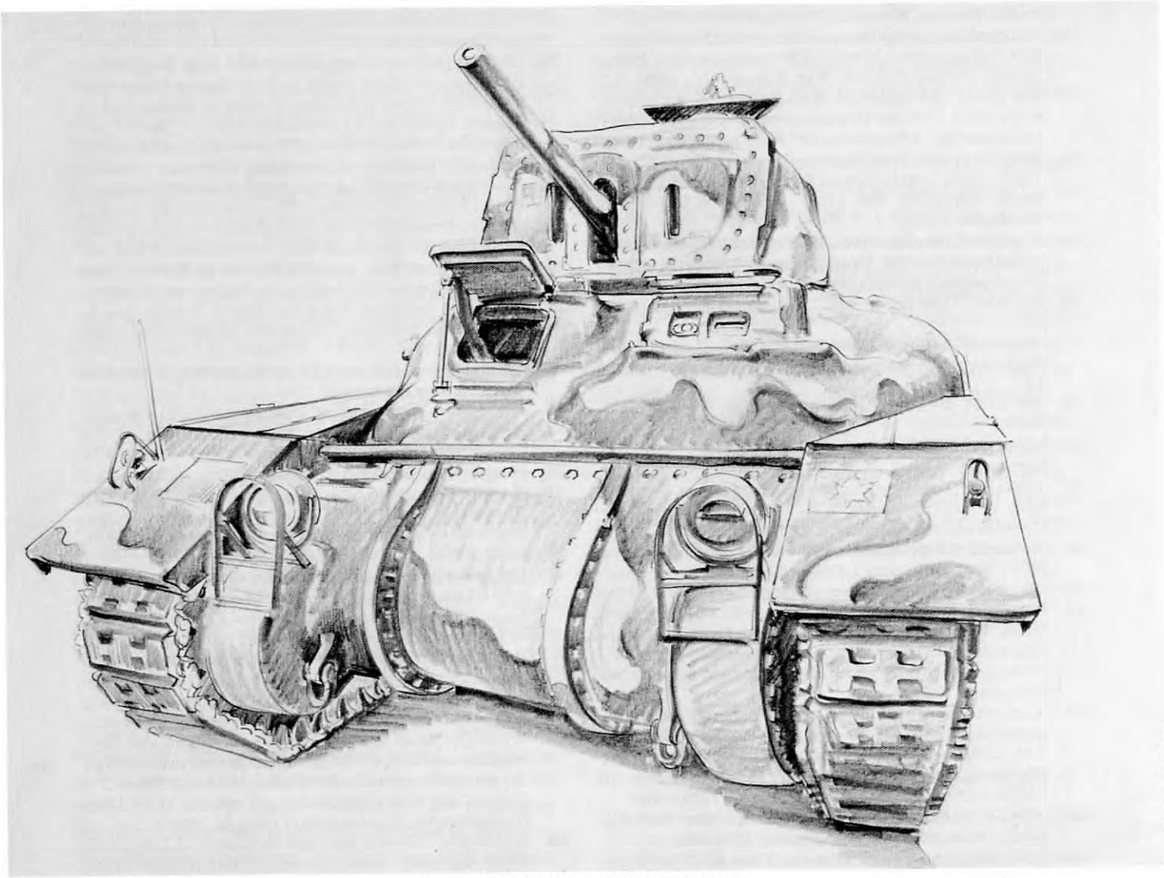

CWM CN 13756

Ram Tank by George Douglas Pepper

"Not competent to produce tanks"
The Ram and Tank Production in Canada, 1939-1945

Graham Broad

In September of 1926 the London *Daily Telegraph* published an article by Captain Sir Basil Liddell-Hart entitled "The Remaking of Modern Armies" in which Hart, already one of Britain's foremost military historians, proclaimed that infantry's day was done and that the ascendancy of armoured warfare was at hand. The crux of his argument was that the machine gun, mobile now by virtue of motorized gun carriers, had made the advance of unprotected troops across no-man's-land impossible. Only massed formations of tanks, Hart concluded, could breach enemy lines. In Germany, France, the Soviet Union, and the United States, military men like Heinz Guderian, Charles de Gaulle, M.N. Tukhachevsky, and George S. Patton had already arrived at the same conclusion: the tank was the future of warfare, the redemption of mobility, the triumph of mind over mud.[1]

In Great Britain, however, the apostles of armoured warfare were sneered at in an army anxious to return to "proper soldiering," which did not involve tinkering with expensive and untried mechanical toys.[2] The French plunged most of their military energies into the fantasy of an impregnable line of fortifications. The advocates of "deep warfare" in the Soviet Union perished in the army purge, victims of Stalin's Caesar-like suspicion of men who think too much.[3] In the United States, isolationism, pacifism, and the Great Depression colluded to bring tank development to a halt, and only 35 tanks were built in the 20 years after the end of the First World War.[4] Canada, a pygmy with a proud military heritage, weathered the pall and decay of armed forces in the 1920s and 1930s worst of all. As late as 1938, the mainstay of Canada's armoured forces was a dozen machine-gun carriers, midget tanks that looked like bumper-cars in a midway ride.[5] In 1939, Germany alone had adequately prepared its armed forces for mobile warfare. Though only a fraction of Hitler's army was mechanized when war erupted in September, the massed formations of tanks that formed the core of the *Wehrmacht* cut like a scythe across Europe.

