1914 1918 ONLINE International Encyclopedia of the First World War

Version 1.1 | Last updated 06 February 2018

Transportation and Logistics

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The Great War witnessed mass armies battling with modern, quick-firing weapons systems and using consumables of all kinds - ammunition, food, water, soldiers - at rates that had not been seen before. The logisticians of all armies created the administrative and infrastructure support that allowed the Great War to become the first truly modern industrial war.

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Introduction

Logistics at its core is the art and science of moving things from where they are produced to where they are consumed in a timely and cost-effective manner. Historians have a tendency to both appreciate and overlook military logistics. While they understand that armies cannot fight without supplies, transportation and logistics lack the glamour of operations or tactics. During wartime logistical practice at the operational (or theater) level of war is in many ways the most critical. At higher levels of policy and grand strategy, logistic decisions generally revolve around force composition and destination. Once the political-military decision-making occurs, logisticians need to

figure out how to get the materiel that their forces will need to the theater or theaters where those forces are to be committed. They must also plan to build up the infrastructure in theater to a point where the materiel can be distributed to the troops with regularity. It is this intermediate level at which much of the true heavy lifting occurs when it comes to logistic issues. A lack of infrastructure in theater or the inability to create such infrastructure can greatly handicap tactical resupply and thus cripple military efforts.

The practice of logistics affects us on a daily basis - when we buy groceries in a supermarket, collect the mail or fill our cars with gasoline for example. It also impacts us in much more subtle ways such as by ensuring a steady supply of coal or natural gas to power plants or by moving waste products to sewage treatment facilities when we flush a toilet. Indeed, by and large we take logistics for granted and only notice when events such as natural disasters cause supply chains to break down because of damage to critical infrastructure. War might well be considered a man-made disaster and it provides special challenges for logisticians. While we see competition in the civilian world, business competitors do not attempt to destroy the infrastructure required to move people or things. During wartime, however, combative nations work actively to try to interdict or destroy their opponent's supply chains. War also removes large segments of a country's population from productive activity such as manufacturing or farming and puts them in a place where they are inherently unproductive and, furthermore, where they have to be actively and continually supported. This article offers an overview of what logistics means at the different levels at which wars are fought, details on the kinds of supplies soldiers need in order to fight, the means of transportation available to deliver those supplies and, finally, a brief case study of these dynamics in a largely ignored theater.

Political, Theater and Tactical Logistics

The complex support systems for soldiers in the field start with the bureaucracies in those soldiers' home countries. While the combatants in World War One each had a unique approach, all had some sort of civil-military organization devoted to determining how best to meet their political and grand strategic goals. Logistic planning at this level involves determining the level of manpower and material support that a nation's forces require and deciding where to employ that manpower.[1] In most simplistic terms, some civil-military body in each nation asked and answered the question: "how many soldiers and sailors can and will we support in this war and where will we send them?" In most cases, this question had to be asked repeatedly as the war proceeded. In Britain, for example, the War Office, after consultation with the prime minister and his cabinet, decided that they could support France immediately with a British Expeditionary Force (BEF) of four infantry and one cavalry divisions.[2] While laughably small compared to the millions France and Germany mobilized in 1914, the BEF represented a very significant chunk of Britain's small peacetime army. The BEF's subsequent growth and the addition of more expeditionary forces in other places such as the Middle East and Mesopotamia were the result of additional decision-making in London.

Colonial powers had to consider globe-spanning empires. While most European great powers had overseas colonies and possessions, the dominance of the Royal Navy (RN) supported by the French and particularly the Japanese in the Pacific meant that the Central Powers had to essentially write off their colonies almost immediately. Britain and France, on the other hand, could call on the resources of their empires for support. Britain's role as the globe's dominant trading power provided scale and scope to allow the Entente to leverage those resources.

In Europe, Germany's political-military decision makers had to prepare for the possibility of a two-front war in both the east and west. For all the planning involved and the resultant war by railroad timetable, once it became clear that the war in France had stalled, both sides began to come to grips with what became the first truly modern industrial war. This meant massive numbers of men facing off and consuming munitions at an unpredicted and staggering rate. No one in a decision making position foresaw the rate at which munitions would be used and all the major powers involved suffered supply crises such as shell shortages in 1915.[3]

At the sharp end - where soldiers actually clash - tactical logistics is a matter of daily resupply often in the most difficult circumstances.[4] Food, water and other consumables need to be physically moved from army, corps and divisional areas to the soldiers in the fighting line. This requires a variety of means of transportation: light railways for artillery ammunition, horse and wagon, sometimes motorized transport and often the backs of fellow soldiers to reach the trenches. During the First World War, this had to be done daily, whatever the conditions, because the soldiers on the front lines could not simply go to the rear to pick supplies up at their leisure. All combatants devised some means of doing this as efficiently as possible. By early 1916, for example, the BEF had worked out what levels of resupply their formations required on a daily basis. They adopted the infantry division as their standard unit for resupply, as by then they had learned what a division consumed daily regardless of the fighting. The contents of what became termed a "divisional pack" filled twenty rail wagons: rations for the troops filled five (two bread, two groceries, one meat), "rations" for the division's motive power filled ten (four forage, five oats, one petrol) and to this they added a wagon each of coal or coke, mail, ordnance, mechanical transport spares and one additional wagon with miscellaneous goods. The BEF assembled the first fifteen wagons for each division each day at base ports and pushed them forward automatically; the last five wagons were added at a regulating station and the complete train (two divisional packs, forty wagons) arrived at a railhead daily where the two divisions collected the contents.[5] Beyond this, the BEF's General Headquarters (GHQ) had to plan for and arrange the transportation of variable supplies such as ammunition, additional construction materials and the like which were needed over and above the daily usage. Continental powers likely made similar determinations much earlier on because they began the war with large standing armies and likely knew at the outset what their formations would need daily.

