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Liechtenstein and Gribeauval: 'Artillery Revolution' in Political and Cultural Context

Ken MacLennan[1]

This article compares artillery and ordnance reform in 1750s Austria and 1760s France. Although the reform programmes were very similar technologically, they assumed considerably different significance in the context of their respective militaries and societies. In France, Gribeauval's system became part of the larger intellectual project of recasting French government and society in a technocratic mould, a project that persisted (against opposition) into the Revolutionary and Napoleonic periods. In Austria, the different structure and organizational culture of the 'technical arms', a military culture with different assumptions about knowledge and expertise, and a more narrowly based political culture made the Liechtenstein reforms part of a considerably less radical centralizing policy.

During the mid-eighteenth century the role of artillery in battle increased dramatically. The average number of guns per thousand combatants more than tripled between the 1730s and the Seven Years War, reaching a level that most European powers would maintain through the Napoleonic period. (See Table 1.) The guns themselves became more specialized for use in field battle. Two powers in particular carried smoothbore artillery toward the limits of its technological possibilities as a battlefield weapon: Austria, during the period between 1749 and 1756, and France, in the decade or so after the Seven Years War. Both the Austrian and French advances emphasized light but powerful field guns, with high tactical and operational mobility.

Although the Austrian reforms, inaugurated by the master of ordnance, Prince Wenzel Liechtenstein, and the French reforms, introduced by the director-general of artillery, Jean-Baptiste Vacquette de Gribeauval, were very similar technologically, they assumed considerably different significance in the context of their respective mili-

[1] I owe particular thanks to my *Doktorvater*, Prof. John A. Lynn, for inspiring this article by bringing the mid-century 'artillery revolution' to my attention, to Prof. Dennis Showalter for his comments on the conference paper from which this article originated, and to my wife, Allison Angell, for her support and suggestions.

Table 1 Artillery pieces per 1000 men in selected battles of the eighteenth century

Battle/campaign	Date	Army	Troops	Guns	GPK	Source
Blenheim	1704	Allies	52 000	60	1.15	Chandler
		Fr.-Bav.	60 000	90	1.61	Chandler
Malplaquet	1709	French	80 000	60	0.75	Chandler
		Allies	110 000	100	0.9	Chandler
Pruth	1711	Ottoman	260 000	444	1.71	Chandler
		Russian	40 000	122	3.05	Chandler
Peterwardein	1716	Imperialist	63 000	80	1.27	Chandler
		Ottoman	60 000	135	2.25	Chandler
Rhine (Berwick)	1734	French	33 800	46	1.39	Pajol
Mollwitz	1741	Prussian	21 600	53	2.45	Bodart
		Austrian	15 800	19	1.2	Bodart
Chotusitz	1742	Prussian	28 000	80	2.85	Bodart
		Austrian	28 000	40	1.43	Bodart
Dettingen	1743	Allies	35 000	98	2.8	Bodart
		French	26 000	56	2.15	Bodart
Fontenoy	1745	French	60 000	70	1.16	Bodart
		Allies	50 000	101	2.02	Bodart
Lobositz	1756	Austrian	34 500	94	2.72	Duffy
		Prussian	29 000	97	3.34	Duffy
Kolin	1757	Austrian	52 750	154	2.92	Duffy
		Prussian	34 000	90	2.64	Duffy
Rossbach	1757	Prussian	22 000	109	4.95	Bodart
		Prussian	22 000	79	3.59	Duffy
		French-Imp.	41 000	72	1.76	Bodart
Leuthen	1757	Prussian	35 000	167	4.77	Bodart
		Prussian	33 000	167	5.06	Duffy
		Austrian	65 000	235	3.62	Bodart
		Austrian	65 000	210	3.23	Duffy
Hochkirch	1758	Austrian	80 000	340	4.25	Duffy
		Prussian	30 000	200	6.67	Duffy
Minden	1759	French	52 000	246	4.73	Bodart
		Allies	38 000	150	3.95	Bodart
Torgau	1760	Prussian	48 500	246	5.07	Duffy
		Austrian	52 000	275	5.29	Duffy
Jemappes	1792	French	45 000	100	2.22	Bodart
		Austrian	13 500	54	4	Bodart

Sources: G. Bodart, *Militär-historisches Kreigs-Lexicon, 1618–1905* (Vienna, 1908); D. Chandler, *The Art of Warfare in the Age of Marlborough*, 2nd edn (New York, 1994); C. Duffy, *The Army of Frederick the Great*, 2nd edn (Chicago, 1996); C.P.V. Pajol, *Les guerres sous Louis XV*, vol. I (Paris, 1882).

taries and societies. In France, as Ken Alder has recently shown, the military and technological programme represented by the Gribeauval reforms became part of a much larger intellectual project of recasting French government and society in a technocratic mould, a project that persisted (against opposition) into the Revolutionary and Napoleonic

periods.[2] On the other hand, the very different structure and organizational culture of the 'technical arms', a military culture with different ideas about knowledge and expertise, and a more narrowly based political culture combined to make the Liechtenstein reforms part of a considerably less radical centralizing policy in Theresian Austria.

