detail outlining the lessons learned from over two years of fierce combat in the trenches. It discussed the integration of the creeping artillery barrage, small groups of infantry using storm troop tactics and aircraft in multiple roles as a precursor to combined arms warfare seen in World War II.

It went to great lengths describing the proper methodology for seemingly inane (or routine) tasks such as establishing supply dumps, communication centers, and work parties, yet it spends just two pages explaining the capabilities, uses, and integration of tanks into the battle scheme.²⁴

In fact, unlike other sections in the manual which give precise methods of training and coordination before the battle, the section on tanks reads more like a disclaimer, outlining the weakness of tanks, their mobility challenges, and the need to plan for success with the other arms while plugging the tanks in where they can be used. A telling insight into the existing prejudice against tanks at the doctrinal level can be gleaned here by the opening statement on the section regarding tanks:

In the present stage of their development, tanks must be regarded as entirely accessory to the ordinary methods of attack, i.e., to the advance of Infantry in close co-operation with the Artillery. Any modifications or alterations required in the plan of attack, when tanks are employed, must be such as will not jeopardize the success of the attack in the event of a failure by the tanks.²⁵

Whether a fair assessment or not, one can argue the tanks, by virtue of these doctrinal restrictions, were set up for failure. Commanders were explicitly discouraged to highlight tanks in their scheme of maneuver. Tanks would be plugged in after the fact, where commanders hoped they might be effective. Training and coordination between tanks and infantry could not have success with the tanks held in such low esteem. Examples of misapplication of tanks would be the aforementioned penny packets and the debacle at Passchendaele in July 1917.

Though some would later argue the tank was misapplied at Flers and failed miserably in its first outing, many observers reporting from the front heralded the tank's performance. They described them as "monsters, mammoths, and Leviathans" as well as

“the Terror that walked by noonday.”²⁶ This sparked a great interest in the British public, driven by fantastic press accounts, and scores of volunteers now wanted to be part of the newly born Tank Corps. The demand for training quickly outstripped the capabilities of the small, scattered tank training camps. However, by May of 1917, reports to GHQ showed a lack of trained men and a great delay in training them for the upcoming offensives.²⁷

At the same time, those already trained in tank basics were shifting training priorities, anticipating larger battles with more tanks working in unison. In February 1917, tank battalions began executing company-level training and maneuver, a shift from section-level training. Drivers trained on both day and night scenarios and unditching drills. Unit training in the field began to more closely mirror training at the Tank Corps qualification school. Crewmen conducted revolver marksmanship, gas drills, gas helmet operations, Lewis gun training and gunnery.²⁸

The training conducted by tank corps soldiers was not unusual. British military culture encouraged and enforced unit-level training and proficiency as a matter of course. Comprehensive manuals and regulations governing tank training were not far from being written and published. What was unusual within the Tank Corps was the attitude of the soldiers assigned. Officers and soldiers in the Tank Corps had felt the power provided by the tank, and as one crewman commented, “Frankly, we were tired of going over the top as infantrymen.”²⁹ Leaders such as then Major J. F. C. Fuller, Operations Officer for the Tank Corps, could see its potential brimming just below the surface, awaiting the right combination of technology, terrain, tactics, and leadership for emergence as a dominating factor on the battlefield. By keeping the tank active in the daily battle and accomplishing

limited objectives, Fuller and other proponents worked to change opinions bit by bit with each small success. One note received from General Haig by the commander of the Tank Corps following the Battle of Arras in April 1917, simply stated, “My congratulations on the excellent work performed by the (Tank Corps) during yesterday’s operation. Please convey to those who took part my appreciation of the gallantry and skill shown by them.”³⁰ Through this subtle information campaign commanders were able to answer the critics following the utter failure of Passchendaele and hold out long enough for Cambrai’s decisive success to silence much of the dissent.

With the matter of the tank’s ultimate usefulness generally settled and the tank’s future somewhat brighter, tank units established themselves into the system alongside traditional army units, creating parallel routines of training and daily activities. Sports, regimental events and social activities occupied crews’ down time, similar to their combat arms brethren. The major differences revolved around tank-specific applications. Daily activities included drivers training, pistol and machine gun marksmanship, gunnery, unditching, mechanical training, carrier pigeon training, map and ground reconnaissance, and the use of aerial photography.³¹

Clearly, leaders and crewmen were invested in the success of their individual units. Tank brigades established local training camps to reinforce the fourteen tank skill proficiency classes taught at the Central School in Britain. Likewise, brigades and battalions instituted large-scale maneuver and gunnery training areas, rotating subordinate units through to maintain proficiency or learn specific skills prior to a mission.³² Their increased unit cohesion, regimental identity and esprit contributed to an existing British Army culture of training to be the best.

The rigorous training efforts resulted in the frequent, if not decisive, victories by the tanks everywhere they fought in good terrain with infantry support. Even without the vast numbers of tanks originally envisioned by the pioneers, tank crews made a difference nearly everywhere they made it to the fight.³³ A letter written by an infantry officer who served at the front and fought in the Battle of Cambrai spoke highly of both the physical and moral effect tanks had in the battle.

Until Cambrai, the tactical knowledge shown in (tank) employment was of the meanest order...tanks covering the advance of (the) battalion functioning under ideal weather and ground conditions, were handled with marked skill and enterprise in the capture of the first two objectives . . . the moral effect of the support given by the tanks on the attacking infantry is *very great*. (T)he men felt the utmost confidence in the tanks and were prepared to follow them anywhere. The effect of the advancing line of tanks on the enemy infantry was extraordinary. They made no attempt whatever to hold their trenches, and either bolted in mad panic or, abandoning their arms, rushed forward with hands uplifted to surrender.³⁴

While improvements due to training continued to sharpen the fighting force, ditchings caused by poor terrain choice (either by commanders when employing the force, or by crews on the battlefield) took their toll on relative combat power. Likewise, ditchings from maintenance defects consumed much of the tank's combat power, forcing a closer look at ways to overcome the deficiency. Both these factors, independent of enemy action, kept the tanks from massing effects for most of 1917. It was obvious tank employment and training needed to change for the tank to become decisive, and forward-thinking officers in the Tank Corps were taking notice.

One of the first published training document specifically targeted at tanks arrived in May 1917. Written by Major J. F. C. Fuller, the manual "Notes on the use of tanks and on the general principles of their employment as an adjunct to the infantry attack"³⁵ provided the necessary focus and direction for commanders in the field to best use their

tanks. It also provided a framework for tank units to best prepare themselves for combined battle. Though a useful document, the quality and volume of training would not be enough to overcome the existing problem of personnel and production shortfalls.

Finally, by the late fall of 1917, production, maintenance, and training converged providing commanders with the opportunity to launch a massive tank offensive. Although maintenance problems and incidents of ditchings remained high, the success at Cambrai showed tank crews could get the most out of what they were given. Sensing this, pioneers and leaders alike pushed to overcome the production, crew training ,and maintenance problems of 1917 in order to set the conditions for the massive offensives expected in the summer of 1918.

Maintenance

Several factors continued to hamper commanders. The first was a shortage of trained mechanics and technicians. Mechanical reliability plagued the tank from the very beginning, making them very labor-intensive, in constant need of tinkering and repairs to stay running. The 1915 technology and capability, though advancing rapidly, did not possess the sustainable durability needed for the 20th century battlefield. Problems persisted in track components, transmissions, engines, carburetion, and fuel delivery systems.³⁶ Tank designers realized this early on, but it appears they initially gambled on the role of the tank being decisive and overwhelming in its first usage, that it could “run fifty miles and might then fall to pieces.”³⁷ Realistically, by early 1917, tanks might travel fifty or even one-hundred miles during the conduct of training, moving from the railhead, or in their approach marches before they ever headed out into No Man’s Land. Once the one-time usage fallacy passed, designers and commanders quickly applied

existing maintenance concepts from their motorized corps consisting of many civilian technicians, field workshops and mobile workshops.