If, as one historian has observed, "the individual soldier...was central to the mythologized version" of the First World War and, in society's remembrance of it, "battles were won by men, not machines,"[6] there can be no mistaking the fact that the Second World War is remembered as a war of machines. It was a war fought with tens of thousands of tanks, planes, and guns; it was a war of materiel, fought in factories as well as on battlefields, a war, as one general was later to remark, "for bulldozers."[7] It in no way belittles the sacrifice made by thousands of Canadian soldiers to acknowledge that all their exertions might have amounted to little had the Allies not produced the implements of war at three or four times the rate of the Axis powers. Ultimately, the Allies won the Second World War because the Axis could not endure a protracted war against a coalition whose economic resources were several times greater than its own. Against the high level of professional competence of the German officer corps, the tremendous fighting qualities of the average German soldier, and the technological superiority of the *Wehrmacht*'s tanks, sheer weight of numbers was often the only advantage which Allied ground forces possessed.[8]

Canada's contribution to the war of materiel was impressive. Nearly a million motor vehicles of all types rolled off the assembly lines of

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Photo by Nicholas Morant, NAC PA 176006

Valentine tanks being constructed at the Angus Shops in Montreal, 26 May 1942.

Canada's automotive industry, the fourth largest in the world, during the six years of war. Canada produced more trucks than German, Italy, and Japan combined, supplying half of the British army's motor transport.[9] This explains why the British army was fully mechanized by 1942, while the German army was increasingly reliant on captured vehicles and hundreds of thousands of horses.[10] Canada's tank program was far smaller, but a remarkable accomplishment nonetheless. While Canada's total production of 5,766 tanks and self-propelled guns was dwarfed by the nearly 62,000 produced in Germany, it nonetheless exceeded the production totals of the junior Axis partners, Italy and Japan, and that at a time when nearly the entire Canadian automotive industry was converted to the production of motorized transport.

Moreover, while Canada's production of motorized transport stemmed naturally from the country's pre-existing industrial infrastructure, the production of tanks reveals a great deal about the nature, and limits, of Canada's wartime manufacturing capabilities. The Ram, Canada's contribution to the evolution of tank design in the Second World War, became obsolete because Canada lacked the engineering talent to keep pace with tank development in the United States.[11] But the ultimate fate of the Ram was determined not only by its obsolescence, for indeed the tank that replaced it, the M4 Sherman, was in many respects obsolete as well, but also and perhaps predominantly because of the overarching importance that Canada's military leadership attached to standardization on a North American basis.

On the outbreak of war in September 1939 the military gave no consideration to producing tanks in Canada and the government agreed that its forces would be supplied with tanks of British manufacture.[12] Not only did a report to the British Ministry of Supply in March 1940 conclude that Canadian firms were not competent to produce tanks,[13] but Canadian industry as a whole was also drastically underutilized for the first eight months of the war. Precious months, during which Canadian firms might have mobilized for war work, slipped by. With the Department of Supply in London eager to foster Britain's own armaments industry, Canada was treated as purely as a marginal source of armaments. Factories that might have converted to military production sat idle or continued to work on civilian orders; indeed, 1940 was another bumper year for the passenger car industry.[14]

But the disaster in France in June 1940 changed all that. As France toppled, the British placed orders for every conceivable kind of military hardware, including tanks, in Canada.[15] Moreover, the loss of virtually all of Britain's modern tanks in France meant that British tank production would be stretched to the limit to supply its own forces. In the short term there would be no possibility of equipping the Canadian armoured divisions with British tanks. Canada would have to build its own.[16]

Such was the extent of the Canadian army's desperation for tanks of any kind that in the autumn of 1940 Colonel (later Major-General) Frank Worthington, Canada's foremost advocate of armoured warfare, arranged for the purchase (for $120 each) of 265 Renault tanks of 1917 vintage from storage in the United States. Hopelessly obsolete, they nonetheless proved to be useful training vehicles.[17] But the newly authorized 4th and 5th Canadian Armoured Divisions needed 1,200 modern tanks between them. The Canadian Pacific Railway in Montreal received orders for light infantry-support tanks called Valentines, but these were earmarked for British use.[18] Moreover, British tank doctrine was at last evolving, and Canadian doctrine evolved with it. The light tanks on which the British armoured forces were based had been next to useless in France: what the army required was a medium or "cruiser" tank which could roam independently of infantry in armoured spearheads of the kind which the Germans used.[19]

With the automotive industry tied up in orders for motorized transport and the CPR's Angus Shops in Montreal producing Valentine tanks, capacity for medium tanks had to be created from scratch. The Montreal Locomotive Works rapidly constructed a huge new tank arsenal, eight acres long, in order to build an American-designed medium tank, the M-3 Grant, in Canada.[20] From a manufacturing perspective, the advantages of building an American design as opposed to a British one were numerous. Component parts were more readily available from sources in the United States than in Great Britain. Furthermore, the Grant, mechanically reliable and armed with a formidable 75 mm gun, was the best medium tank then available to the western Allies. But the Grant had one serious defect: its main armament was mounted not in the turret, but in a fixed position on the left side of the chassis, making it difficult for the tank to maneuver into firing position.[21]