In between the political-strategic decision making and the tactical resupply of soldiers on the fighting lines lies the operational or theater level of logistics. This encompasses everything from base ports or major home nation depots, rail lines and regulating stations to the railheads where supplies were

delivered to armies, corps and divisions. It can also encompass maritime theaters, such as the Atlantic, and the movement of supplies through those theaters from home nation ports to base ports in combat theaters on land. In all theaters an enormous effort went into building, maintaining and expanding the infrastructure that supported this level of war. The American Expeditionary Force (AEF) for example used, maintained and expanded eighty-nine berths in twenty-eight ports and used over 8,000 kilometers of rail lines to move supplies from those ports to storage areas, depots and railheads during 1917 and 1918. They planned for ninety days' supplies in theater at all times with another thirty continually in transit. The AEF forecast that it would need 92,000 metric tons of supplies per day had it reached its 4 million man goal. As a result, as soon as American troops began to arrive in France and through the end of the war, the AEF was the focus of numerous massive construction projects. These included the storage yard at Montoir with its 14 million square feet of storage on 1,200 acres and other facilities of only slightly less massive scale.[6] Tens of millions of square feet of storage, hundreds of kilometers of rail and light rail, plus roads were under construction simply to put the AEF in a position where they could ensure that their soldiers at the sharp end had what they needed to fight.

Soldier's Needs

In order to fight effectively a soldier (indeed an army) requires many things. First and foremost he needs weapons, ammunition and their regular resupply. Unlike wars in the early 19th century where a soldier carried black powder and the tools required to cast his own musket balls, Great War soldiers carried highly machined standardized rifles firing modern brass cartridges with little tolerance for error. The cartridge for the British Army's Lee Enfield rifle (.303 inches, or slightly less than 7.7 mm) could not be used if captured by a German soldier armed with a 7.92 mm Mauser (roughly .312 inches). As a result, armies had to ensure that sufficient stocks of the correct ammunition were readily and plentifully available to front line soldiers. By and large, standardization helped in this regard, since most armies adopted a single primary rifle for the majority of their infantrymen. Even so, some variation occurred, as with the Ross rifle which the Canadian government chose to issue their soldiers as their primary infantry rifle. On the surface, this ought not to have been an issue since it required the .303 cartridge used by the Lee Enfield. In practice, however, this was not the case. While an excellent target and sniper rifle, the Ross had less tolerance for slight variance in the cartridge size and it needed careful attention to cleanliness as mud and dirt had a tendency to cause its breech mechanism to jam open or closed.[7] Unfortunately dirt and mud was exactly what Canadian soldiers faced in Western Europe and the Enfield proved a much more robust design in battlefield conditions.

Soldiers were also supported by formations using a wide array of field and heavy artillery pieces ranging from the famous French "*Soixante-quinze*" (75 mm) field piece to the massive Krupp "Big Bertha" 420 mm siege guns used by the Germans. During the war both sides expended vast quantities of ammunition, especially on the western front, and use ramped up steadily over time. The

BEF, for example, in spite of beginning the war with a tiny force in France and then dealing with a major shell crisis during 1915, managed to expend 3.4 million metric tons of artillery ammunition over the course of the war (see Figure 1).

Figure 1: BEF, Cumulative Shell Tonnage Expended, 1914-1918 (millions of metric tons)[8]

Figure 2: BEF, Artillery Expediture by Type, 1914-1918[9]

In addition, the composition of this ammunition changed drastically over the war. As illustrated in Figure 2, 75 percent of the expenditure in 1914 was field artillery (13-pounder, 18-pounder and 4.5" howitzer). By early 1918 that number had slipped to one third and over the course of the war 62 percent of British tonnage expenditure in France was heavy artillery (4.7" guns and 60-pounders through 15" howitzers).[10] The truly staggering thing to note about Figure 1 is how Britain's expenditure accelerated so dramatically from the second quarter of 1917. We are used to thinking of the battle of the Somme as a vast artillery struggle. While it did represent an order of magnitude increase over earlier battles, the engagements in 1917 and 1918 saw that kind of order of magnitude increase again. While the BEF did expand from roughly 1.6 million to just over 2 million men from 1917-18, this growth does not explain the dramatic change in ammunition expenditure. The growth in ammunition expenditure can be more accurately tied to the rationalization of the BEF's lines of communication following a near-breakdown during the Somme offensive. This allowed them to maintain in 1917 and 1918 a level of ammunition expenditure commensurate with modern, high intensity conflict.[11] For the continental powers growth in ammunition expenditure might not have been as dramatic since they started with a much larger military base. It would not be surprising, however, to see a similar change in the rate of their ammunition expenditure between 1914-1916 and 1916-1918.

A soldier also requires shelter — clothing and relief from the weather, even if that relief is little more than a small dugout carved into a trench wall. This meant a continuous supply of clean clothing and building materials had to be available. For all armies, clothing issue, repair and reissue was a large and significant task. Natural materials, which were what tailors and cobblers of the day had to work with, break down easily in harsh conditions and conditions on the western front in particular were very harsh on clothing — the wet and mud proved inimical to the long term survival of clothing and footwear. As such, a large supply of replacements had to be kept readily available and a significant infrastructure grew on the lines of communication for both the distribution and salvage of clothing.

