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Science and Technology (Canada)

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Canada's overseas military forces fought in the Great War under British Army command. The Canadian Corps largely employed the battlefield technology and doctrine of the British Expeditionary Force. Yet Canadian soldiers also innovated and adapted to meet the challenges of static and mobile operations. Within and beyond the Canadian Corps, specialist formations such as the Canadian Railway Troops and the Canadian Forestry Corps also made significant logistical contributions to the British Empire's war effort, often using peacetime technological skills that were particular to pre-war Canada.

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Introduction

Canada's involvement in pure scientific research – military or otherwise – during the First World War was limited. Upon the outbreak of hostilities, many British and Canadian scientists who were then working in Canada left their posts to volunteer for military service.[1] It was not until late 1916 that Sir George Foster (1847-1931), Minister for Trade and Commerce, presented the cabinet of Prime Minister Robert Borden (1854-1937) with a list of members who were to comprise the Honorary Advisory Council on Scientific and Industrial Research (the forerunner of the National Research Council). The council had a broad mandate: it was to mobilize Canadian research agencies; to survey scientific and industrial research in Canada; to enhance the supply of labor and capital in support of scientific and technological development; and to expand Canada's pool of research talent. Borden's government, preoccupied with the overseas military effort, provided limited resources to support the council. In any case, only a handful of Canadians were undertaking scientific research at the time, perhaps not more than fifty according to one estimate.[2]

Notwithstanding Canada's limited research efforts at home, elements of the military forces overseas were active technological practitioners and innovators, in combat and along the lines of communication. The nature of Canada's technological role was in part determined by a pre-war economy based on natural resource extraction and railway construction. Special skills from these sectors proved highly relevant to military logistics. There were fewer precedents to draw from in tactical or operational terms. But, like other soldiers on the Western Front, Canadians used technology reactively, to adapt to operational challenges.

This article considers technological aspects of the Western Front that were especially relevant to the Canadian forces, with appropriate reference to related activities at home. Broadly speaking, the article explores topics and themes that fall under two general categories: combat operations (weapons, ammunition and communications) and logistics (transportation, infrastructure and service support). The discussion is limited to the Canadian overseas forces (and related activities in Canada). It does not consider Canadian involvement in foreign armed services, such as the Royal Flying Corps or the Royal Naval Air Service, or Canadians serving in the Royal Navy or Royal Canadian Navy.

Infantry Weapons

Infantry weapons in Canadian (and British) service did not witness significant technological change

during the war. Some older weapons, such as mortars, were resurrected for static warfare. More recent inventions, such as the Lewis light machine gun, assumed greater importance. The Canadian experience, compared to the British, was unique with respect to the Ross rifle.

Service Rifles

In 1914, British troops went to war with the excellent Short Magazine Lee Enfield. The first Canadian overseas contingent, however, was equipped with the domestically manufactured Ross, a weapon that had been in service with the Canadian Militia since 1902, albeit in many variations. Although an accurate weapon, the Ross was prone to jamming and proved generally unsuited to the rigours of field service. The weapon generated intense controversy after the Second Battle of Ypres in April 1915 during which many soldiers lost confidence in it. Sir Sam Hughes (1853-1921), Minister of Militia and Defence, and a tireless advocate for domestic arms manufacturing, vigorously defended the rifle. On the orders of British General Headquarters, it was withdrawn from frontline service in the 1st Canadian Division in June 1915. The 2nd, 3rd and 4th Divisions, which subsequently arrived overseas, continued to use the Ross until August-September 1916. It is notable, however, that specialist infantrymen such as scouts and snipers continued to use the Ross throughout the war as they valued its accuracy.[3]

Machine Guns

Canadian forces went to war with Colt machine guns purchased in the United States. Although heavy and prone to jamming these were useful defensive weapons during the Second Battle of Ypres.[4] The number of machine guns allotted to each division increased throughout the war and the superior Vickers and Lewis gradually supplanted the Colt.