These faults prompted Worthington and his tiny engineering staff, working in consultation with the British Tank Mission in Washington, to propose a modified Grant for Canadian production. The envisioned tank, to be called the Ram (the animal was displayed on Worthington's family crest), would retain the Grant's chassis but mount its main gun on a revolving turret rather than on the hull, giving the tank a 360-degree range of fire. Furthermore, it would have a much lower silhouette than the Grant, thus exposing a smaller target to the enemy.[22] The completed Ram was a five-man, 30-ton medium tank, armed with a 6-pounder main gun and two .30-calibre machine guns. It was reliable, quick, and maneuverable for its size.[23] The prototype was tested in July at the Aberdeen Proving Grounds in Maryland (significantly, six months before the United States entered the war) where test crews considered it to be a much better tank than the Grant. Worthington also believed that the design of the M-4 Sherman, successor to the Grant, was based in large part on the Ram prototype.[24]

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Colonel Frank Worthington, father of the Canadian armoured corps, climbing out of one of the obsolete Renault tanks acquired from the Americans in 1940.

NAC PA 803922

Ram tanks in production at the Montreal Locomotive Works, July 1942.

The loss of nearly a year's lead-time on military orders had serious consequences. Industry received its first orders for tanks in May 1940, but a year passed before the first Canadian-built tank, an already obsolete Valentine, appeared. The prototype of the Ram followed in July 1941.[25] Full-scale production did not to begin until early 1942, by which time the Sherman was already rolling off assembly lines in the United States. Between the inception of the idea of Canadian tanks and actual production lay a jungle of administrative, economic, technical, and military confusion. The central problem was perhaps the most elementary one: Canadians knew virtually nothing about designing, building, or testing tanks, simply because there were hardly any tanks in Canada to begin with. That tanks were something new under the sun is evidenced by contemporary accounts of their development in Canada in which the authors struggle to find language to describe vehicles which most Canadians had never seen: "The tank," wrote *Maclean's* Frederick Edwards, "is comparable to a submarine, only the tank is smaller," while a columnist in *Canadian Business* gushed about "awe inspiring, armour-plated, mobile fortresses" that are "exceptionally difficult for the enemy to stop."[26] Delacour Beamish, Director of the Tank Production Branch, fared little better in an article for the *Canadian Geographic Journal*: "the tank," he wrote, "is somewhat like a tractor...and somewhat like a locomotive."[27]

The fact of the matter, however, was that tanks were not like tractors, submarines, and locomotives. Nothing like a tank had ever been manufactured in Canada. Many Canadian engineers had never seen a tank, let alone been tasked with designing one. Furthermore, American branch plants in Canada tended to be involved in manufacturing engineering and final assembly only; design engineering remained the domain of their parent firms in the United States.[28] But American firms, despite their abundance of engineering talent, had scarcely more experience in tank design than their Canadian subsidiaries,[29] a fact which required the British, in the summer of 1940, to establish a mission in Washington to assist in tank design.

Much of the original design work on the Ram would emerge, not from Canada, but from the United States and from the British tank mission in Washington. Indeed, a plan to design diesel engines for tanks in Canada was shelved because "the forecasted period of time necessary to evolve design, manufacture engines, test, and finalize design" in Canada was considered prohibitive.[30] Furthermore, although 12 Canadian firms were involved in making component parts for the Ram, many of the tank's major sub-assemblies could not be manufactured in Canada.[31] The Ram's gun mountings, transmission, engine, suspension, and indeed the armour plate itself had to be imported from the United States.[32] The dependence on the United States, a hallmark of the Canadian automotive industry, was even greater in tank production. Beamish complained that the US Ordnance Department literally dominated Canadian tank production by virtue of its stranglehold on essential component parts.[33]

The problems that confronted production were so numerous and so complex that, were it not for the fact that so many tanks were successfully built, one might be tempted to agree with the British government's initial assessment that Canadian firms were not competent to build tanks. No firm in Canada had ever produced armoured steel. Shortages of machine tools delayed production. Specifications received from Britain lacked the necessary instructions. Shortages of 6-pounder guns forced the installation of nearly useless 2-pounder guns on the first 50 Rams.[34] Arguments about the composition and jurisdiction of the Directorate of Tank Design, an administrative body charged with coordinating army engineering and industrial production, persisted until August 1942.[35] But by the time production ceased in the summer of 1943, nearly 2,000 Rams had been built, a remarkable accomplishment considering that, just two years earlier, no tank had ever been manufactured in Canada.

As early as August 1942, however, A.G.L. McNaughton, commander of the First Canadian Army, had decided that standardization of tank forces and production on a North American basis should be achieved as quickly as possible, and that the M-4 Sherman, by then rolling off American assembly lines in huge numbers, would be the tank of choice.[36] Nevertheless, the army had compelling reasons to continue Ram production in the short term. McNaughton had publicly declared that the Canadian Army in England was a "dagger pointed at the heart of Berlin"[37] but the fact of the matter was very different. The same month, Brigadier R.A. Wyman, commanding officer of the 1st Canadian Tank Brigade, complained bitterly:

Male and female workers assemble instrument panels fo Ram tanks at the Montreal Locomotive Works Plant, 1942.