By November 1916, GHQ was looking at a fully tank-equipped army concept. Preliminary steps entailed shifting engineer, signal, medical, and service companies to become organic elements of the new Tank Corps.³⁸ Key to continued tank operations was the workshops. Highly skilled, contracted civilian professionals or enlisted technicians manned workshops deployed throughout the battle area. Large field workshops located in rear areas conducted detailed repairs, fabrication of spares, and construction of purpose-built items.

Nearer to the front, service companies established mobile workshops. These maintenance outposts were designed to provide limited critical and timely repairs very close to the action. As the British became more dependent on mechanical transportation everywhere on the battlefield, mobile workshops began to pop up all along the front. Demand for work required more men, specialized tools, and materials brought forward to supply the mobile workshops, until they eventually became as immobile as the field shops in the rear.³⁹ While this was acceptable when the front remained stable, once the British and German offensives began to drastically alter the lines, a new concept became necessary, one that would place technical expertise continually at the most needed location: with the tanks.

Until they successfully transitioned to a new paradigm of maintenance, the tanks were tied very tightly to their maintenance support. This limited the speed and distance a tank could travel from the basically immobile, mobile workshops. The finite number of specialized mechanics created a chokepoint for efficiency, shrinking the number of tanks

available for battle on a daily basis. Tank recovery and salvage operations were stove-piped, executed slowly and as skilled workers with appropriate equipment became available. Combat power was slow to regenerate, and installation of spare parts, when available, took time. Many tanks awaiting maintenance were scuttled by crews during fluctuations in the front line.⁴⁰ Without a rapid turn-around on maintenance, commanders could not generate the combat power necessary to make a decisive attack on the enemy.

Colonel Swinton, and later General Sir Hugh Elles, Commander of the Tank Corps, both identified the underlying solution to the tank maintenance challenge early on. Swinton wanted educated people with technical expertise to fill out his new service.⁴¹ While this appeared a logical and necessary demand, in practice it was near impossible. Elles notes “the idea is prevalent that it is essential that Tank Corps personnel should be highly technical experts by origin, and that they were so during the war. Nothing is further from the truth.”⁴²

With the Tank Corps immediately expanding from six companies to nine battalions, adding technical experts like those who formed the tank nucleus in 1916 would be a problem. Other technical branches such as the Royal Flying Corps, Royal Engineers, Royal Artillery, and Army Service Corps-Mechanical Transport were all undergoing rapid expansion. Skilled mechanics and those of a technical nature were highly sought after by every technical branch. Most had already been pulled out of front line duty and placed into critical skill positions. Reflecting on the dire condition of technically trained personnel, Elles stated:

The Tank Corps was the newest and smallest of all these organizations and, as was natural, only got what was left, and that was very little. Some thirty or forty officers with civil engineering experience were transferred from the R.A.S.C.;

from the other technical corps nothing could be spared. Of the remaining 80 percent of the personnel, about half joined with the knowledge and experience of the average motorist, the remainder were just plain men.⁴³

Training such a vast body of ‘just plain men’ in a short time to perform basic crew tasks would be a difficult task under the best of conditions. Elles had no such luck, with nearly every factor from instructors, facilities, existing student knowledge, and external factors bearing down. This would create an additional chokepoint to Elles realizing his vision of a technically trained and proficient force.

Facing steep odds, Elles took his vision a step further. Not only did he want to mold a technical force, he wanted to effect a fundamental change in the approach to tank maintenance by demanding, and then training, tank crews to take over their own routine maintenance and upkeep. Taken for granted in modern day, this concept was revolutionary for the British Army of 1917. Specialists, technicians, and engineers conducted the upkeep of modern devices, while combat soldiers closed with and engaged the enemy. The tank blurred this line, creating a paradigm shift in defining a combat soldier, his capabilities, and his duties. Creating a unique identity for the Tank Corps allowed Elles to implement his radical plan. Throughout 1917, crews at the initial training camps in Britain received more instruction on mechanics and maintenance. They were asked to complete more complex technical tasks in keeping their machines operational. In the field, tank crews received training from technicians informally, and in command-sponsored schools.⁴⁴

The end result was that by December 1917, most maintenance, short of large-component replacement, was completed by tank crewmembers. Major repairs and restoration fell to repair shops well to the rear. Fixing forward served to lengthen the

tether to which tanks had been attached, expanding their tactical and operational reach. A secondary effect was freeing additional skilled technicians to increase tank testing, development and production. A great example of this effect was the Battle of Cambrai, where crews managed to launch 376 of 378 tanks into No Man's Land--a huge improvement over Flers' statistics. Maintenance statistics are difficult to amass for Cambrai, since many tanks broke down, only to be repaired, returned to battle, and then subsequently break down again. One report came from 2nd Brigade, 62d Division, originally assigned eighty-four tanks for Cambrai.⁴⁵ It stated "though at 8 a.m. on November 30 not one machine in the Brigade was in a fit state or fully equipped for action, by 6 a.m. on the following day no fewer than seventy-three tanks had been launched against the enemy."⁴⁶

Crew-level maintenance provided more combat power to commanders, freed up more technicians for tank production, and gave better training methods to focus crews. Commanders could now focus on the second maintenance problem facing them: what to do with the number of damaged and disabled tanks accumulating on the battlefield.

It took a shortage of six-pounder guns in the Royal Navy in late 1916 to provide the answer. Salvage parties working to recover weapons from derelict tanks realized the tanks were not as damaged as thought. Of the seventy tanks originally identified for salvage of their guns, fifty-eight were determined to be repairable back to fighting condition.⁴⁷ This sparked a movement to recover and rebuild the tanks. The R.A.S.C. organized tank salvage companies to bring the tanks back for refit. Initial efforts to use operational tanks to recover derelict tanks only worked on dry, level terrain. Men with shovels were often the only solution in preparing a hull for movement. Field-expedient

methods for loosening mired tanks or removing or repairing damaged parts included jacks, cutting torches, and even German grenades.⁴⁸

Working within the concept of a fully self-sustaining tank army, engineers modified an existing tank chassis with an A-frame boom and winch system to assist in salvage. This became the tank recovery vehicle of choice, able to lift and drag derelict tanks, and assist in maintenance operations like engine and sprocket replacement.⁴⁹ Commanders now possessed the means to repair and recover tanks further forward than ever before. This continued to extend the distance which a tank could attack across the front. Relative combat power continued to climb and commanders were able to muster larger scale attacks. They were gradually working toward the point when an attack might be decisive. Cambrai might have been that point. Cambrai's attack went well, with the tanks seizing sizable terrain, capturing many enemy and equipment in the process. However, the tanks still could not provide a decisive blow to the enemy. Cambrai stalled out after several days and fierce German counterattacks regained nearly all terrain won initially. Although maintenance efforts were vastly improved over their condition at Flers, the tanks still could not operate continuously for more than about three days. Not only did mechanical problems, such as track components and carburetors, still plague the force,⁵⁰ it appeared the tank attacks did not possess the logistical staying power necessary to bite, hold, and press forward to a decisive finish.

Logistics

Basic British doctrine required similar equipment to provide logistics support for the supported unit. For example, the cavalry used horses to carry supplies. Infantry carried supplies forward by hand or on mules and horses. Artillery units moved supplies

in wagons drawn by lorry, tractor, or horse, depending on type of artillery unit. Logically, the tank would require a tank or tank-like vehicle to provide supply support.

Additionally, the unique requirements for tanks, namely large amounts of fuel and heavy stores of repair parts, added greater challenges to tank logistics. Unfortunately, in 1916, tank production precluded commanders from using tanks to carry supplies forward. Every tank available had to be in the fight so all supplies went forward by hand.⁵¹

Another key aspect of early trench logistics was the supply dump. Everywhere along the static line, mounds of equipment, ammunition, fodder, raw materials, and arms sprang out of the ground. Huge warehouses became collection points for personnel replacement units. Laborers and prisoners of war constructed hundreds of miles of rail lines to connect these islands of goods and personnel. While also effective in supporting the stagnant or slow-moving pace of trench warfare, supply dumps were too constraining for visionaries conceptualizing rapid, deep penetration into the enemy's rear echelon forces and command networks.