The marked increase in size of field artillery trains during the Seven Years War indicates a shift in the emphasis of Western European warmaking away from siegecraft and toward battle. In part this reflects geopolitical factors: the Franco-Austrian alliance, and to a lesser extent the neutrality of the United Provinces and the Italian powers, removed the most heavily fortified areas of Europe from operational consideration and thus drastically reduced opportunities for sieges. However, Alder and Christopher Duffy have detected a pressure toward offensive warfare earlier in the century, theorizing that advances in siegecraft during the late seventeenth century, especially those pioneered by the French engineer Vauban, reduced the value of fortifications by tilting the balance of operations in favour of the offensive.[3]

Increased interest in open-field warfare helped to spur interest in field artillery. The arguments of the so-called 'ancients' notwithstanding, fire-power ruled the eighteenth-century battlefield: it was the primary element of defence and, in the opinion of most practitioners, a necessary element of attack. Commanders thus wanted the fire-power that artillery offered, but without the cost in mobility that it usually entailed. During the War of the Austrian Succession, the Prussian, Austrian and French armies introduced new light cannon specifically designed for direct infantry support.[4] Though hardly the first of their type – indeed, during the War of the Spanish Succession, Allied troops had used 'battalion' or 'regimental' guns in the same role – these new weapons indicate increased interest in the problem, and indeed the number of guns per thousand men rose for all armies during this conflict, from an average of just over one in the Spanish and Polish succession wars to just over two in the Austrian.

This development met with little enthusiasm from the artillery authorities of continental powers. In France and Austria the same litany of complaints arose against the new field guns. Because the savings in weight derived primarily from shortening the barrels, critics argued,

[2] K. Alder, *Engineering the Revolution: Arms and Enlightenment in France, 1763–1815* (Princeton, NJ, 1997).

[3] Op. cit., pp. 32–35; C. Duffy, *The Fortress in the Age of Vauban and Frederick the Great* (London, 1985), pp. 153–57, 291. M.S. Anderson, in *War and Society in Europe of the Old Regime, 1618–1789* (London, 1988), p. 90, claims even more forcefully that 'by the 1730s the siege warfare which had bulked so large for a century and a half was losing its former importance even in Western Europe'.

[4] C. Duffy, *The Army of Frederick the Great* [*AFG*], 2nd edn (Chicago, IL, 1996), p. 172; Vienna Kriegsarchiv [KA], *Der Österreichische Erbfolgekrieg* [*ÖEK*], 8 vols (Vienna, 1896), vol. I, part 1, pp. 437–38; E. Picard and L. Jouan, *L'artillerie française au XVIIIe siècle* (Paris, 1906), pp. 63–65. Though Frederick implemented piecemeal improvements to the artillery, over the course of his reign he did not sponsor anything like the overhaul occurring in the Austrian and French services.

the guns were worthless in permanent and field fortifications because of the damage they would cause to any embrasures in which they were used. Furthermore, and perhaps more damning, the loss of weight brought with it an increase in recoil prejudicial to accuracy, safety and speed. 'Such pieces', grumbled General Anton Feuerstein, commandant of the Austrian field artillery, 'give the enemy heart, but drain courage from their own artillery.'[5]

Despite such complaints, the experience of the Austrian succession war favoured the supporters of lighter field artillery, and largely because of the achievements of the Prussian army. The bluecoats fired faster, marched faster and kept formation better than any other army of the war. In addition, they almost always put more artillery on the battlefield than either their enemies or their allies. Five battles won, no battles lost, and the annexation of virtually all Silesia added up to an eloquent argument for combining fire-power with mobility. And Austria was among the first powers to absorb this lesson.

In 1748 no army had more immediate and obvious cause for reflection and reform than the Austrian. Although Maria Theresa's forces had won some striking successes during the past war, most notably in Bavaria, northern Italy and Moravia, the loss of five battles and the greater part of Silesia to the upstart Prussians stung badly. To prepare for a second encounter with this now-dangerous neighbour, the Empress-Queen initiated a series of comprehensive reforms in her government and her army. These measures provided a more solid financial foundation for the army, standardized and raised its level of discipline, established institutions to provide its future officers with formal military education, and improved its weaponry.[6] The artillery and ordnance system supplied one of the reform movement's greatest successes.