Photo by Nicholas Morant, NAC PA 116080

Photo by Alexander M. Stirton, NAC PA 171706

RAF Mustang aircraft fly over Ram tanks of the 4th Canadian Armoured Division during an Air/Tank Cooperation exercise, Aldershot, England, 22 December 1942.

> after fourteen months in England, the Cdn. Tank Bde. is non-effective because of faulty equipment. *It has no place in an operational role*...the man element is excellent, and there is an abundance of qualified specialists, but, out of a total issue of 271 Churchill tanks, only 107 are serviceable.

One battalion had been reduced to only ten serviceable tanks.[38] Morale among the personnel assigned to the Churchill tanks was falling, as they had "entirely lost confidence in the mechanical reliability of the Churchill."[39] The following month, the remaining Churchills would test their mettle on the beaches at Dieppe, with results that are well known. So acute was the shortage of operational tanks in the First Canadian Army that McNaughton felt compelled to order drastic limits on the speed of operation of all tanks in training and on the road so as to reduce the potential accidents and mechanical breakdowns which would further reduce his forces.[40]

Better tanks were forthcoming in the form of Rams and Shermans. In May 1943 Wyman's brigade conducted a series of trials to evaluate the M4 Sherman and the Ram, and concluded that the Sherman equaled or exceeded the Ram in almost every respect. The Sherman's engine was mechanically superior and had far fewer daily maintenance requirements than the Ram's radial engine. The Sherman started more quickly, was considered easier to drive and maneuver than the Ram, and had superior cross-country performance. In terms of its fighting qualities, Wyman deemed the Sherman far superior to the Ram in offensive armament and crew protection. The Ram's worst features were held to be its crew accommodations: the small turret made working inside the tank exceptionally uncomfortable, and the turret was so cramped that the loading breech actually pressed down on the gunner's right leg when the 6-pounder was elevated.[41] Furthermore, the Ram's turret ring had been designed with an utter lack of foresight: it was too small to easily accommodate a gun heavier than the 6-pounder. A series of other evaluations reached the same conclusions. The Ram, not yet finished its production run, was already obsolete, and the Canadian Armoured Corps finished receiving them just in time to start replacing them.

The Sherman was, without doubt, a superior tank to the Ram, and it proved to be a much more adaptable tank than any other that the Allies produced in the Second World War. Later models were rearmed with a more powerful 76 mm high-velocity gun, and some British models were armed with an even bigger 17-pounder. It should not be construed, however,

that it represented the cutting edge in tank design. By 1944 it was outclassed by the new generation of German tanks, and it had barely been a match for the previous one. Undergunned (except in the rare 17-pounder variants), thin skinned, and with an alarming tendency to burn when hit, the Sherman was a match for German heavy tanks only when it was available in superior numbers – which it usually was.[42] It was less a triumph of engineering than a victory for the American system of manufacturing, that mode of production which the US Army's official history defines as "standardization of design and production in volume." In the war of machines, mass production, not the machines themselves, was the Allies' most powerful weapon.

This is in stark contrast to the German armed forces. As R.J. Overy has observed, the hallmarks of German industry had always been the high quality and technical complexity of its products. German weapons were produced to exceptional standards, but were very costly and labour-intensive.[43] Furthermore, in the jungle of fiefdoms that comprised the Reich's economy, the technical demands of the armed forces took precedence over the Nazi leadership's demands for higher production. The military's incessant demands for changes to design and specification mandated short, expensive production runs. The result was a drastic shortfall in armaments production. In 1940, Germany produced only two-thirds as many planes and half as many vehicles as Great Britain despite an arms expenditure twice as large.[44]

The imbalance in favour of design and development over actual production resulted in a multitude of redundant weapon systems in Germany. While the United States produced a mere 18 different models of aircraft in the Second World War, Germany developed 86.[45] "At one point in the war," Overy writes, "there were no fewer than 425 different aircraft models and variants in production" in Germany.[46] Under the spur of armaments minister Albert Speer, German industry made extraordinary efforts to rationalize production and boost output in the last two years of the war, but the German preference for matching Allied quantity with a variety of weapons of very high quality persisted throughout the war. While 80 percent of American tanks built in 1943 and 1944 were Shermans, German production was divided almost evenly between about 16 models of heavy and medium tanks, assault guns, tank destroyers, and self-propelled artillery, making mass production almost impossible. The rather crude observation made in the US Official History that "perfection is the enemy of good" when applied to the war in Europe, was essentially correct.[47] The Germans, Overy argued, attempted to win the war with the weapons of the 1950s (heavy tanks, jets, guided rockets), while the Allies actually did win it by mass producing the weapons of the 1930s.[48]

There is no denying that Germany's tanks could be formidable. In one famous incident in the summer of 1944, a solitary Tiger tank crawled from the woods near Caen and left 25

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A Ram tank on exercise.

British tanks burning in its wake. As a rule of thumb, American tank crews considered five Shermans equal to one German Panther, and eight Shermans equal to a Tiger. But such weapons were thankfully so scarce that they could only delay, not alter, the eventual outcome of the war.[49] Mass production did not necessarily yield inferior equipment. The United States manufactured several superb models of aircraft and the Canadian Military Pattern trucks were well-known for their robustness and mechanical reliability. Nor was the insistence on mechanical perfection always limited to the *Wehrmacht*.[50] But it was a general characteristic of the American and Canadian armies to tolerate inferior equipment provided it could be furnished to them in vast quantities.