Food is another necessity and providing some 4,000-5,000 calories per day was a difficult challenge, particularly in combat conditions. Malnourished, starving, dehydrated or frozen soldiers simply cannot be expected to fight effectively except in cases of direst need. When modern forces' lines of communication are severed, crisis generally strikes quickly — the United Nations forces' retreat from the Chosin Reservoir during the Korean War and the surrender of the remnants of German Sixth Army at Stalingrad in early 1943 are two excellent examples. These are not, however,

examples of the kind of conditions under which armies prefer to fight; given a choice, army leadership would always want their soldiers healthy, well nourished and plentifully resupplied with all that they need. As Frederick Maude (1864-1917), commander of the Mesopotamian Expeditionary Force (MEF) in 1916-17, wrote, “if you feed them well they feel well, and consequently they fight well, and it is money well invested.”[12] The difficulty in providing rations was exacerbated by the fact that the calories supplied needed to comprise a reasonably balanced diet that will not trigger health issues due to a lack of key nutrients. A lack of certain elements in the diet, such as vitamin C, leads to health problems like scurvy, from which British forces suffered in Mesopotamia before their lines of communication became a focus of effort. In some cases the challenge was even further enhanced by religious dietary requirements.[13] This was evident in British Empire forces, particularly those from the Indian subcontinent. India had both a tremendous and diverse population and her soldiers shared that diversity. Delivering beef to a predominantly Hindu battalion or pork to a predominantly Muslim one would raise serious problems. First, the affront to their religion would deal a blow to unit morale and cohesion and second, the refusal of the soldiers to eat the meat would leave them short on rations. Given the sheer size of the armies involved, simply keeping the soldiers on the front lines resupplied with rations on a daily basis proved a tremendous challenge to the quartermasters of all armies.

Finally, a soldier required at least a couple of liters of potable water over and above that contained in their food, plus water for sanitary purposes such as shaving and a means of efficiently disposing of human waste, ideally in a manner that would not result in its being spread liberally about the countryside by shelling. Even more than food, water is required to sustain human activity and its absence can prove disastrous far more rapidly than lack of food. Not only did armies have to get potable water to the front lines but they also had to provide water to the soldiers and laborers who built their infrastructure at all points from bases and ports through to the front lines. These requirements would have run up to two liters *per hour per man* for hard labor during the heat of the day and one liter per hour in cooler conditions or at night.[14] Furthermore, when the temperature or combined effect of temperature and humidity reaches roughly thirty degrees Celsius, one must break up the working period with considerable periods of rest — say twenty minutes work and forty of rest per hour — which draws out the amount of time it takes to get things done.[15] It is simply not possible to perform hard labor continuously in extremely hot and/or humid conditions without endangering the laborers. The difficulty here is that soldiers on the front lines could not, in all but the most unusual circumstances, turn on a faucet and get potable water. As a result, armies had to build the infrastructure required not only to get the water in the first place but then also to treat it to make it potable and both store and move it in sufficient quantities to meet the needs of soldiers in the trenches and those building the lines of communications.[16] Pipelines were used in some areas but they were very vulnerable to shell fire. Anywhere near where fighting might occur, water had to be moved by vehicle in containers and physically delivered to the troops.

Beyond these daily basics, a soldier needed access to such things as medical care and regular mail

delivery. Sick soldiers fight poorly, if at all, so regular care and attention to their well-being was necessary. Casualties due to sickness and disease were, until the advent of penicillin, historically higher than battle casualties. In the Great War, this remained the case, particularly in theaters where maladies such as malaria were prevalent. Edward Erickson, for example, offers Ottoman Empire figures of 466,759 disease fatalities during the war compared to 305,085 combat dead and missing.[17] The injurious possibilities of disease were also evident in 1918 when the great influenza pandemic swept the globe. The German offensives in the late spring in the west were impacted by the first pandemic wave from May to July which left 139,000 soldiers debilitated by June. The second and more deadly wave swept Western Europe in September and killed nearly as many Americans as died in battle (43,000 influenza fatalities).[18] Indeed, the global death toll of the pandemic, at least 50 and possibly over 100 million, killed far more than died in battle during the entire war.[19] While soldiers did not require the daily intervention of medics unless they had actually fallen ill, ready access to medical care was crucial.

In addition, regular mail service is something that armies needed to provide in order to maintain morale. This took more effort than one might assume at first glance. Mail, both letters and packages, took up significant space — up to one rail car per division per day in the case of the BEF. Without communication with the outside world and accessible medical care, sickness and poor morale can easily sap an army's ability to fight effectively.

The western front required massive logistic support because of the sheer manpower involved - millions of troops engaged in modern, high-intensity conflict. At the same time, the dense population and transportation infrastructure there necessitated the vast number of troops involved: this is something of a catch-22 but one that could be overcome by applying yet more mass to the problem. On the eastern front, massive numbers of Russian, German and Austro-Hungarian troops also faced off but the sheer length of the front meant that troop densities never matched those in the west. Nonetheless, huge quantities of railway construction occurred in the east, particularly after the Central Powers pushed the Russians back nearly 450 kilometers following the confrontation at Gorlice-Tarnow in May 1915. Though, as late as mid-August, German railway construction was still 125 kilometers short of the new front lines.[20]

Other theaters, such as the Middle East saw fewer troops because they possessed less dense infrastructure to leverage. Theaters such as East Africa and Mesopotamia placed rather unique problems in the way of logisticians. How, for example, does one get foodstuffs or ammunition from London to the center of the East African conflict? In this case, as Edward Paice relates, most supplies arrived from overseas at Durban, South Africa; from there, the supplies:

- were shipped to Beira,
- transferred to smaller steamers and shipped eighty miles to Chinde,
- transferred to river boats and moved up the Zambezi to Chiromo,
- moved by rail from Chiromo to Blantye,

- overland by wagon, truck or porter to Lake Nyasa,
- and finally moved 200 miles up Lake Nyasa by ship.