Brigadier-General Raymond Brutinel (1872-1964), a French immigrant, was the best-known authority on machine guns in the Canadian forces. He had organized the Automobile Machine Gun Brigade (later the 1st Canadian Motor Machine Gun Brigade) with help from Sir Clifford Sifton (1861-1929) in 1914.[5] In early 1918 the brigade saw heavy defensive action during the German spring offensives. Later that year, the Canadians formed the 2nd Canadian Motor Machine Gun Brigade and the two brigades, along with cavalry, cyclists, trench mortar sections and an artillery battery, comprised the Canadian Independent Force. This highly mobile combined-arms unit played a prominent role in the Battle of Amiens in August 1918.[6]

Grenades

Known among British Empire soldiers simply as “bombs,” the various types of grenades that appeared throughout the war provided the infantry with much needed close support. As of 1917, Canadian infantry platoons included a section of specialist hand grenadiers (bombers) and rifle

grenadiers.[7] During the summer of 1918, Canadian infantry were equipped with experimental anti-tank rifle grenades, forerunners of infantry anti-tank weapons of the Second World War.[8]

Trench Mortars

Mortars experienced a renaissance during the First World War as their high angles of fire were ideally suited to trench warfare. Canadians adopted British mortars as they became available but placed a premium on mobility. As early as August 1915, Sir Sam Hughes, Minister of Militia and Defence, proposed that “bomb-guns” (mortars) be mounted on armored lorries.[9] Later in the war, mortars were indeed fired from Canadian motor lorries, such as at Beaucourt Wood during the Battle of Amiens.[10]

Artillery

Evolving tactics and techniques shaped the role of artillery throughout the war. Aerial photography and the production of large-scale maps of the front allowed for more effective fire plans. In 1916, “creeping” barrages protected infantry as they advanced across no-man’s land toward their objectives.[11] Artillery also targeted the enemy’s guns, a process known as counterbattery fire.

Canadian artillery operated according to British doctrine and Canadian gunners were keen practitioners of new techniques introduced in the British forces. For example, as the Canadian Corps counterbattery staff officer in 1917, Lieutenant-Colonel Andrew McNaughton (1887-1966), an engineering professor at McGill University in civil life, employed the principles of “scientific gunnery” to improve the effect of counterbattery fire and artillery support more generally. Scientific gunnery involved the use of flash-spotting and sound-ranging to determine the location of enemy gun positions and also accounted for meteorological conditions and barrel wear when engaging targets.[12]

Ammunition Production in Canada

At the outbreak of war, Canadian industry lacked the experience and tooling necessary to produce artillery ammunition, yet Canadian companies accepted significant manufacturing contracts. After ongoing difficulties filling ammunition orders from Britain, the Canadian government dissolved the Shell Committee, its federal purchasing agency, in late 1915. The Imperial Munitions Board, a branch of the British Ministry of Munitions, supplanted the Shell Committee for the remainder of the war, taking responsibility for war contracts, and even coordinating production in state-owned plants. In the meantime, manufacturers imported better machinery and instruments. Annual ammunition output increased from 5.3 million shells in 1915 to 23.7 million in 1917. Canadian companies turned out more than a dozen types of artillery ammunition, plus an assortment of fuses, primers, explosives and propellants.[13] In 1917, Canada provided somewhere between one quarter and one third of

artillery ammunition fired by the British forces on the Western Front.[14]

Gas Warfare

Elements of the 1st Canadian Division were badly gassed at the Second Battle of Ypres in April 1915 when the Germans employed chlorine in lethal concentrations for the first time. Soon after, most armies equipped their troops with respirators, limiting the tactical value of gas.

Over the next two years, both the Allies and the Central Powers released gas clouds, but generally with disappointing – even disastrous – results. Elements of the 4th Canadian Division, for example, launched an ill-conceived gas raid at Vimy Ridge in March 1917, suffering a 43 percent casualty rate on the eve of the Arras offensive.[15]

Early on, gas was transported to the frontlines in compressed-air tanks (canisters) and released through hoses in cloud form. In the British Empire's forces, the role of gas evolved when artillery and mortar shells were loaded with gas in early 1917, making it possible to deliver concentrations more suddenly and accurately than canister attacks. The German army had employed gas shells in 1916 but British production was delayed by a poorly organized research effort.[16] Not until April 1917 did the Canadian Corps artillery fire its first lethal gas shells during the Battle of Arras.