British production methods apparently fell somewhere between the German and American extreme. British industry, which did not adopt the moving assembly line until the 1930s, only gradually adopted mass production techniques in the production of aircraft and unarmoured vehicles.[51] Moreover, British production was increasingly afflicted by incessant demands for modifications. In 1942 the exasperated American manufacturer of the Grant actually refused further design changes from the British army. By 1944, tank production in Britain itself was no higher than it had been in 1941, while in Germany and the United States it had quadrupled.[52]

The question that arises, then, is whether Canadian production was organized on the American model or one closer to that used by the European powers. The British official history notes with paternalistic dismay the "undue" size of the Canadian automotive industry and country's natural preference for vehicles made to American standards, even in spite of long-standing British policy mandating the standardization of weapons throughout the Empire.[53] But were Canadian production methods, in fact, based on the American model? In regards to motorized transport, the answer is yes. Canadian branch plants of General Motors, Ford, and Chrysler not only produced military vehicles in vast quantities, but also broke away from the policy of standardizing basic design with that of the British Army. By mid-war, standardization on a North American basis became the unofficial policy, and the British official history of overseas supply grudgingly admits that "it was only possible for Canada to pull her weight as a manufacturer of armaments by producing American types."[54]

Here again the contrast with Nazi Germany is striking. As the Army Engineering Design Branch's Design Record notes, "while outstanding points of criticism (in regard to vehicle design) were corrected...it must be understood that industry bent every last facility towards production and thus a pause to change tooling or layout for a new design was often next to impossible."[55] Organized around a handful of basic models, the so-called Canadian Military Pattern vehicles attained a very high degree of interchangeability of parts and were produced in enormous quantities.[56] By contrast, the German armed forces at one point had 141 different models of truck in production, and on the eve of its invasion of the Soviet Union, the army was saddled with 2,000 different types of vehicles requiring more than a million different spare parts.[57] That such a situation was a quartermaster's nightmare, and untenable from the point of view of mechanical maintenance, is obvious enough – and is confirmed in the almost total collapse of the logistical backbone of the German army in the late fall of 1941 as the truck pool diminished to barely one-tenth its pre-invasion size. By contrast, the British, American, and Canadian armies achieved an extraordinary degree of standardization on a few basic models of motorized transport, and comparable incidents, like the breakdown of the British Second Army Group's truck park owing to a faulty piston ring design, were thankfully rare.[58]

With tank development, the question about mass production is more difficult to answer. There are fewer examples to judge by: only the Valentine and Ram were produced in any quantity in Canada. Nonetheless, most indications are that something like mass production was achieved with tanks in Canada. Despite the enormity of the administrative and engineering problems facing the Ram's designers, the actual rate of production met or exceeded expectations once the Ram entered the manufacturing stage. Moreover, Canadian production was not afflicted by a desire to produce what the British official history calls tanks built to the "Rolls-Royce" standard.[59] The emphasis in Canadian manufacturing was on

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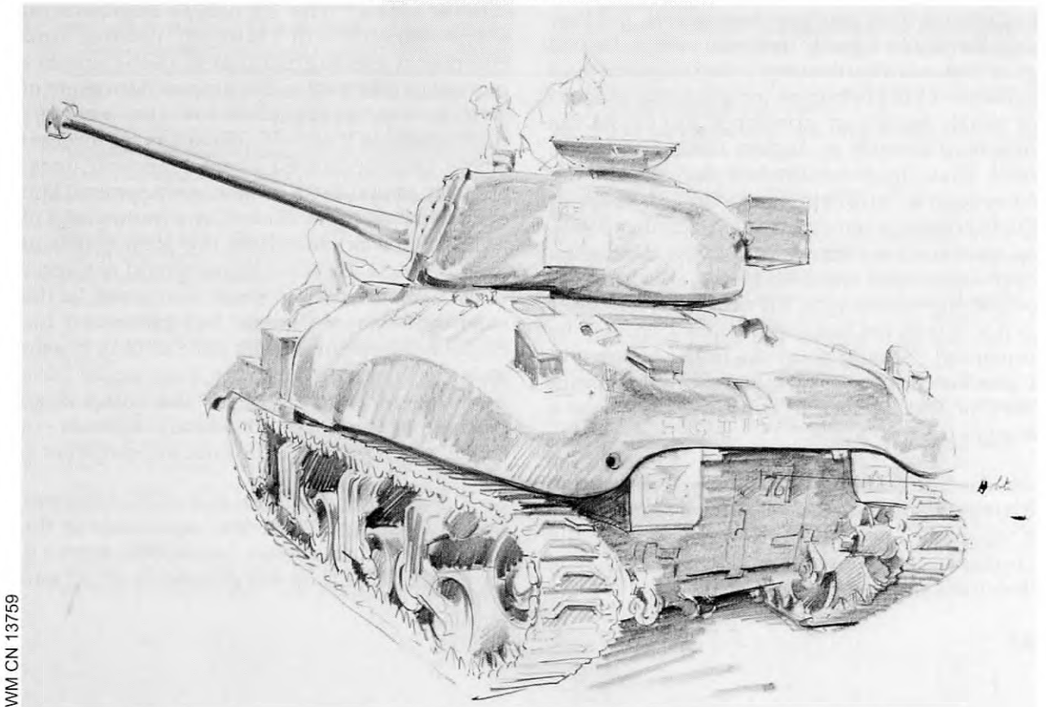
Two Ram tanks on a firing range in England.