A second route ran by rail from Cape Town to Livingstone (around 1,500 miles) and then "a further 700 miles by carrier and canoe through Northern Rhodesia to Fife."[21] All this, as Paice notes, merely got the supplies to the equivalent of a base port in France—into the theater, in other words. The supplies still had to be moved forward by rail, road, wagon and porter to the troops themselves. Essentially, to supply troops in East Africa, the British used every means of transportation except aircraft.

Another example of such difficulties is the one faced in general by the Ottomans. The Ottoman Empire operated a mere 5,759 kilometers of railway in 1914 and generally lacked natural internal lines of communications such as major navigable rivers. Nonetheless the Ottomans faced four widely separated fronts at most times during their participation in the war, of which three faced serious logistic obstacles. The Middle East (Palestine) battle front lacked continuous rail lines from Istanbul — supplies headed from Istanbul to Haifa had to be trans-shipped (off-loaded from one rail system and re-loaded on a second) at Pozanti and then a second time at Osmaniye before arriving at Haifa. The Mesopotamian front lacked *any* direct rail links to the Mediterranean and the nearest railhead to the Caucasus front was Ankara. This meant that supplies to Mesopotamia or the Caucasus faced long overland routes by pack train which greatly limited the forces that Ottoman commanders could bring to bear.[22]

Means of Transportation

The armies of 1914-1918 faced the challenge of supplying millions of men in theaters scattered around Eurasia and Africa with, essentially, 19th century technology. Steam ship, steam locomotive and horse drawn wagon were the prime movers of supply for much of the war. While the automobile began to impact some areas (particularly with its use by the AEF) by the end of the war, it remained eclipsed by the horse. Indeed, the vaunted German *blitzkrieg* of the *next* world war was primarily supported by horse-drawn transport.[23] Nonetheless, armies did seize on the automobile and motorized transport to as great an extent as possible. By the armistice the British employed over 81,000 vehicles in eight overseas theaters (France, Italy, Salonica, northern Russia, Malta, Egypt, East Africa and Mesopotamia) with nearly 14,000 more in service in Britain and some 24,000 in depots ready to ship overseas. Of these, 70 percent were in France and just under 8 percent in Mesopotamia with Egypt, Salonica and East Africa accounting for between 5 and 6.5 percent.[24] The AEF also made extensive use of motorized transport, using 274,000 vehicles during their time in France. These "included 219 makes and models of American, French, British and other allied designs."[25] The sheer number of models and their attendant parts caused maintenance difficulties which at times, such as during the Meuse-Argonne offensive, had half the available trucks down for servicing.[26] This experience convinced the U.S. to standardize its trucks in the next world war.

With the exception of commercial aviation, businessmen and militaries moved goods and people around the globe in 1914 much the same as in 2014. In 1914, almost all global trade moved by sea, generally in coal-fired shipping; today, almost all global trade still moves by sea but the ships are oil-fired, much faster and far larger than their predecessors. Modern shipping is also far more automated. In 1914 veritable armies of stevedores loaded and unloaded ships by hand. Ships of the day used a combination of cranes, booms and manual labor with everything being loaded through large cargo hatches on the ship's main deck. All contents had to be moved dockside to a point where the ship's cranes and booms could access them and lift them into the hold. Once there, stevedores and longshoremen physically moved the goods around in the hold and secured the cargo therein.[27] At the end of the voyage, the whole process had to be reversed to unload the cargo. Today, most goods travel in shrink-wrapped, palletized and containerized form and require few dock workers to load or unload. Even modern bulk ships' loading and unloading is largely controlled by computer. On land the most efficient way to move things was and remains the railway — while there are fleets of large trucks plying modern highways, rail is still the most cost-effective means for moving goods over significant distances. The biggest change over the past century, however, has occurred in the means by which we move people. For long distance or inter-continental travel, today's primary choice is commercial aviation; for shorter distances, the automobile is the first choice of many. In 1914, truly long distance or inter-continental travel happened by sea and, outside of those immigrating to new countries, was largely the purview of the wealthy. We take for granted that today we can move goods and people faster and in vastly greater volumes than in 1914. What took days in 1914, travel from New York to London for example, now takes hours. It is useful to consider just how much things have changed during the past century.

At the outbreak of the war, roughly 45 percent of the world's merchant ships in excess of one hundred tons carried British Empire flags; they totaled just over ten thousand ships and roughly 20.5 million tons of shipping.[28] In fact, Britain controlled closer to 55 percent of the globe's merchant marine and global trade.[29] In 1914 Britain's maritime power, the combination of the strength of a nation's navy and the transport capacity of its merchant marine,[30] was essentially devoted to the maintenance of the British economy. It could not simply be switched over to support overseas military commitments. Nevertheless, its sheer scale when combined with pre-war ship building output allowed scope for supporting military operations without undue detriment to the economy. At that time, when counting only ocean-going ships greater than 1,600 gross registered tons (GRT), the British merchant fleet averaged just over 4,300 GRT per ship; by April 1918 the average had increased to just over 4,600 GRT.[31] At around the same time the United States Shipping Board's production had just begun to arrive in service. This consisted of ships running 4,800 to just over 5,600 GRT. A good example of these is the four ships that comprised Pan Atlantic Shipping's 1935 fleet and averaged 391 feet in length and 5,023 GRT.[32] One GRT is really a measure of volume equal to one hundred cubic feet,[33] so the average British merchant ship in 1918 had a carrying volume of roughly 460,000 cubic feet. In comparison, modern container ships are rated in terms of the number of "trailer equivalent units" or TEU that they can nominally carry. One TEU represents a