Tank engineers, building upon the idea tank armies being self-sustaining, began exploring the possibility of manufacturing supply tanks able to keep up with and provide fuel, water, ammunition, and other goods to attacking units across the front. However, without the benefit of excess production, they were slow to respond to field requirements. Instead, supply tanks began as ditched or damaged tanks abandoned on the battlefield. Enterprising technicians responding to local commanders' requests repaired and modified tanks able to carry additional fuel, ammunition, water, food, and other supplies forward to the tanks and infantry in the attack. The idea took hold and the first official supply tanks appeared in June 1917.⁵² Supply tanks immediately proved their worth. One

commander estimated they did the work of 300 to 400 men in moving supplies.⁵³ Typical unit organization was six supply tanks assigned to a tank battalion. These six tanks collectively carried one basic load of supplies for all the fighting tanks.⁵⁴

Though beleaguered with the same mechanical and mobility challenges as their combat brothers, the supply tanks proved successful and labor saving in other endeavors. Engineer supplies, ammunition, and water moved out shortly after a successful breach by ground forces and were often brought to within several hundred yards of the infantry's final objective within thirty minutes of its capture.⁵⁵ Some infantry units adopted them organizationally as well to carry supplies forward. The Royal Artillery developed their own tank, called the Gun Carrier tank, which served an identical purpose as the supply tank.⁵⁶

By late 1917, the Tank Corps possessed all the elements of the modern armor force: organic maintenance, well-trained soldiers, responsive and flexible logistics. Yet it was still lacking in the area of integration with other arms. Leaders still failed to see the value in overwhelming mass. Tanks still attacked in penny packet attacks, and projections for British tank production throughout 1918 did not foretell of a massive increase. In fact, tank engineers expected to fall short in 1918 of their per month averages of late 1917. Even so, tactical decision-making by leaders would evolve to make more efficient use of the dwindling number of available tanks throughout 1918.

¹Wilfrid Miles, *History of the Great War based on Official Documents: Military Operations, France and Belgium, 1916* (London: Macmillan and Co., Ltd, 1938), 39-40.

²Firstworldwar.com. Battles: The Battle of Flers-Courcelette, 1916, 11 August 2001, <http://www.firstworldwar.com/battles/flers.htm> (accessed 4 June 2007).

³John Foley, *The Boilerplate War* (New York: Walker and Company, 1963), 24.

⁴Ibid., 23.

⁵Ibid., 25.

⁶This was a term of dual use, describing either a vehicle stuck in impassible terrain, or the action of a crew abandoning their incapacitated vehicle.

⁷Foley, 25.

⁸A pejorative term for the early use of tanks, named for the cheapest possible arrangement of personal demand items, usually candy or cigarettes, provided in packets of three to five individual items.

⁹Stern, 94.

¹⁰General Rawlinson, Commander of 4th Army where most tanks first saw action, held a dim view of tanks following Flers. Swinton, 289.

¹¹Stern, 96.

¹²Ibid., 98.

¹³Ibid.

¹⁴Childs, 83.

¹⁵Stern, 101-6.

¹⁶British Government. *The War Cabinet Report for the Year 1917*. London: His Majesty's Stationery Office, 1918, 130-141.

¹⁷John Keegan, *First World War* (New York: Alfred A. Knopf, Inc., 1998), 353.

¹⁸Stern, 113.

¹⁹Timothy Travers, British Army Command and Leadership Styles, *Journal of Contemporary History* 29, no. 3 (July 1994): 403-442.

²⁰Stern, 213.

²¹Childs, 44.

²²Charles Messenger, *Call to Arms: The British Army 1914-18* (London: Weidenfeld and Nicolson, 2005), 15-16.

²³Paddy Griffith, *Battle Tactics of the Western Front* (London: Yale University Press, 1994), 77-8.

²⁴Instructions for the Training of Divisions for Offensive Action 1916 (London: His Majesty's Stationery Office, 1916), 40-41.

²⁵Ibid., 44.

²⁶The Times History of the War, 299.

²⁷Stern, 149.

²⁸Tank Actions for the Month, *Tank Corps Journal* (February 1923): 281.

²⁹Richard Haigh, *Life in a Tank* (Boston: Houghton Mifflin Co., 1918), 2.

³⁰J. F. C. Fuller, *Tanks in the Great War* (London: John Murray, 1920), 89.

³¹Tank Actions for the Month, *Tank Corps Journal* (February 1922): 196.

³²Tank Actions for the Month, *Tank Corps Journal* (December 1923): 217.

³³A key element identified with success was close coordination with and proximity to infantry units who provided security by suppressing field gun crews.

³⁴Fuller, *Tanks*, 155.

³⁵The only version of Fuller's "Notes" I could locate were an original copy located at the Kings College London, Liddell Hart Centre for Military Archives where archivists were unwilling to make copies.

³⁶Stern, 105-6.

³⁷Hugh Elles, Some Notes on Tank Development during the War, *Tank Corps Journal* (March 1922): 274-7.

³⁸Martel, 15.

³⁹Forbes, A. *A History of the Army Ordnance Services*. (London: The Medici Society, Ltd., 1929), 81.

⁴⁰Tank Actions for the Month, *Tank Corps Journal* (March 1923): 311.

⁴¹Stern, 74.

⁴²Hugh, 274-277.

⁴³Ibid., 274-275.

⁴⁴Tank Actions for the Month, *Tank Corps Journal* (June 1922): 196-7.

⁴⁵Fuller, *Tanks*, 146.

⁴⁶*Ibid.*, 152.

⁴⁷Childs, 105.

⁴⁸Baxter, 7.

⁴⁹Baxter, 8.

⁵⁰David Fletcher, *Tanks and Trenches: First Hand Accounts of Tank Warfare in the First World War* (Dover: Alan Sutton Publishing Ltd., 1994), 88.

⁵¹Stern, 135.

⁵²Childs, 125.

⁵³Stern, 135.

⁵⁴Tank Actions for the Month, *Tank Corps Journal* (March 1923): 354.

⁵⁵Stern, 226.

⁵⁶Childs, 126.

CHAPTER 4

YEAR OF DECISION

1918 proved to be a year of decision for the warring nations. However, it was not a year of decisive action for the tank. Tanks saw action in large numbers at the Battles of Hamel and Amiens in July and August 1918. They contributed to the allied breakthrough at Arras at the end of August 1918. Nevertheless, with the rapidly changing nature of the war, and continued shortfalls of the tank as a complete combat system, the Tank Corps never achieved truly decisive results.

During the final year of the war, engineers improved tank engines with better fuel systems, more reliable components and higher horsepower.¹ Tank production continued at a moderate rate. The Tank Corps expanded with the addition of the Whippet, a medium tank much lighter, faster, and more agile than the original rhomboid-shaped Mk I series with the potential to directly support traditional horse-mounted cavalry units. Additionally, gun carrier tanks, troop carrier tanks, and the improved Mk V were added to the inventory to increase battlefield mobility.² Changes in maintenance and training originally implemented in 1917 were coming to fruition throughout 1918, and tank logistics improved. All of these improvements, one can argue, resulted in more lethal and effective tanks and tank units on the battlefield. However, while one can argue the effectiveness of tank from 1916 to 1918, what is clear is time ran out on tanks, the Germans and eventually, support for the war.