easier and better production, as opposed to minor changes for tactical improvement.[60]

Furthermore, production at the Montreal Locomotive Works was standardized on the Ram and then the Sexton self-propelled gun (which was itself essentially a heavy artillery piece mounted on a Ram chassis) in spite of the demands from certain individuals in the Department of Munitions and Supply that MLW produce a tank as a successor to the Ram. Senior figures in Munitions and Supply were anxious

Ram Tank by George Douglas Pepper



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that Canada not purchase more tanks in the US than absolutely necessary, as they desired to maintain a continual flow of production in Canada in light of the enormous expense they had incurred by creating tank manufacturing capacity in the first place. McNaughton, however, believed that the advantages of limiting the number of types of vehicles in production outweighed all other considerations, and a production-run of Canadian-made Shermans (called Grizzlies) was cancelled after fewer than 200 units were completed.[61]

After a brief period of technical innovation in which it managed to produce a tank that was a fine balance of speed, armour, and armament, Canada's tank program rapidly fell behind on the engineering front. But while it is true that Canada's Directorate of Tank Design lacked the engineering talent to keep pace with tank development in the United States, it is also true that the exigencies of mass production made an over-emphasis on design engineering undesirable anyway. The rapid obsolescence of the Ram therefore reflected not just a lack indigenous engineering talent, but a preference for mass production over technical excellence. It is an important fact that after 1942 none of the western Allies produced a tank capable of combating the best German tanks on anything like equal terms. Canada's shortcomings on the engineering front may have been severe, but they may have been equally irrelevant when the real goal was standardization. McNaughton had expressed his preference for a standardization of North American armoured forces on the Sherman as early as August 1942, well before field trials had established for certain the Sherman's superiority over the Ram. Furthermore, even as late as November 1943, he continued to express faith in the Ram as an operational tank should the need arise, and the possibility of rearming the tank with a heavier gun was reserved as a contingency. "No one," he remarked, "should point the finger of scorn at Canadian industry."[62] The biggest problem with the Ram was not its inferiority, but that it was a Ram in the first place.

The Sherman was, undeniably, a better tank than the Ram. Canadian engineers *had* failed to keep pace. But to McNaughton and his counterparts in the American army, the Sherman's real virtue was that it was rapidly becoming the tank on which the Allied armoured forces were standardizing. The volumes of memoranda passed between the First Canadian Army and Canadian Military Headquarters return to this point again and again. The armoured division was desperate to replace the "mixed bag" of Rams, Churchills, and early model Shermans with a single tank in order to reduce training, maintenance, and spare parts problems,[63] a view they emphasized in a lengthy memorandum to McNaughton which concluded:

> It is considered that the standardization of tank equipment of the Canadian army overseas with that of the War Office and of the US Army would present distinct advantages to the Canadian Army through commonality of maintenance facilities and parts, especially in cases where individual units or formations are operating in conjunction with a British or US force.[64]

This paralleled the US Army's own policy. They considered the advantages of maintaining Sherman production, despite all the tank's defects, to outweigh the advantages of disrupting production in favour of a newer, more powerful tank – of which several were in the development stages. Whether or not this was the correct decision is beside the point: American military planners made the decision because they agreed that the advantages of standardization outweighed the disadvantages of producing inferior tanks.[65] The US Army's emphasis on standardization of training, tactics, and equipment was so great that in 1945 Canada's request to take part in the proposed invasion of Japan was accepted with the express understanding that the Canadian forces involved would be reorganized along American lines, supplied entirely with American equipment, and trained in the United States. Australia's offer of assistance was refused by the Joint Chiefs of Staff because the Australians would not agree to the same terms.[66] In short, it may well be the case that even if Canada had possessed the engineering talent to keep pace in tank design with the United States, the Ram would have nonetheless been fated for the scrap heap because of the desire for standardization – a desire which preceded the tank's obsolescence.

C.P. Stacey's admonition that the Ram was Canada's Second World War equivalent to the Ross Rifle and was better not produced at all is too severe.[67] The Ram was designed and put into production at a time when the United States was neutral and before the Lend-Lease agreement was made. No one could confidently predict when (or if) the United States, with its enormous military potential, would join the Allied cause. Furthermore, the Ram did serve a useful purpose: it equipped the Canadian armoured divisions in the interval between the collapse of Britain's own armoured forces in the Battle of France and the availability of tanks from American production in sufficient quantities to equip all the Allied armies. Modified Rams saw service in a variety of forms, most notably as command vehicles and as the famous Kangaroo armoured personnel carriers.[68]

To the historian, however, the Ram stands for something greater. It symbolizes both the remarkable achievements and limitations of Canadian industry in the Second World War. It also sheds some light on what is perhaps the fundamental reason why the Allies won the war: the preference for mass production and standardization over high quality, but low volume manufacturing. In the Allied armies, quantity had a unique quality of its own.[69]