container that is twenty feet by eight feet by eight feet and roughly 1,150 cubic feet in volume when the container itself is allowed for — the definition varies slightly — and many modern container ships carry 7,500 TEU or more.[34] Ironically, one TEU is roughly the same size as one of the famous "forty and eight" boxcars that saw use on the French railways during the Great War. All armies invested enormously in infrastructure development, but French, British and American building included significant port expansion to handle more ships simultaneously.

While land combat gets much of the attention of authors, naval logistics and, for the first time, aerial logistics played roles in the Great War. The latter by and large fell under the land warfare category because most of the planes of the day were short-ranged with limited load capacity. As a result their resupply generally fell in amongst the supplies being moved to support armies in the field. While the tonnage of those supplies increased steadily as fighter and bomber performance and capability grew, they never approached the level that would be seen later in the 20th century. Naval logistics, on the other hand, was important to powers that maintained navies — vitally so to Britain.

A warship is an inherently different fighting tool than, say, an army division or brigade. For starters, capital ships carried far larger and more powerful artillery than armies used; certainly they were heavier than those deployed by brigades or divisions. Capital ships deployed batteries of main guns ranging from 280 to 380 mm and the 330 guns that comprised the main batteries of the RN's Grand Fleet dwarfed those available to the BEF.[35] Further, fleet warships of 1914 were entirely mechanized, the coal or oil-fired boilers of the RN's "capital ships, cruisers and destroyers coming to some 3 million horsepower" or likely at least sixty times that of the BEF.[36] Finally, once it leaves port, a warship is effectively a self-contained ecosystem carrying with it all it requires until it again reaches port—fuel, ammunition, water, food and shelter for its crew. The limits of its range and ability to project power are determined largely by the contents of its fuel bunkers and ammunition magazines. Indeed, one of the primary reasons for the plethora of RN bases in out of the way places such as Port Stanley in the Falklands was to provide ready access to coal supplies, thus extending the range of their fleet assets to a global scale. Units of the Imperial German Navy (IGN) that left or found themselves outside the confines of the North Sea had a range that was limited to the coal in their bunkers plus what they might be allowed by neutral countries or what they could commandeer. In some cases, secretive rendezvous were set up between German high seas raiders such as the SMS *Emden* and supply ships that had run the gauntlet of the RN's blockade but this was always a calculated gamble.

The early months of the war at sea provide excellent examples of the difficulties faced by the IGN in supplying their fleet units overseas. The IGN wanted to conduct cruiser warfare as they clearly realized that Britain relied on her merchant marine. A lack of overseas bases and the need for modern ships to re-fuel with coal regularly made this a very difficult proposition. Considerable effort went into creating a system where supply ships could rendezvous with cruisers overseas. These meetings frequently brought German commercial and diplomatic personnel into disputes with neutral parties. Ultimately, the difficulties with trying to get supply ships in contact with raiders left German

captains obsessed with finding coal sources, whether from neutral countries, raiding allied ports or capturing prizes at sea.[37] For example, Vice Admiral Maximilian Graf von Spee (1861-1914) and his East Asiatic Cruiser Squadron based around the modern armored cruisers *Scharnhorst* and *Gneisenau* learned of the opening of hostilities on 6 August 1914 while at Ponape in the Carolines. Spee immediately topped up his coal and sailed for Pagan in the Marianas to await the "colliers, supply ships, and auxiliary cruisers which had been ordered to join him." By 12 August he had eight colliers and supply ships with him but four others had been captured; this, combined with Japanese hostility meant that he could not operate in "East Asian, Australian, or Indian waters: lack of bases and coal was the overriding consideration, and the coal consumption of the *Scharnhorst* and *Gneisenau* was too high."[38] The need to continually refuel with coal combined with the Japanese declaration of war on 23 August forced Spee towards South America where, following the capture of a British ship loaded with coal on 3 December, he decided to attack the Falklands which he believed undefended.[39] The British, however, had instituted an active hunt for Spee and realized the importance of their coaling station at Port Stanley. Spee's squadron arrived on the morning of 8 December, midway through the roughly forty-eight hours it normally took to reload the coal for Vice Admiral F.C.D. Sturdee's (1859-1925) battle cruisers *Inflexible* and *Invincible* which had arrived the day before and which significantly outclassed the German warships in terms of speed, armor and fire-power. The destruction of Spee's squadron on 8 December left the naval war between the British and Germans largely to the North Sea, the Mediterranean and, ultimately, to submarines, which proved far more dangerous than cruisers without overseas bases from which to replenish coal supply.[40]