The Canadians formed the Canadian Corps Gas Services in May 1916 with a mandate to develop preventative measures and instill anti-gas discipline. The Gas Services, overall, were highly effective. Moreover, through experience and experimentation, physicians in the Canadian Army Medical Corps developed new treatments and learned more generally about the effects of gas. For instance, a study of gas casualties by two Canadian medical officers in November 1917 revealed that soldiers who had been burned once by mustard gas were much more susceptible to serious skin injuries if exposed a second time.[17]

Armored Warfare

There were no Canadian tank units on the Western Front. Canadian troops, however, operated periodically with British armor. Indeed, when the tank made its debut in September 1916, the 2nd Canadian Division was allotted six machines for the attack at Courcelette. While the new weapon made a significant moral impression, its tactical value was limited in the Canadian sector.[18]

The impact of tanks on later Canadian operations, such as the Battle of Amiens, was arguably much greater, but never decisive. Even the best tanks of 1917 and 1918 were mechanically unreliable and highly vulnerable to direct fire from German artillery. There was also much debate surrounding the optimal tactics for armor. At Amiens, for example, it was not always clear if the tanks were to support the infantry, or vice versa.[19]

In 1918, the Canadian government raised two tank battalions, recruiting heavily from university students in Toronto and Montreal. Neither unit reached France before the armistice.[20]

Communications

Reliable battlefield communications eluded all armies during the First World War. Although signallers went to war with serviceable telephones, the wires were easily cut by artillery fire. Wireless communication was in its infancy when the war broke out. When the 1st Canadian Division arrived in France in 1915, it had just eight wireless sets, too few to have a major effect on ground communications.

One of very few substantial technological improvements in Canadian wireless communication came in early 1917 with continuous wave sets which offered greater range while employing smaller antennas; these new sets were used to good effect during the Battle of Hill 70 in August 1917. For the most part, however, units on the ground relied heavily on telephones, combined with visual signals (such as flags, lamps and flares) and runners. Still, communications between infantry units and their headquarters routinely failed when offensives were in progress, leaving commanders uncertain when or where to direct reserves or artillery support.[21]

Tactical Railways

Although the British and Dominion armies counted substantial motor and horse-drawn transport in their establishments, trench warfare encouraged narrow-gauge tactical railway development (light railways). Motor lorries burned large volumes of scarce fuel, destroyed delicate roadways and required constant repair. Overworked horses fell ill and made conspicuous targets for enemy guns. Broken ground, furthermore, prevented motor or horse-drawn transport from carrying ammunition and supplies directly into the firing lines, especially in wet weather.

Light railway lines offered many advantages in comparison. They could be laid relatively quickly and could be resituated as required. While steam and petrol-electric engines provided traction for heavier cars, men or animals pulled smaller cars along trench tracks that ran directly into the battlefield.[22]

Early in the war, British formations experimented with light railways in the forward area. In 1915 for example, the VI Corps operated a 1,200-yard trench tramway that terminated within 300 yards of the firing line. Thirty-six men and a train of six cars could, in a return trip of eighty minutes, carry sufficient rations, water and mail for a whole battalion. Without the tramway, the job normally required 120 men.[23]

Canadian Corps Light Railways

The Canadian Corps was an early user of light railways. The presence of hundreds of skilled railway

workers in Canadian uniform encouraged the development of light railway capacity, beyond the official establishment of the Canadian Corps. In April 1916, the Canadians organized the Composite Pioneer Company to undertake light railway duties. This company had neither an official establishment nor any formal authorization from British General Headquarters; its 240 soldiers – mostly experienced railway workers – were borrowed from each of the three extant Canadian pioneer companies on a semi-permanent basis.[24]

In 1916 and 1917, the Composite Pioneer Company was reorganized as the scope for light railways expanded but its unofficial status continued.[25] What had changed was the volume of light railway traffic operating in British sectors. At the start of 1917, there had been just ninety-six miles of narrow gauge line with 655 locomotives, tractors and wagons operating under British control. Six months later, there were 440 miles of track in operation with 3,882 locomotives, tractors and wagons. During a seven day period in July 1917, some 38,000 tons of ammunition – the rough equivalent of 13,000 three ton lorry loads – were transported on narrow gauge lines.[26]

As the efficiencies of light railway became clear, General Headquarters wished to centralize construction and operation across all British sectors on the Western Front. Lieutenant-General Arthur Currie (1875-1933), the Canadian Corps commander, was reluctant to surrender the independent light railway construction and operating capacity that his troops had developed. After heated exchanges between Currie and higher British headquarters, the War Office authorized the Canadian Corps to add one narrow gauge operating company and one construction company to its establishment.[27] The two new units, the 1st and 2nd Tramway Companies, were formed in November 1917 and served for the duration of the war under Canadian Corps command.