Final Push

The Bolshevik Revolution of 1917 forced the Russians to abandon their war with the Germans. The resulting treaty between the Germans and Russians allowed the Germans to shift nearly a half a million troops from the Eastern to the Western Front in anticipation of a grand offensive in the spring of 1918. For a brief time, they enjoyed a narrow numerical superiority over the allies. This ended in late summer once the Americans entered the war in full force. The German High Command, specifically General Ludendorff, knew he needed a quick victory over the allies before the Americans could throw their weight in, and before Germany succumbed to a war of attrition it could not win. In March 1918, he launched the Michael Offensive with the aim of “Punch[ing] a hole in their line. For the rest . . . we shall see.”³

The Michael Offensive was highly successful in penetrating allied lines and driving deep into France. It reestablished maneuver warfare, a strong suit of the German Army. However, the Germans quickly outran their logistic support, running short on supplies, horses, fodder, and replacement soldiers. The offensive ground to a halt, failing to achieve anything decisive. At the same time, the Germans wasted valuable resources and, more importantly, took hundreds of thousands of casualties as the return to maneuver warfare proved just as deadly as trench warfare. Correspondingly, other frictions degraded Germany’s war effort.⁴

On the home front, German civilians were restless and unhappy with the war. Massive loss of life, hunger, a Spanish flu epidemic, and other privations caused uprisings and general discontent. Communist ideals returned with German soldiers from

the Eastern Front, creating further conflict and division among the German people. At the same time, Germany's wartime coalition was falling apart.⁵

By early 1918, both Austria-Hungary and the Ottoman Empire were failing states. Bankruptcy, famine, and political infighting led to massive desertions in the Austrian Army, and the Turks effort at military conquest in Mesopotamia, in direct conflict with German aims, had failed. Ethnic minorities in Austria saw a chance for independence, and the Bulgarians shakily held the Montenegrin Front.⁶

In August, the allies launched its greatest of a series of offensives beginning at Amiens. After one day of fighting, General Rawlinson's 4th Army was eight miles deep into enemy-held territory. Like the pistons of an engine, allied armies attacked all along the German front, first hitting one location, then another before the feared German counterattacks could come to bear. Following the attack at Amiens on 8 August, General Ludendorff made his famous declaration of a "Black day for the German Army."

The allies capitalized on numerical superiority provided by the Americans and pushed the Germans back along the entire Western Front. Meanwhile, following a fierce offensive in the Balkans, the allies defeated the battered Bulgarians on 28 September. On 29 September, the allies breached the once-impenetrable Hindenburg Line. On 1 October 1918, after analyzing reports from the front, weighing the situation, and knowing his army had taken over one million casualties since March, General Ludendorff addressed the Kaiser and Reichs Chancellor. He informed them the Army could no longer go on, and asked them to consider an armistice. By 11 November, the peace terms agreed to by all parties resulted in an end to the war.⁷

Production

By the end of 1917, the British had built over twelve-hundred Mk IV tanks. GHQ had ordered sixteen-hundred new Mk V tanks for 1918, but again, shortfalls in resources and competing priorities forced dips in production. For a while, Britain tried to bridge the gap between requirements and production through a joint Anglo-American construction treaty. Mk VII tanks (larger than the Mk V variants) were to be built jointly using raw materials and engineered components from both Britain and the United States (US). The pact failed to amount to much, and only twenty-four of the Mk VII “Liberty Tanks” were ever produced and deployed before war’s end.⁸

Further, the American brought nearly nothing with their fighting units to France except for massive amounts of manpower--namely two-hundred fifty thousand fresh soldiers each month. The British were forced to provide arms, field gear, helmets, ammunition, and other necessary equipment to the Americans. The French had pitched in with artillery rounds, ammunition, and training for the Americans.⁹ To add to the problem, American troop movements tied up a large amount of British shipping which formally had transported raw materials from the colonies, further deepening material shortfalls.¹⁰ With all the competing requirements, the British managed to manufacture and field just one-thousand and thirty-two Mk V series tanks before the armistice in 1918.¹¹ Still, the Tank Corps managed to train, maintain, and supply sufficient numbers of tanks and crews to conduct major attacks beginning in July 1918.

Training

Improvements over the previous year in the scale and type of training came in 1918. The distribution, scope, and nature of training would be recognizable to any tank

crewman of the modern era. Tank brigades established mechanized driving schools in their operating areas and rotated subordinate battalions through training on a strict cycle, similar to the US Army's current Training Center rotations. At a higher level, the Tank Corps also operated driving schools, corps-level gunnery schools, and training depots. These facilities, located throughout Britain and France, dramatically expanded both the number of crews able to be trained, and the quality of the training.¹²

The Tank Corps' emphasis was on presenting realistic training conditions as well as producing fit, capable soldiers. GHQ's official publication, "Instructions for the Training of the Tank Corps in France," printed in 1917 but carried forward to 1918, for example stipulated, "All work must be carried out at high pressure;" "Order is best cultivated by carrying out all work on a fixed schedule," and "Men [must be] taught to care for themselves, so as to maintain their physical fitness."¹³ Course instructors extensively overhauled courses with actual requirements from the front. Maintenance training no longer involved solely a basic understanding of operational procedures. The classes emphasized an operational understanding and repair of fuel delivery systems, carburetion, electrical and electromechanical, drive train, engine, and transmission. Instructors taught crews on troubleshooting, preventative maintenance, hourly and daily performance measures, after-operations maintenance, and rail-head operations.¹⁴

Gunnery training also mirrored modern-era techniques. The fire-and-maneuver training was called the "Battle Practice Course." It involved crews, under battlefield conditions, firing various gunnery engagements with machineguns and main guns. Drivers maneuvered on ranges into battle positions, protective-masks were worn in certain engagements, and observers rode on top of the tanks to evaluate the crew's

performance. Gunnery instructors held after action reviews at the end of each Battle Practice Course with all crewmen involved to assess, reinforce, and correct performances.¹⁵

At the same time, the Tank Corps addressed the serious flaw of tanks at the time--mobility--by creating an intensive reconnaissance training program which sought to overcome the high incidence of ditchings due to navigational errors and poor terrain selection. Tank crews underwent a five-day training cycle which included lectures on map reading, orienteering, aerial photographs, and terrain identification. Practical exercise included terrain walks, terrain visualization, and comparative observation from multiple perspectives. Crews were evaluated on their ability to visualize terrain, landmarks, and mobility lanes. They were given the opportunity to read and interpret maps and photos, evaluate routes, and then physically walk the ground to validate or refute their assumptions.¹⁶ Though difficult to quantify, training in terrain selection likely resulted in lower incidences of ditchings throughout 1918, contributing to the successes of July and August. An example from the Battle of Hamel described a company of twelve tanks advancing on their final objective, with one tank being hit by a field gun, one tank becoming ditched, and the remaining ten arriving at the objective.¹⁷ This may also be a reflection of the leadership, either by choice or chance, selecting weather and terrain conditions more favorable for tank maneuver.

By the end of 1918, the Tank Corps had established the following schools: Tank Drivers and Maintenance School; Tank Gunnery School; Tank Reconnaissance School; Tank Signal and Pigeon School; Camouflage School; Revolver School; Gas School; and Tank Compass School.¹⁸ A decision by GHQ to double the size of the Tank Corps (from

nine to eighteen battalions and later, to thirty-four battalions) in 1919 resulted in facility expansion, improvements to training infrastructure and increased allocations of new recruits.¹⁹ The commitment to expand the Tank Corps, held by at least some in the higher echelons of GHQ and the government, showed the tanks were slowly receiving greater priority in allocation of resources which should have led, given time, to increased emphasis in tactical employment of a more decisive nature.

Expanding the Tank Corps while adding new equipment required greater efficiency in training as well. During the winter of 1917 to 1918, trained, front-line battalions equipped with the obsolete Mk IV tanks were pulled from action and sent to Bray for retraining and refitting with the new Whippet Medium A tanks. Newly trained battalions reporting from Britain received the old Mk IVs and moved forward into action. After the retreat in the face of the Michael Offensive, tank units rotated in May and June 1918, back through corps-level gunnery schools to prepare for the upcoming offensive.²⁰

Still, intensive training and daily drills could not fully discount external factors such as weather and actions by the enemy. One account, from the Battle of Amiens, described a company of eleven tanks assaulting a German position, which resulted in nine of the eleven tanks being destroyed by direct fire from field guns.²¹ This begs the question of the fire-and-maneuver training effectiveness, but could also reflect localized leadership decisions resulting in poor performance.