Example: Mesopotamia

While the western front provides numerous logistic lessons, the Mesopotamian Theater provides an interesting example of both theater logistics and a theater where water was critical. The area in which the British and Ottoman empires faced off was not blessed with abundant transportation infrastructure. Moreover, its climate at certain times of the year was brutal, with the summer heat placing huge water demands on any strenuous outdoor activity. Indeed, the summer was so hot that it was often described as "leave season" since the idea of carrying out active, high-tempo operations was borderline madness. British operations in late 1915, for example, began on 1 September after the worst of the summer heat and in late 1917 British operations ceased in May due to the heat.[41] Shortly thereafter, in early June, Maude noted that his troops were in their summer camps — the desert corollary to winter quarters in Europe — and that they had access to ice plants, fluids and other comforts. He noted that the troops "must be kept under cover during the heat of the day" but that he also expected them to keep fit and well trained during the cooler parts of the day.[42] Maude noted in early 1917 that September to December were "the best months for operations" with some additional reasonable weather normally expected in February. January was generally bad due to wet weather which all but stopped motorized transport, slowed rail traffic and forced animal transport to

be used only for short periods for fear of exhausting them in the mud.[43]

British forces landed at Fao in early November 1914 and secured Basra, the primary port, three weeks later. During 1915 British forces pushed from the Basra area up the Tigris to Amara then Kut and up the Euphrates to Nasiriya. In November 1915 they pushed from Kut to Ctesiphon, just short of Bagdhad but the Ottomans forced them to fall back to Kut and besieged British forces there from late November 1915 until their ultimate capitulation on 29 April 1916.[44] From 4 January through 24 April 1916 British forces attempted to relieve Kut but failed, largely because their lines of communications did not enable them to bring sufficient force to bear. Ironically, once these issues had been ironed out, the MEF occupied Kut on 25 February 1917, having begun their push late the prior year on 13 December. They reached Baghdad two weeks later and consolidated their position there by the end of April 1917 having pushed a hundred miles beyond to Samara. By the armistice, the MEF had pushed as far as Mosul and the logistic focus of 1916 and 1917 left the Ottomans unable to push back the MEF.

In early 1916 the War Office assumed control of the campaign and began the process of developing a modern line of communication originating at a fully functioning base port. At the time of capture and for the following year, ocean going shipping in Basra unloaded via lighter (barge) from midstream to shore rather than tying up at wharves. Had the lighters been able to then proceed immediately up river this might not have been such a problem. Instead the contents had to be moved ashore in Basra, sorted, stored and then dispatched to the formations upstream. After twelve months the continuation of this state of affairs had forced the War Office to take note and institute changes which led to the construction of docks and proper storage depots, over time converting Basra into a fully functional base port from which supplies could be forwarded via river, rail or road. Maude and his successor ultimately benefitted from this work as it, along with the delivery of significant quantities of riverine transport, rail supplies and land transport (both animal and motor-powered) created the modern line of communications on which they and their troops relied.

When Maude took over the MEF on 24 August 1916 he keenly appreciated the need to get his transportation infrastructure in order, writing, “The whole crux of the question is one of supply and transport.”[45] Indeed, it might be fair to say that Maude proved obsessive about his supply and transport situation, as it cropped up with startling frequency in his letters and telegrams, but it was an obsession shared by the Government of India and the War Office which both realized that the war in Mesopotamia required full and complete planning.[46] Unlike the Ottomans, who had to rely entirely on overland transport, Maude could make use of riverine transport on the Tirgis and, to a lesser degree, the Euphrates. The Tigris was navigable to shallow-draft vessels from Basra to a considerable distance upstream of Baghdad. While movement could be slow because the supply had to flow upstream against currents that could reach six miles per hour, this meant Maude did not have to rely on rail or road alone. In late 1916 Maude continued to emphasize the issues of supplies and transportation; following the advance to the Haj, he immediately began pushing the rail line forward and supplemented it with “streams of Ford motor vans perpetually on the move and long

lines of camels and mule carts..."[47] All of this was aimed at accumulating supplies, ammunition and stores as far in advance as possible. By February 1917 he had reached a point where he could provide reasonable estimates to the War Office of the kind of daily needs his lines of communication had to meet. He wrote that for four infantry divisions and one cavalry division he needed "500 tons daily for rations, forage and fuel" with another hundred tons per day for "mails, canteen, ordnance and RE stores" and a variable quantity of ammunition which ranged from ten to 120 tons per day during heavy fighting.[48] Erickson notes that the British pause in the late spring of 1917 was a godsend for the Ottomans and that its impetus was logistic. Maude paused to shore up his logistics and because "disease season" had arrived. He did not realize that while his situation was dicey, the Ottomans' was dire.[49] Nonetheless, Maude's decision to pause, while helping the Ottomans, is simply another indication that he was determined not to allow his forces to over-extend and suffer a reverse.

By late August 1917, Maude's line of communications was working to extend one 2'6" rail line to Shahraban and pushing the standard gauge line to Museyib. They also planned to convert an existing 2'6" line to meter gauge in order to reuse the smaller gauge forward from Shahraban. In addition, Maude had six mule columns, three motorized columns and three camel columns moving supplies forward. Finally, even though the rivers were at their summer lows, few ships were grounding because a great deal of work had gone into buoying the channels adequately.[50] By the end of the war, Maude's successor, Lieutenant-General Sir William Marshall (1865-1939), commanded one of the largest riverine fleets in the world – "419 river steamers, 27 hospital steamers, 774 barges and 414 motor boats" operating from what had become a very large base port.[51] Indeed, Basra's mid-1918 capacity of 130,000 tons per month was not far short of what the BEF planned to import to France in March 1917 through the wharves it had been assigned at Boulogne.[52] Marshall's inland water transport ran a daily average of nearly 3,700 tons of supplies from this base port to the river head at Mosul, 792 river miles upstream. On land, forty-two Army Service Corps motor transport companies, with over 7,000 vehicles, provided support still further forward and supplemented the roughly 750 miles of railways and their attendant 191 locomotives and 3,950 wagons.[53]