Notes

1. See Kenneth Macksey, *Tank Warfare: A History of Tanks in Battle* (New York: Stein and Day, 1971) for a general discussion of the development of armoured warfare theory. On Tukhachevsky and Soviet contributions tank doctrine, see David Glantz and Jonathan House, *When Titans Clashed: How the Red Army Stopped Hitler* (Kansas: University of Kansas Press, 1995). Among the many contemporary works on armoured warfare are J.F.C. Fuller, *Armored Warfare: An Annotated Edition of Lectures on F.S.R. III (Operations between Mechanized Forces)* (Westport, CT: Greenwood Press, 1983) and Heinz Guderian, *Achtung-Panzer!: The Development of Armoured Forces, Their Tactics and Operational Potential* (London: Arms and Armour, 1992). Liddell-Hart had described trench warfare as "the triumph of mud over mind" in his *Daily Telegraph* article.
2. A.J. Smithers, *Rude Mechanicals: An Account of Tank Maturity During the Second World War* (New York: Hippocrene Books, 1987), 89.
3. Glantz and House, *When Titans Clashed*, 11-14.
4. Harry C. Thomson and Lida Mayo, *The Ordnance Department: Procurement and Supply*, ed. Stetson Conn, *The United States Army in World War Two: The Technical Services* (Washington, DC: Department of the Army, 1960), 224.
5. William Gregg, *Blueprint for Victory: The Story of Military Vehicle Design and Production in Canada from 1937-1945*, vol. III, *Canadian Military Vehicle Series* (Rockwood, ON: Canadian Military Historical Society, 1981), 171.
6. Jonathan F. Vance, *Death So Noble: Memory, Meaning, and the First World War* (Vancouver: UBC Press, 1997), 174.
7. R.H. Barry, *D-Day: Invasion of Hitler's Europe* (New York: Exeter Books, 1969), 254.
8. See John Ellis, *Brute Force: Allied Strategy and Tactics in the Second World War* (New York: Viking, 1990).
9. H. Duncan Hall and C.C. Wrigley, *Studies of Overseas Supply* (London: HMSO, 1956) 51.
10. See R.L. DiNardo and A. Bay, "Horse Drawn Transport in the German Army," *Journal of Contemporary History* 23 (1988).
11. Nurse, "Canada's Wartime Tank Program," 131.
12. *Canadian Developed Military Vehicles*, vol. 2, *Munitions and Supply Design Records* (Ottawa: Department of Munitions and Supply, 1946), 1.
13. Hall and Wrigley, *Studies of Overseas Supply* 54.
14. Hall, *North American Supply*, 16, 18.
15. See J. de N. Kennedy, *History of the Department of Munitions and Supply: Canada in the Second World War*, vol. 1 (Ottawa: King's Printer, 1950).
16. Or so it seemed at the time. In fact, the 1st Canadian Armoured Brigade was outfitted with British made Churchill and Matilda tanks prior to be being equipped with the Ram.
17. Gregg, *Blueprint for Victory*, 247. Worthington was no doubt a formidable negotiator. The scrap value of the tanks was $2000-$3000 each. Furthermore, he managed to get 45 tons of spare parts thrown in with the deal. The cargo manifest for the trainloads of these relics listed them as "scrap iron" destined for the "Camp Borden Foundry" to circumvent American neutrality laws. Doubtless everyone involved knew exactly what they were really for: one tank entered Canada with the words "Good luck, Canada! Take 'em away" painted on its front plate.
18. Kennedy, *History of the Department of Munitions and Supply*, 68. In the event, all 2000 of these Valentine tanks would end up being sent to the Soviet Union.
19. See Alistair Horne, *To Lose a Battle: France 1940* (Toronto: Little Brown, 1969).
20. The Grant was known, with some caustic humour, as the Lee in British service.
21. Smithers, *Rude Mechanicals*, 110.
22. Gregg, *Blueprint for Victory*, 176.
23. *Ibid*.
24. Worthington to McNaughton, 23 December 1941 in National Archives of Canada [NAC]: A.G.L. McNaughton Papers, MG 30 E133, ser. III, vol. 215, f. PA 9-4-14.
25. Delacour Beamish, "His Majesty's Landship: The Tank," *Canadian Geographic Journal*, June 1942, 281; *Canadian Developed Military Vehicles*, vol. 2, *Munitions and Supply Design Records*, 1-2.
26. Frederick Edwards, "Sweet Chariot!," *Maclean's*, 1 December 1941, 61; "Canada Builds Tanks," *Canadian Business*, November 1941, 74.
27. Beamish, "His Majesty's Landship: The Tank," 280.
28. Hall, *North American Supply*, 46.
29. On lack of American experience in tank design, see Constance McLaughlin-Green, Harry C. Thomson, and Peter C. Roots, *The Ordnance Department: Planning Munitions for War*, ed. Stetson Conn, *The United States Army in World War Two: The Technical Services*

(Washington, DC: Department of the Army, 1955), ch. 9.