Another account from March 1918 showcased the drama of an uncertain situation, when the instructional staff of the Tank Driving School at Aveluy was forced to take their training tanks, form provisional tactical units, and deploy to hold ground against Germans driving deeply into France during the Michael Offensive.²² Though the training base at

Aveluy was lost to the Germans' March offensive, the Tank Corps was able to quickly fall back on existing infrastructure at alternate locations and continue to train soldiers and crews for the allied summer offensive. No doubt, the determination exhibited by the cadre and leadership within the Tank Corps to maintain and sustain the tank training program stemmed from their belief in it as a key to eventual allied victory.

Maintenance

Maintenance procedures continued to adapt to battlefield realities following the philosophy forged in early 1917 that no major repairs be carried out in the field and crews should conduct their own maintenance. At the end of 1917, company and battalion workshops were disbanded and brigade-level workshops established for major repair operations. Mechanical specialists still worked far forward, assisting crews and the workshops in complicated procedures. By the beginning of 1918, the emphasis shifted from trying to cover the entire battlefield with capable, but terribly stretched, expert mechanics to establishing the Central Workshops, a modern equivalent to depot-level maintenance. All expert mechanics were recalled to man the Central Workshops and tank crews became fully responsible for tank maintenance. At the same time, the chief mechanical engineer of the Tank Corps began preparing pamphlets to instruct crews on tank maintenance.²³ These would be the rough equivalent to a modern Army Technical Manual.

The Tank Corps clarified maintenance procedures when they established an important distinction regarding maintenance and repairs. One British officer saw this division as a relevant distinction to a society and army still learning to embrace technology. As he argued:

In this way it was possible to draw a clear line between maintenance (i.e. the replacing of damaged parts, which was done entirely by the crews) and repairs (i.e. the mending of broken parts, which was done entirely by the Central Workshops). At this time the argument was frequently heard that a man who uses a machine should be able to repair it, and that, if all repair work is done by a different organization from the one which actually fights the machine, there will be a serious loss of mechanical efficiency. This idea was based upon a misconception of the difference between the functions of repair and maintenance. On the contrary, it was found that the efficiency of the crews increased several hundred percent after the crews were made responsible for the maintenance of their machines.²⁴

Streamlining maintenance now became a problem of rational calculation instead of an exercise in exploratory learning. The British perceived the limiting factors for keeping tank units combat ready were spares (parts and tanks) and mechanical expertise. To reconcile disparities among these variables, the British focused on three areas: crew training, repairs, and spare availability.²⁵

As previously described, crews had received extensive training on daily upkeep, troubleshooting, and preventive maintenance, to include replacement of common parts. Crews replaced nonfunctioning parts with spares provided from a variety of Central Stores locations. The training crews had received allowed them to quickly identify problems and replace the necessary part, returning the tank to duty “perhaps within a day of being damaged.”²⁶ This is a far cry from 1916 to 1917 where crews abandoned their tanks in wholesale fashion after often minor mechanical maladies. Perhaps an even better indicator is the mechanical success of the tanks committed to the attack at Hamel in July 1918. All sixty tanks allocated for the attack reached and crossed the point of departure, a vast improvement over the attacks of 1916 to 1917, and a trend that would be repeated at Amiens, with 430 of 435 tanks crossing the point of departure.²⁷

Divisional support companies, specifically the salvage and later the field companies, assisted in the repairs by collecting the broken parts and sending them back to the Central Workshops where an expert then applied his skills. Instead of a large number of dispersed technicians repairing one or two items at a time at a company or battalion workshop, one or two technicians could now repair all the damaged parts of a specific type for the entire theater. By creating an assembly line system, the British leveraged their highly skilled but limited number of technicians to complete all necessary repairs and fabrications.

The efficiencies attained by pulling technicians to a centralized location targeted an overall increase in operational readiness of the Tank Corps as a whole. Central Workshops sent small teams forward to assist with repairs in conjunction with major offensive operations. The teams consisted of a junior workshop officer, workshop non-commissioned officer, and technicians traveling to the front in lorries.²⁸ These teams would be the equivalent of the modern maintenance contact team sent forward by a Main Support Battalion or Brigade Support Battalion (MSB or BSB).

In conjunction with a more robust maintenance and repair effort, the Tank Corps used the divisional support companies to assist in recovering, evaluating, and repairing ditched tanks in the field. Salvage tanks from the Salvage companies provided necessary winching and lifting capacity to recover mired or disabled tanks and tow them to secure locations. They also possessed mobile workshops with substantial toolsets and could provide limited to extensive forward repair capability for tanks, usually depending upon availability of spares carried forward. Their work was often completed while under direct observation and fires from the enemy, resulting in many casualties. This drove them to

operate after hours of darkness as a force protection measure.²⁹ However, the linchpin for all repair operations continued to be the availability of the spares--both replacement parts and complete tanks.

In a coordinated effort, logisticians responsible for supplies combined with those responsible for maintenance and production to create a new support paradigm which survived and maintained relevancy into the modern era. This paradigm involved the merging of responsibilities of maintenance, logistics, and production further away from the front line units, creating a streamlined system which nested all three functions.

By early 1917, the tank pioneers were cognizant of shortfalls in production of spare parts. Data accumulation for parts failure, now available after a year of fighting, allowed tank maintenance managers to develop by-year estimates of parts requirements.³⁰ However, the emphasis on producing complete tanks overrode the capability of manufacturers to provide both spares and battle-ready tanks. Production managers knew they could not sustain such a process and lobbied to effect change supporting a more balanced production run.³¹ Their efforts ultimately resulted in additional production of operational spare parts which went to the Central Workshops for distribution to the field forces. All damaged or inoperable parts, now collected and repaired at the Central Workshops, immediately went back into the repair parts inventory for reissue.³² This system worked for individual parts, but another system was needed for catastrophic tank damage or failure.

The Central Stores provided the necessary solution to tank-for-tank replacement on the Western Front. After passing individual mechanical trials at the testing grounds, tanks became the property of the Central Stores, located near the village of Erin

approximately 250 kilometers north of Paris. From here, battalions received tanks to replace those lost to battle damage or extensive maintenance overhaul. The inoperable tanks, after being salvaged from the battlefield, were transported by lorry, rail, or tow vehicle to Central Workshops where they underwent complete overhaul.³³ Upon repair, the tanks were returned to the Central Stores facility for reissue back to a front-line battalion. Just prior to the Battle of Cambrai in 1917, the Central Stores established a system of Advanced Stores. These highly mobile organizations followed closely behind the main battle front and provided responsive tank-for-tank replacement until the end of the war.³⁴ As maintenance procedures matured and became more efficient, so did the process of supplying the daily demands of the Tank Corps.

Logistics

In 1915, the R.A.S.C. still conducted divisional support operations much the same as in 1914. Trains moved supplies as close to the combat as possible. Horse-drawn wagons moved the bulk of supplies to interim supply dumps, and lorries moved supplies from the dumps forward to the combat units. Once the supplies reached the combat units, the units generally assumed responsibility for moving their supplies forward in the attack. Since 1917, the Tank Corps had employed supply tanks outfitted with special spools and sledges to bring supplies up in the attack. Infantry and engineer units began using supply tanks as they became available to move their supplies forward. The field artillery also capitalized on the caterpillar craze by developing their own gun carrier tanks to move field pieces and ammunition around the battlefield.³⁵ However, the linking of supply with maintenance support proved the greatest advantage in the latter part of the war.

The evolving construct of maintenance logistics in 1918 is mirrored by the modern system of organizational, direct and general support and depot-level maintenance. The divisional support companies mentioned earlier, namely the Salvage Companies (later renamed Tank Field Companies), bridged the gap of supply and maintenance. Employed directly with the combat units, the Salvage Company provided a recovery function, organizational maintenance and repair function, and a parts supply function. The parts they carried could be compared to the modern day Prescribed Load Listing menu of critical parts authorized by local commanders based on actual demand.