Figure 3: Weekly Average Freight Tons on MEF Railways and Waterways: December 1916 through December 1918[54]

* Baghdad—Baiji—Sadiyeh line began operations

** Kut—Hinaidi; Hinaidi—Table Mountain—Kizel; and Basra (local) lines began operations

*** Nahr—Umar (local) line began operations

**** Baghdad—Fallujah—Dibban line began operations

***** Baghdad East (local) line began operations

****** Baghdad—Hillah line began operations

Figure 3 illustrates the growth in the combined river and rail tonnage capacity enjoyed by the MEF. While Maude succumbed to dysentery on 18 November 1917, his focus, indeed near-obsession, on the lines of communication is evidenced by steady growth in 1917 and then the relative explosion in total tonnage moved in the last half of that year. Marshall was able to make full use of a line of communication that, at its peak in the late spring of 1918, was moving nearly 13,500 tons of supplies per day by rail and river.

In contrast, the Ottomans did not have the relative luxury of a navigable river and they faced having to move all of their supply needs overland through a very harsh desert by rail, motorized transport or animal train. Furthermore, the overland distances they had to cover were considerably longer. Basra to Baghdad is roughly 450 kilometers, direct. Aleppo to Baghdad is 750 kilometers and from Ankara it is nearly 1,250 kilometers, direct. While the MEF could take advantage of the river to move the majority of their freight until railway construction finally allowed the rails to begin moving more in mid-1917, the Ottomans had no alternatives except pushing their supplies over land. While Baghdad was a major population center, much of the war-fighting material needed had to come from as far away as Constantinople or Germany. Early on, the Ottomans faced a 360 mile gap between Samara, north of Baghdad, and the rail head at Ras-El-Ain and had only just finished closing the gap in October 1918 allowing rail traffic from Constantinople. Even though all of the MEF's supplies arrived from overseas and from all over the British empire, once in theater those supplies had far less distance to travel. The British could use the natural lines of communication provided by the rivers and this allowed the MEF to bring more force to bear more efficiently than its opponents.[55]

Conclusion

Logistics is a critical part of both modern life and of modern military endeavor. A century removed from the opening salvoes of the Great War, there is little truly new in terms of means of transportation. Logisticians of the combatant powers in the Great War made extensive use of ship and rail. They made increasing use of the automobile as the war progressed but the true logistic implications of the automobile and airplane would not be illustrated until the next world war. Overall, the Germans, French, British and eventually United States made the most effective use of transportation as all began the war as highly industrialized nation-states with dense transportation infrastructure and global trade routes. Even more importantly, they had the civilian expertise and organizations that used and managed that infrastructure and trade on a daily basis and could be tapped to help the military effort. As a result they proved best able to meet the demands of modern war. At the same time, the density of infrastructure in France and Germany contributed directly to the intensity and mass of combat on the western front.

The Russians, Austro-Hungarians and Ottomans proved less successful not because they were incapable but because they simply began the war as less industrialized powers with correspondingly

less well-developed infrastructure and a smaller base of expertise upon which to draw. Furthermore, in the Russian case they had to deal with the vast overland distances from their industrial centers to the front lines. The Ottomans dealt with both distance and, even more significantly, fighting on multiple fronts. The Mesopotamian Theater is a useful case study because it illustrates many of the difficulties facing the Great Powers when they faced off in areas that, for all intents and purposes, lacked infrastructure. Both the Ottomans and the British had to create and maintain that infrastructure in order to support their troops in theater and both had to do so while also dealing with other combat theaters. Limitations of scale and efficiency in 1914 meant that logisticians of the day had to work extremely hard to build infrastructure and support the troops. In spite of such limitations, the continental powers all fielded and supported millions of men. Both the British Empire and United States managed to support multi-million man armies overseas well enough that those armies could fight successfully on a continental scale. Most of the major powers also supported armies on fronts around both the Eurasian and African land masses. This was no small feat and the success of the logisticians of all combatant nations ushered in an era of modern industrial, high-tempo, high-intensity mass warfare.

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Notes

1. ↑ Newell, Clayton R.: Logistic Art. In: Parameters (1989), p. 34.
2. ↑ Brown, Ian M.: British Logistics on the Western Front, 1914-1919, Westport and London 1998, p. 42.
3. ↑ Stevenson, David: With Our Backs to the Wall: Victory and Defeat in 1918, Cambridge, MA 2011, p. 11.
4. ↑ For a good description of the term “sharp end” see the introduction to Cook, Tim: At the Sharp End: Canadians Fighting the Great War 1914-1916, Toronto 2007, pp. 1-7.
5. ↑ Henniker, A.M.: Transportation on the Western Front, 1914-1918. London 1937, pp. 103-104.
6. ↑ US Department of the Army, Historical Division: United States Army in the World War, 1917-1919, Volume 14, Washington, DC 1948, CD-ROM reprint, Center for Military History, 2001, pp. 228-232.
7. ↑ Cook, Sharp End 2007, pp. 50-52 for the decision to use the Ross, pp. 312-314 for the jamming issues.
8. ↑ Source: Birch to Dawnay, 11/21/18, Maj-Gen G P Dawnay Papers, Imperial War Museum.
9. ↑ Source: Birch to Dawnay, 11/21/18, Maj-Gen G P Dawnay Papers, Imperial War Museum.
10. ↑ Birch to Dawnay, 11/21/18, Maj-Gen G P Dawnay Papers, Imperial War Museum.
11. ↑ See Brown, British Logistics 1998, pp. 139-154, passim.