30. Defensor to Canmilitary, 28 June 1943, in McNaughton Papers, vol. 215, f. PA 9-4-16, vol. 2.
31. Frederick Edwards, "Battle Buggies," *Maclean's Magazine*, May 15 1942, 28.
32. Kennedy, *History of the Department of Munitions and Supply*, 68.
33. Letter from Beamish, 4 July 1942, in NAC: Department of Munitions and Supply Records, ser. A, vol. 35, f. M & S, 1-1-22, vol. 1.
34. Kennedy, *History of the Department of Munitions and Supply*, 62-3; *Canadian Developed Military Vehicles*, vol. 2, *Munitions and Supply Design Records*, 1.
35. Meeting for the Purpose of Discussing a Suitable Organization to Handle Matters of Design, Production, and Supply of AFVs between the United Kingdom and Canada, 30 May 1941, in McNaughton Papers, vol. 215, f. PA 9-4-15. See also Kennedy, *History of the Department of Munitions and Supply*, 69.
36. McNaughton to Canmilitary, 2 August 1942, in McNaughton Papers, vol. 215, f. PA 9-4-15.
37. Quoted in Brian Loring Villa, *Unauthorized Action* (Toronto: University of Toronto Press, 1989), 216.
38. General Wyman, 1st Cnd. Army Tank Bde Hq, to Major General G.R. Turner, 1 August 1942, in McNaughton Papers, vol. 215, f. PA 9-4-15. Italics in original.
39. Defensor to Canmilitary GS 2812, 11 August 1942, in MG 30 E133 ser. III vol. 215: PA 9-4-15.
40. Memorandum from McNaughton, 1st Cdn. Army, 29 August 1942, in ibid.
41. Comparison Ram Versus Sherman Tanks, Hq First Cdn Army, 31 May 1943, in McNaughton Papers, vol. 215, f. PA 9-4-16.
42. For a discussion of the Sherman's shortcomings from the perspective of its crews, see relevant passages in William L. O'Neill, *A Democracy at War: America's Fight at Home and Abroad in World War II* (New York: The Free Press, 1993).
43. R.J. Overy, *Why the Allies Won* (New York: W.W. Norton, 1995) 202.
44. R.J. Overy, *War and Economy in the Third Reich* (New York: Oxford University Press, 1994), 251, 254.
45. R.J. Overy, *The Air War: 1939-1945* (London: Stein and Day, 1980) 229.
46. Overy, *Why the Allies Won*, 201.
47. Peter Chamberlain and Hilary Louis Doyle, *Encyclopedia of German Tanks of World War Two*, rev. ed. (New York: Arms and Armour, 1993) 261-3, 266.
48. Overy, *Why the Allies Won*, 201.
49. Smithers, *Rude Mechanicals*, 193.
50. McLaughlin-Green, Thomson, and Roots, *The Ordnance Department: Planning Munitions for War*, 286.
51. See William Hornby, *Factories and Plants* (London: HMSO, 1958) 299-344, part of the Official History series.
52. Smithers, *Rude Mechanicals*, 111; Overy, *Why the Allies Won*, 332. Some of the shortfall stems from the fact that a substantial portion of British tanks were by then supplied from the United States under Lend-Lease.
53. Hall and Wrigley, *Studies of Overseas Supply*, 48-9.
54. Hall, *North American Supply*, 24.
55. *Canadian Developed Military Vehicles*, vol. 1, *Munitions and Supply Design Records*, 4.
56. *Ibid.* See also Kennedy, *History of the Department of Munitions and Supply*, 56, which concludes that "it was this policy of restricting the number of types of manufactured that enabled Canada to build over 850,000 military vehicles."
57. Omer Bartov, *Hitler's Army: Soldiers, Nazis, and War in the Third Reich* (New York: Oxford University Press, 1991).
58. *Ibid.*
59. M.M. Postan, Denys Hay, and J.D. Scott, *Design and Development of Weapons: Studies in Government and Industrial Organization* (London: HMSO, 1964), 363.
60. *Canadian Developed Military Vehicles*, vol. 2, *Munitions and Supply Design Records*, 1.
61. Minutes of Conference to Discuss the Future of Canadian Tank Policy, 3 June 1943, in McNaughton Papers, vol. 215. The minutes read: "McNaughton paid tribute to the assistance which Canadian industry had provided, but pointed out that final decisions made about tank policy must be based on military considerations" which favoured standardization. In a later meeting, McNaughton argued it would be more logical to concentrate MLW facilities on one item (SP guns) required by all, leaving to the US the provision of Shermans. See PA to GOC-in-C First Canadian Army, 28 August 1943, in McNaughton Papers, vol. 215, f. PA 9-4-16, vol. 2.
62. Stuart and Young to McNaughton, 3 June 43, in McNaughton Papers, vol. 215, f. PA 9-4-16, vol. 2..
63. Murchie to Stuart and Montague, 20 July 1943, in ibid.
64. Stuart and Young to McNaughton, 3 June 43, in ibid.
65. Macksey, *Tank Warfare*, 176-7.
66. John Ray Skates, *The Invasion of Japan* (Columbia: University of South Carolina Press, 1994), 229-30.
67. C.P. Stacey, *Arms, Men and Governments: The War Policies of Canada, 1939-1945* (Ottawa: Queen's Printer, 1970), 514.
68. John R. Grodzinski, "Kangaroos at War: The History of the 1st Canadian Armoured Personnel Carrier Regiment," *Canadian Military History* 4/2 (1995).
69. Thomson and Mayo, *The Ordnance Department: Procurement and Supply*, 264.

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