The next level involved the Advanced Stores. These most closely replicate the direct or general support maintenance functions of today. Parts located at Advanced Stores compare with the Authorized Stockage Listing menu of demand-driven parts and bulk-storage components. Also, the tank-for-tank replacement would compare to the Operational Ready-Float vehicles released as a general support function today.

The final level of maintenance logistics linked the Central Workshops with the Central Stores. Complete overhaul, testing, major component replacement, and return to the theater supply channels made this echelon most like modern depot-level operations. Combining the three echelons created a robust system with the potential to provide flexible, responsive, and complete support to tanks in the advance. In practice, it was not quite as streamlined.

Trial and error over the previous three years had taught the British some hard lessons about logistics. Passchendaele showed that supplies needed a variety of transport platforms to account for severe weather conditions. Where tanks and horses lay mired, wheeled MT vehicles traveling on plank roadways moved freely about. The German's

failure in the Michael Offensive taught the British those units dependent upon rail, roads, and foraging for logistics support were vulnerable to interdiction, and that units with cross-country capability were more difficult to deny resupply.³⁶ Perhaps most importantly, the British remained committed to mechanization as the way forward in resupplying combat units on the battlefield, and continued to allocate the older Mk IV tanks for retrofit as supply tanks for all the branches.

Drive to Armistice

While failing to achieve critical mass at any particular point on the battlefield, the Tank Corps soldiers and their tanks represented themselves well throughout 1918. They trained hard and fought harder for the eventual victory. One continuing Achilles heel remained the lack of reserves at any echelon to help press the fight. In fact, with the crush of the Michael Offensive appropriating many soldiers into infantry units originally allocated to expand the Tank Corps, the Corps was reduced from six brigades to five for the remainder of 1918. Help was all but nonexistent as the Tank Corps only received two fresh battalions between August and November 1918. All other tank battalions were in a continuous though piecemealed fight essentially through war's end.³⁷

After the tank's highly successful use in the battles of Hamel and Amiens in the summer of 1918, few figured dramatically in the final weeks before the Armistice. Some historians, such as John Terraine, hold that the tank force had culminated by the end of September 1918. A noted exception is historian Tim Travers, whose calculations on mission-capable tanks available to General Haig from August through November 1918 revealed around 300 ready at any particular time of choosing.³⁸ Travers cites lack of trained crews, lack of reserves, and lack of spares (complete tanks) as the prime suspects

in keeping tanks out of the majority of fighting during late 1918. Though compelling, Travers fails to account for crew or unit cohesion, or logistical support. Further, with the allied breakthrough in October 1918, tanks likely lost significance with many leaders who envisioned the tank's role as primarily to execute the breakthrough, not win the war of maneuver.

¹Childs, 45.

²Williams-Ellis, 193.

³Keegan, 394.

⁴Travers, *How the War was Won*, 53-6.

⁵Hew Strachan, *The First World War* (New York: Oxford University Press, 2001), 269-71.

⁶*Ibid.*, 277-87.

⁷Keegan, 412-14.

⁸Childs, 35-7.

⁹Edward Goedecken, Charles Dawes and the Military Board of Allied Supply, *Military Affairs*. 50, no. 1 (January 1986): 1-6.

¹⁰Byron Farwell, *Over There: The United States in the Great War, 1917-1918* (New York: W. W. Norton and Co., 1999), 79-81.

¹¹The War Office, *Statistics of the Military Effort of the British Empire During the Great War: 1914-1920* (London: His Majesty's Stationery Office. 1922), 479.

¹²Williams-Ellis, 202.

¹³*Ibid.*

¹⁴*Ibid.*, 204.

¹⁵*Ibid.*, 207.

¹⁶*Ibid.*, 238-40.

¹⁷Fletcher, *Tanks and Trenches*, 129-30.

- ¹⁸Fuller, *Tanks in the Great War*, 163.
- ¹⁹Williams-Ellis, 192.
- ²⁰Tank Actions for the Month, *Tank Corps Journal* (June 1923): 328.
- ²¹Williams-Ellis, 301
- ²²Tank Actions for the Month, *Tank Corps Journal* (March 1923): 310.
- ²³Martel, 61.
- ²⁴Fuller, *Tanks in the Great War*, 126-7.
- ²⁵Williams-Ellis, 195.
- ²⁶*Ibid.*, 197.
- ²⁷Stern, 225-6.
- ²⁸Martel, 61.
- ²⁹Fuller, *Tanks in Great War*, 128.
- ³⁰Tank commanders were required to maintain logbooks showing fuel, oil and parts consumption in order to assist in the by-year estimates. Martel, *In the Wake of the Tank*, 63-65.
- ³¹Childs, 94-8.
- ³²Martel, 66.
- ³³Tanks required extensive overhaul, even if not damaged in battle, after about 70 miles of use. Fuller, *Tanks in the Great War*, 105.
- ³⁴Fuller, *Tanks in Great War*, 127-8.
- ³⁵Williams-Ellis, 193.
- ³⁶Fuller, *Tanks in the Great War*, 177.
- ³⁷*Ibid.*, 196.
- ³⁸Tim Travers, Could the Tanks of 1918 Have Been War-Winners for the British Expeditionary Force? *Journal of Contemporary History* 27 (1992): 389-406.

CHAPTER 5

CONCLUSION

Plan 1919?

Before the tide turned in favor of the allies in early fall 1918, some leaders were looking ahead to continued war in 1919. For those who championed mechanical warfare, thoughts revolved around what a potentially decisive employment of tanks might look like. Could the systems reviewed in this study have met the challenge of grandiose future plans?

In January 1918, Major General Sir John Capper, Director-General of the Tank Corps,¹ submitted a paper with an ambitious plan to raise a mighty allied force of over 8,000 tanks and 110,000 soldiers.² Two months later, General Elles submitted his own plan for action in 1918, referencing a force of 4,000 tanks used in a mass attack.³ Major Stephen Foot, one of Capper's staff officers and a battle-experienced tank officer, drafted a plan in April 1918, calling for the establishment of a completely Mobile (mechanized) Army. He envisioned an attack, "on a sort of super-Cambrai basis with heavy use of the newer types of tank."⁴ Most famous of the plans, normally referred to as "Plan 1919" was actually titled *The Tactics of the Attack as Affected by the Speed and Circuit of the Medium D Tank* written by J.F.C. Fuller.

Drafted in April 1918, the plan sought to unhinge the German war effort by a rapid penetration to sever communication links and destroy division, corps, and army group headquarters. Using a mix of 5,000 light, medium, and heavy tanks, the force would execute the decapitation stroke with medium tanks and aircraft, conduct a general

attack with heavy tanks, infantry and artillery, and follow up with a pursuit and exploitation with cavalry, light tanks and truck-borne infantry.⁵

Fuller's grand plan was in fact, based upon the evidence from this study, a pipe dream with little chance of ever being accomplished. In light of the findings from Chapter Four, infrastructure for training crews seemed adequate to meet the challenge. American tankers were being trained alongside British tankers by war's end. However, with the personnel challenges discussed in both Chapters Three and Four, expansion of maintenance capacity at the Central Workshops would be threatened by critical shortfalls in highly skilled technicians and engineers. Personnel shortfalls across the board would require a drastic shake-up in how Great Britain allocated general purpose and reserve recruits to their forces. Other forces (for example Americans) would have to fill the personnel gap, either as front-line infantry, tankers or skilled labor. Logistics capacity would actually grow as the tank force expanded and modernized. As shown in Chapter Four, more reliable tanks would need less support backbone, and conversion of the now excess Mk IVs to supply tanks would absorb additional supply requirements from more tanks and troops to feed and fuel. The largest drawback to not only Fuller's but all future tank war plans was a tangible link to reality regarding production capacity.