12. ↑ Syk, Andrew (ed.): The Military Papers of Lieutenant-General Frederick Stanley Maude, 1914-1917, Stroud 2012, pp. 186-187.
13. ↑ For examples of both scurvy and dietary issues in Mesopotamia see Roy, Kaushik: From defeat to victory: logistics in the campaign in Mesopotamia, 1914-1918, in: Journal of First World War Studies 1/1 (2010), pp. 44-45.
14. ↑ Headquarters, Department of the Army, US Marine Corps, FM 90-3/FMFM 7-27, Desert Operations (Washington 1993), G-5. The field manual uses US quarts and gallons. 1 US quart equals roughly 0.95 liters so 1 quart to 1 liter is used here.
15. ↑ FM 90-3/FMFM 7-27, Desert Operations, G-3.
16. ↑ For examples from Basra's expansion see Roy, From defeat to victory 2010, p. 46.
17. ↑ Erickson, Edward J.: Ordered to Die: A History of the Ottoman Army in the First World War, Westport 2001, Appendix F, Table F-3, p. 240.
18. ↑ Stephenson, Backs to the Wall 2011, p. 91 and 162.
19. ↑ For the total death estimate see Barry, John M.: The Great Influenze: The Epic Story of the Deadliest Plague in History, London 2005, p. 397 and 452 and pp. 362-365 for some specifics of areas brutally hard-hit by the virus.
20. ↑ Dowling, Timothy C.: The Brusilov Offensive. Bloomington and Indianapolis 2008, pp. 25-33; Wolmar, Christian: Engines of War: How Wars were Won and Lost on the Railways, New York 2010, pp. 194-195.
21. ↑ Paice, Edward: World War I, The African Front, New York 2010, pp. 264-265.
22. ↑ Erickson, Ordered to Die 2001, pp. 16-17.
23. ↑ Lynn, John A. (ed.): Feeding Mars, Logistics in Western Warfare from the Middle Ages to the Present, Boulder 1993, pp. 184-185.
24. ↑ War Office: Statistics of the Military Effort of the British Empire during the Great War, 1914-1920 [hereafter: Statistics] (London 1922), p. 595.
25. ↑ Beaver, Daniel R.: "Deuce and a Half": Selecting US Army Trucks, 1920-1945, in: Lynn (ed.), Feeding Mars 1993, p. 253.
26. ↑ Beaver, "Deuce and a Half" 1993, p. 254.
27. ↑ Cudahy, Brian J.: Box Boats: How Container Ships Changed the World, New York 2006, pp. 8-9.
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29. ↑ Lambert, Nicholas A.: Planning Armageddon: British Economic Warfare and the First World War, Cambridge, MA 2012, pp. 238-240.
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31. ↑ Stephenson, David: With our Backs to the Wall: Victory and Defeat in 1918, Cambridge, MA 2011, p. 341.
32. ↑ Cudahy, Box Boats 2006, p. 14.
33. ↑ Ibid., p. 255.
34. ↑ Ibid., p. 41, p. 291 note 1, p. 243. In 2012 the Moller-Maersk shipping group alone had seventy-four container ships with greater than 8,000 TEU capacity in service. A. P. Moller-Maersk A/S Group Annual Report, 2012, p. 39.

35. ↑ Sumida, Jon Tetsuro: Forging the Trident: British Naval and Industrial Logistics, 1914-1918, in: Lynn, Feeding Mars 1993, p. 217.
36. ↑ Ibid., p. 217.
37. ↑ Halpern, Paul G.: A Naval History of World War I. Annapolis 1994, pp. 66-67.
38. ↑ Ibid., pp. 71-72.
39. ↑ Ibid., pp. 96-97.
40. ↑ Ibid., p. 100.
41. ↑ Erickson, Ordered to Die 2001, p. 111; Syk, Maude 2012, p. 246.
42. ↑ Syk, Maude 2012, p. 248.
43. ↑ Ibid., p. 191.
44. ↑ Erickson, Ordered to Die 2001, pp. 111-114, 149-151.
45. ↑ Syk, Maude 2012, p. 161.
46. ↑ Roy, From defeat to victory 2010, p. 45.
47. ↑ Syk, Maude 2012, p. 187.
48. ↑ Ibid., pp. 201-202.
49. ↑ Erickson, Ordered to Die 2011, p. 166.
50. ↑ Syk, Maude 2012, p. 276.
51. ↑ Graham, R. C. L.: British Supply and Evacuation in the Mesopotamia Campaign (IR 220). Fort Leavenworth 1931-32, p. 17.
52. ↑ Brown, British Logistics 1998, p. 156. Boulogne's planned imports were 33,875 tons (roughly 135,500 tons per month using four weeks). For comparison, Rouen imported 44,935 per week in March 1917 (roughly 180,000 tons per month) and Dunkirk 34,250 (137,000) tons.
53. ↑ Graham, Mesopotamian Campaign 1931-1932, p. 17 and 19.
54. ↑ Source: *War Office, Statistics of the Military Effort of the British Empire during the Great War, 1914-1920, London: HMSO, 1922,* pp.616-168.
55. ↑ Roy, From defeat to victory 2010, pp. 49-50.

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Citation

Brown, Ian M.: Transportation and Logistics (Version 1.1), in: 1914-1918-online. International Encyclopedia of the First World War, ed. by Ute Daniel, Peter Gatrell, Oliver Janz, Heather Jones, Jennifer Keene, Alan Kramer, and Bill Nasson, issued by Freie Universität Berlin, Berlin 2014-10-08. **DOI**: 10.15463/ie1418.10454/1.1.

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