Canadian Railway Troops outside the Canadian Corps

As a consequence of Canada's national expertise in railway building, various railway units were raised for overseas service outside of the Canadian Corps. In the summer of 1915, the Canadian Overseas Railway Construction Corps arrived in France to assist the British forces with broad gauge railway construction. The Canadian government organized the unit with cooperation from the Canadian Pacific Railway (CPR). Virtually all of the volunteers were CPR men, including the commanding officer, Lieutenant-Colonel Colin W.P. Ramsey (born 1883), a civil engineer. Ramsey's troops worked on a range of projects in France, Belgium, and Britain, including broad gauge construction for the Ministry of Munitions around Newcastle factories.

The British decision to invest in light railways in 1917 prompted Ottawa to raise a series of Canadian construction and operating units to fall under the administration of the Canadian Railway Troops (outside of the Canadian Corps). These units included the 13th Light Railway Operating Company, 58th Broad Gauge Operating Company, 69th Wagon Erecting Company, 85th Engine Crew Company and twelve battalions of construction troops (broad and narrow gauge).[28] During a one year period (1 April 1917 through 1 May 1918), Canadian Railway Troops in France and Belgium laid 190 miles

of broad gauge and 828 miles of narrow gauge track. This work stretched across virtually all British sectors at the front.[29] In 1918, the units of the Canadian Railway Troops boasted an establishment of some 15,000 men.[30]

Forestry Operations in Britain and France

The Allied war effort demanded enormous volumes of wood products. In February 1916, the British Colonial Secretary invited Canada to form a military unit of experienced lumbermen for service in the United Kingdom (and later in France). The Canadians raised the 224th Forestry Battalion with an initial strength of 1,600 recruits from across the country. Elements of the 224th were at work in Britain by the second week of May 1916. Canadian tools, equipment and machinery were quickly adapted to working conditions in British forests. Contemporary accounts suggest that British forestry units, in turn, adopted novel Canadian tools and techniques with resulting improvements in efficiency. The Canadian cant-hook, wrote one eye-witness, “has become Britain’s lesson in the handling of timber.”[31] The cant-hook was a tool used to manipulate logs. It was comprised of a long pole with a metal hook fitted on one end.

Canadian forestry expertise in France helped to reduce the volume of timber that was imported (from Britain or elsewhere) to meet British front-line requirements. British and Canadian timber harvesting in French forests accounted for 55 percent of consumption between April and September 1917; by October-November 1918, this proportion climbed to 94 percent by tonnage.[32] In the final months of the war, the strength of the Canadian Forestry Corps in France approached 14,000 men, with more than 4,450 animals, 1,430 horse-drawn vehicles and 270 motor vehicles.[33]

Conclusion

Canada’s status as a British Dominion shaped its wartime technological experience. National experiments in military procurement, such as the Ross rifle, proved short lived. For the most part, Canadian soldiers employed British weapons and equipment according to British doctrine. Still, Canadian soldiers were active innovators. McNaughton’s work in scientific gunnery is an example from the combat arms but innovation was also a feature of Canadian logistics. The Canadian Corps operated its own tactical railway unit ahead of many other British formations.

Beyond the Canadian Corps, national expertise in railway construction and forestry secured a central place for Canadian units within the larger British logistics system. Indeed, by the end of the war, there were nearly one-third as many Canadians serving with forestry or railway units as there were in the fighting divisions of the Canadian Corps.

In sum, the First World War demanded technological adaptation from Canadian soldiers fighting under British command. At the same time, it permitted Canadians to apply their peacetime

technological expertise to military problems in a total war context.

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