Apparently optimism abounded for prospects of the future, specifically in developing, testing, and producing the 2,000 Medium D tanks required for Plan 1919. Chapter Two outlined the shaky start tank production began under. Chapter Three detailed the actual shortfalls from the first real production run and Chapter Four gives account of total production shortfalls and projected shortfalls at the time of armistice. In reality, production could not meet current obligations for heavy tanks, and technical

problems with the Medium D tank made mass production by 1919 unlikely.⁶ Previously discussed shortfalls in skilled civilian labor, manufacturing infrastructure, and raw materials were not likely to be alleviated anytime soon, even with the Americans fully engaged in the war. Interestingly, Fuller himself in his 1920 history of tanks in the Great War described the Tank Corps as a shattered force by November 1918, and his accounting of tanks showed out of 1,993 tanks and other armored vehicles engaged in battle during the last hundred days of the war, 887 were turned over to Salvage. Only 204 had been repaired and reissued by the end of the war; 15 were declared unsalvageable; the rest were still in some sort of maintenance limbo.⁷ How he planned to bridge the gap between reality and the audacious Plan 1919 remains a mystery.

Past Is Prologue

One wonders if at the moment those first tanks crawled across the battlefield at Flers in late 1916 if the tank pioneers had any idea their invention would alter the way war would be fought for the remainder of the Twentieth Century. From clunky, slow, loud beasts spewing poisonous fumes to modern marvels of technology, the tank embodies the modern firepower triad of shoot, move, and communicate.

So what kept the tank from being the decisive weapon of World War I? That the tank failed at being decisive is a highly defensible proposition. Evidence indicates the Germans likely buckled under a combination of factors including: the economic strain and privation brought on by allied blockades; the failure of the German spring offensives of 1918 to achieve substantial results; the decline of German military morale as the Americans brought a quarter-million fresh troops into theater monthly; and socio-political upheaval and threat of internal revolution.

The waning strength of the German Army notwithstanding, the tank failed to be the war-winner through a variety of factors. First, and to be fair, no where did it appear to be the overtly stated outcome by any contemporary figure that the tank was to be the decisive weapon. Within the military culture of the Edwardian Army, technology was not to be trusted. Infantry and cavalry won battles with the close and deadly support of the artillery. Years passed before the tank would find its niche as a decisive weapon of modern ground warfare and then only by the impetus of a German officer, Heinz Guderian. Tactics manuals from the period specifically state the tank was a subordinate and supporting arm designed to enable infantry to close with and destroy the enemy while the cavalry exploited success.

Second, tanks never received a high enough priority within the GHQ to receive all the personnel necessary for them to become a decisive arm. Manpower shortages resulted in a shortfall of trained crews. Due to the inhospitable environment inside the tank, crews could only last several hours in operation before they needed rest and recuperation. A substantial boost in numbers of trained crews would have extended the operational reach of tanks through crew rotation.

Third, materiel shortages, including raw materials such as steel, and manufacturing infrastructure, proved intractable for the duration of the war. These shortages prevented the tank corps from ever meeting its approved tank end strengths, and consistently left few or no reserves in support of large tank attacks. With a lack of reserves, the common metric used was seventy-two hours of battle. This was the length of near-continuous combat time a commander could expect from his tanks and crews before they needed substantial rest, repair, or overhaul.⁸ Tank production numbers never met

their stated monthly or annual goals, and commanders were never able to build effective reserve forces prior to the end of the war.

Finally, technology from 1916 to 1918 was not mature enough to produce a machine that could, by its capabilities, become a decisive war-winner. Tanks remained mechanically unreliable, even with the introduction of the Mk V, a vastly superior offspring of the original Mk I design, with limited effective combat reach. All models were painfully slow, making them easy prey on the battlefield for field artillery pieces in direct fire mode. Wireless communication was still in its infancy as well, further hampering the efforts of the tank to achieve synergy with other combat arms on the battlefield.

What is important to note is the Tank Corps did an effective job of identifying and implementing a systematic method for training soldiers, repairing equipment, and supplying the force, all within a very short period. The British used existing military training models as the basis for their new requirements and quickly established training bases with skilled cadres in both England and France to start training crews, even before the first tank rolled off the production line. They continued to modify their training requirements based upon feedback from the front, emerging technologies, and advances in the ability of brigade-and-below echelon units to conduct their own training.

Throughout 1917, the Tank Corps wrestled with the issue of maintenance, spare repair parts, and skilled technicians. Out of a greater need to redistribute skilled workers across the entire army, the Tank Corps adopted a maintenance philosophy that empowered tank crews to execute more of the tank maintenance and repair tasks, thus freeing up skilled technicians to work in other, more critical areas of the war effort.

Appropriate crew training accompanied this mandate and maintenance efforts appeared to improve over the latter part of 1917 and throughout 1918. Despite these continually evolving systems for support, the tank failed to become decisive by 1918 and did not appear poised to emerge as a decisive weapon under wartime conditions in 1919 either.

Looking Ahead

How can the failures and successes from a hundred years ago help a military on the leading edge of technology and innovation? The US Army is currently undergoing a radical modernization while in the midst of the Global War on Terrorism. At the forefront of “transformation” is the development and implementation of the Future Combat System (FCS). This system consists of sixteen manned and unmanned systems linked by a common network which is designed to facilitate situational understanding and battlefield lethality. The program is scheduled to be phased in using spin-out technologies to bridge the gap between current systems and the finished product.

Though it sounds like the stuff of science fiction, the FCS shares many challenges and requirements of the tank in 1915. FCS must either integrate into the Army’s current maintenance program or develop its own system. Providing logistics under combat conditions to FCS has never been accomplished. Not a single soldier in the Army is currently trained and or certified on the operation or maintenance of any manned FCS systems. Leaders comfortable with their battle-tested equipment are reluctant to trade the known for the unknown. Branches that see the FCS as a threat are maneuvering to diminish that threat. Politics are thoroughly enmeshed in the process and every dollar spent and resource used for the FCS is one not being spent on the current fight. It appears the powers-that-be may be well-served by reviewing the lessons learned by the tank

pioneers before embarking on the latter stages of “transformation” to prevent the disasters endured by the tank force in its infancy. The British example with tank development suggests the successful fielding of the FCS requires adaptive thinking, flexible support concepts and a military culture willing to experiment while executing.

¹As Director-General, Capper served as representative for the Tank Corps with the War Office in Great Britain, while General Ellis commanded the Tank Corps in France.

²Harris, 163.

³Childs, 155.

⁴Harris, 166.

⁵Childs, 156.

⁶Ibid., 84, 156.

⁷ Fuller, 286.

⁸Ibid., 184.

BIBLIOGRAPHY

Books

- Baxter, Brian S. *Breakdown: A History of Recovery Vehicles in the British Army*. London: Her Majesty's Stationary Office, 1989.
- Beadon, R. H. *The Royal Army Service Corps: A History of Transport and Supply in the British Army*, Vol 2. Cambridge: Cambridge University Press, 1931.
- Boraston, J. H. *Sir Douglas Haig's Despatches, December 1915-April 1919*. London: J. M. Dent and Sons Ltd., 1979.
- Brown, Ian M. *British Logistics on the Western Front, 1914-1919*. London: Praeger, 1998.
- Cassidey, Robert M. *Peacekeeping in the Abyss: British and American Peacekeeping Doctrine and Practice after the Cold War*. London: Praeger, 2004.
- Childs, David J. *A Peripheral Weapon? The Production and Employment of British Tanks in the First World War*. Westport: Greenwood Press, 1999.
- Churchill, Winston. *The World Crisis*. New York: Scribner's, 1923.
- Cooper, Bryan. *The Battle of Cambrai*. New York: Stein and Day, 1968.
- Deighton, Len. *Blitzkrieg: From the Rise of Hitler to the Fall of Dunkirk*. London: Jonathan Cape, 1979.
- Edmonds, J. E. *Military Operations, France and Belgium*. London: Macmillan and Co., 1925.
- Eisenhower, John S. D. *Yanks: The Epic Story of the American Army in World War I*. New York: Touchstone Books, 2001.
- Farwell, Byron. *Over There: The United States in the Great War, 1917-1918*. New York: W. W. Norton and Company, 1999.
- Fletcher, David. *Mechanised Force: British Tanks Between the Wars*. London: His Majesty's Stationary Office Press, 1991.
- Fletcher, David. *Tanks and Trenches: First Hand Accounts of Tank Warfare in the First World War*. Dover: Alan Sutton Publishing Ltd., 1994.
- Foley, John. *The Boilerplate War*. New York: Walker and Company, 1963.

- Forbes, A. *A History of the Army Ordnance Services*. London: The Medici Society, Ltd., 1929.
- Fuller, J. F. C. *Armoured Warfare*. Westport: Greenwood Press, 1983.
- . *Tanks in the Great War, 1914-1918*. London: John Murray, 1920.
- Great Britain War Office. *Tank Training*. London: His Majesty's Stationery Office, 1930.
- Griffith, Paddy. *Battle Tactics of the Western Front*: London: Yale University Press, 1994.
- . *Battle Tactics of the Western Front: The British Army's Art of Attack, 1916-18*. New Haven: Yale University Press, 1994.
- Haigh, Richard. *Life in a Tank*. Boston: Houghton Mifflin Co., 1918.
- Hart, B. H. Liddell. *Reputations: Ten Years Later*. New York: Books for Libraries Press, 1928.
- Harris, J. P. *Men, Ideas and Tanks: British Military Thought and Armoured Forces, 1903-1939*. Manchester: St. Martin's Press, 1995.
- Keegan, John. *First World War*. New York: Alfred A. Knopf, Inc., 1998.
- Klein, Robert E. J. F. C. Fuller and the Tank. (Doctrial Dissertation, University of Chicago History Department, bound by CARL library), 1983.
- Know, MacGregor, and Williamson Murray. *The Dynamics of Military Revolution, 1300-2050*. Cambridge: Cambridge University Press, 2001.
- Larson, Robert H. *The British Army and the Theory of Armored Warfare, 1918-1940*. Newark: University of Delaware Press, 1984.
- Macksey, Kenneth. *A History of the Royal Armoured Corps and its Predecessors, 1914 to 1975*. Beaminster: Newtown Publications, 1983.
- . *Tank Warfare: A History of Tanks in Battle*. New York: Stein and Day, 1971.
- Marshall, S. L. A. *World War I*. New York: Mariner Books, 1964.
- Martel, G. Le Q. *In the Wake of the Tank: The First Eighteen Years of Mechanization in the British Army*. London: Sifton, Praed and Co., Ltd., 1935.
- Messenger, Charles. *Call to Arms: The British Army, 1914-18*. London: Weidenfeld and Nicolson, 2005.

- Miles, Wilfrid. *History of the Great War: Military Operations, France and Belgium, 1916*. London: Macmillan and Co., Ltd., 1938.
- Murray, Williamson. *Armored Warfare: The British, French and German Experiences. Military Innovation in the Interwar Period*. New York: Cambridge University Press, 1996.
- Murray, Williamson, and Allan R. Millett. *Military Innovation in the Interwar Period*. Cambridge: Cambridge University Press, 1996.
- Paret, Peter. *Makers of Modern Strategy from Machiavelli to the Nuclear Age*. Princeton: Princeton University Press, 1986.
- Parker, Geoffrey. *Cambridge Illustrated History: Warfare*. Cambridge: Cambridge University Press, 1995.
- Prior, Robin, and Trevor Wilson. *Command on the Western Front: The Military Career of Sir Henry Rawlinson, 1914-18*. Oxford: Blackwell Publishers, 1992.
- Samuels, Martin. *Command or Control? Command, Training and Tactics in the British and German Armies, 1888-1918*. London: Frank Cass, 1995.
- Sheldon, Jack. *The German Army on the Somme: 1914-1916*. South Yorkshire: Pen and Sword Military, 2005.
- Smithers, A. J. *Cambrai: The First Great Tank Battle, 1917*. London: Leo Cooper, 1992.
- Stern, Albert. *Tanks 1914-1918: Log Book of a Pioneer*. London: Hodder and Stoughton Ltd., 1919.
- Strachan, Hew. *The First World War*. New York: Oxford University Press, 2001.
- Swinton, Ernest. *Eyewitness: Being Personal Reminiscences of Certain Phases of the Great War, Including the Genesis of the Tank*. London: Hodder and Stoughton Ltd., 1932.
- Travers, Tim. *How the War was Won: Command and Technology in the British Army on the Western Front, 1917-1918*. London: Routledge, 1992.
- . *The Killing Ground: The British Army, the Western Front and the Emergence of Modern Warfare, 1900-1918*. London: Allen & Unwin, 1987.
- Williams-Ellis, Clough, and Amabel Williams-Ellis. *The Tank Corps*. New York: Doran, 1919.
- Wilson, Dale E. *Treat 'Em Rough! The Birth of American Armor, 1917-1920*. Novato: Presidio Press, 1989.

Winton, Harold R. *To Change an Army: General Sir John Burnett-Stuart and British Armored Doctrine, 1927-1938*. Lawrence: University Press of Kansas, 1988.

Wren, Jack. *The Great Battles of World War I*. New York, 1971.

Media

The First World War: The Complete Series. A Major Channel Four Historical Series. Based on the book by Professor Hew Strachan, Oxford University Press of Kansas.

Scholarly Articles

Barker, Ernest S. A Critical Analysis of the Employment of Tanks by the British in the First Battle of Cambrai. Fort Leavenworth: The Command and General Staff School, 1933.

Elles, Hugh. Some Notes on Tank Development during the War. *Tank Corps Journal*, (March 1922): 274-277.

Goedeken, Edward A. Charles Dawes and the Military Board of Allied Supply. *Military Affairs* 50, no. 1 (January 1986): 1-6.

Hoskins, Frank L. A Study of the History and Development of the Tank Prior to the Battle of Cambrai. Fort Leavenworth: The Command and General Staff School, 1930.

Hueper, Remi P. A Study of the British and Australian Tank Attack, 8 August 1918. Fort Leavenworth: The Command and General Staff School, 1933.

Maloney, Edward J. A Critical Analysis of the Employment of Tanks by the British in the First Battle of Cambrai. Fort Leavenworth: The Command and General Staff School, 1933

Royse, Frank. The British and Australian Tank Attack on 8-10 August 1918. Fort Leavenworth: The Command and General Staff School, 1933

Travers, Timothy. Could the Tanks of 1918 Have Been War-Winners for the British Expeditionary Force? *Journal of Contemporary History* 27 (1992): 389-406.

----- . The Evolution of British Strategy and Tactics on the Western Front in 1918: GHQ, Manpower, and Technology. *Journal of Military History* 54, no. 2 (April 1990): 173-200.

----- . British Army Command and Leadership Styles. *Journal of Contemporary History* 29, no. 3 (July 1994): 403-442.

Journals

Royal British Army. *Army Quarterly and Defence Journal*. London, 1919-1934.

Royal British Army. *Royal Artillery Journal*. London, 1919-1934.

Royal British Army. *Royal Tank Corps Journal (Tank)*. London, 1919-1934.

Royal United Services Institute for Defence and Security Studies. *Journal of Royal United Service Institute (RUSI)*. London, 1919-1934.

FMs and Official Government Documents

Great Britain War Office. *Tank and Armoured Car Training* vol 2 (provisional). London: H.M.S.O., 1927.

Great Britain War Office. *Tank Training*. London: His Majesty's Stationery Office, 1930.

Headquarters 301st Center. Training Order No. 27, Headquarters 301st Center, Tank Corps. American Tank Corps Training Requirements at British Tank Training Facilities. England: American E.F., 30 August 1918.

Encyclopedias

The Times History of the War, Vol 10. London: The Times Printing House, 1917.

British Government. *The War Cabinet Report for the Year 1917*. London: His Majesty's Stationery Office, 1918.

British Government. *The War Cabinet Report for the Year 1918*. London: His Majesty's Stationery Office, 1919.

Internet

Firstworldwar.com. Battles: The Battle of Flers-Courcelette, 1916, 11 August 2001. <http://www.firstworldwar.com/battles/flers.htm> (accessed 4 June 2007).

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