Since May 1744 the Austrian ordnance system had been under the authority of Prince Joseph Wenzel Liechtenstein. An experienced and learned soldier, Liechtenstein was also a scion of one of the oldest and

[5] *ÖEK*, vol. I, part 1, p. 437, n. 2. For the French reaction, see H. Rosen, 'The Système Gribeauval: A Study of Technological Development and Institutional Change in Eighteenth Century France', PhD diss. (Chicago, 1981), pp. 140–42, and D. Chandler, *The Art of Warfare in the Age of Marlborough*, 2nd edn (New York, 1994), p. 191.

[6] The best account of Theresian military reform in English is C. Duffy, *Instrument of War: The Austrian Army in the Seven Years War*, vol. I (Rosemont, IL, 2000), which largely supersedes his earlier *The Army of Maria Theresa* [*AMT*] (New York, 1977). Overviews in German include J. Zimmerman, *Militärverwaltung und Heeresaufbringung in Österreich bis 1806 (Handbuch zur deutschen Militärgeschichte 1648–1939*, part 2, vol. III, Frankfurt, 1965), pp. 69–84, 103–6; J.C. Allmayer-Beck, ed., *Maria Theresia: Beiträge zur Geschichte des Heerwesens ihrer Zeit* (Graz, 1967); and S. Fiedler, *Kriegswesen und Kriegführung im Zeitalter der Kabinettskriege* (Koblenz, 1986), pp. 72–91. On the broader political reforms, see P.G.M. Dickson, *Finance and Government under Maria Theresia*, 2 vols (Oxford, 1987), and F. Walter, *Die Geschichte der österreichischen Zentralverwaltung in der Zeit Maria Theresias* (*Die österreichische Zentralverwaltung* [*ÖZV*] II.1.1, *Veröffentlichungen der Kommission für neuere Geschichte Österreichs*, vol. XXXII, Vienna, 1938).

wealthiest families in the Habsburg monarchy.[7] During the war he had continued and expanded the experiments with light field guns initiated before his appointment; with the breathing-room granted by peace, he embarked upon a more thorough transformation of the artillery service. In the spring of 1749 he appointed a professor of mathematics, holding the rank of captain, for the artillery corps; Liechtenstein had already commissioned him to prepare translations of leading French texts on artillery and fortification for the use of the corps.[8] That summer Liechtenstein held the first of a series of annual camps for training and experimentation at a specially prepared ground near Moldauthein (modern Týn nad Vltavou) in south-western Bohemia, about 20 miles north of Budweis (modern České Budějovice). Franz Rubli, an officer of the *Hausartillerie* or garrison artillery service, recorded the results of 47 experiments and gunnery exercises, as well as a map of the site and drawings of special equipment and structures used during the camp, in bound manuscript form.[9] The tests compared various types of artillery, including siege guns and mortars as well as field guns and howitzers, primarily for range and accuracy. Particular experiments compared the effects of chamber design on mortar performance and investigated the claims of Feuerstein and others about the faults of light field guns – claims which the experiments at least partially bore out.

The technical results of these annual camps, supplemented by other experiments, were officially unveiled in 1753 as a complete system of field and siege guns, howitzers, mortars and transport hardware.[10] The concerns that drove this new system were multifarious, although

[7] For biographical material see J. von Falke, *Geschichte des fürstliches Hauses von Liechtenstein*, 3 vols (Vienna, 1879–81), vol. III, pp. 107–228; KA, *Biographien k.k. Heerführer und Generale* (Vienna, 1888), pp. 61–64; and M. Rufersdorf, 'Joseph Wenzel von Liechtenstein (1696–1772): Diplomat, Feldmarschall, und Heeresreformer im kaiserlichen Dienst', in Volker Press, ed., *Liechtenstein: Fürstliches Haus und staatliche Ordnung* (Vaduz, 1988), pp. 347–81.

[8] KA, Hofkriegsrat (HKR) Protocolle in Expeditis (PE) 1749 May 88. Several authors, most notably Anton Dolleczek in *Geschichte der österreichische Artillerie* [*GöA*] (Vienna, 1887, p. 419) and Friedrich Gatti in *Geschichte der k.u.k. technischen Militärakademie* (2 vols., Vienna, 1901, vol. II, p. 12), have claimed that Liechtenstein founded a corps school at Bergstadl, near Budweis (modern České Budějovice), in 1744, but neither cites any particular sources, and my own research at the Vienna Kriegsarchiv has not revealed any solid contemporary evidence that such a foundation occurred during the war – though an ad hoc establishment would not have left the paper trail that a formal institution would have. The Liechtenstein-sponsored German translation of Bélidor's 1732 *Noveau cours de mathematique à l'usage de l'artillerie et du genie* first appeared in 1745 as *Neue mathematische Lehrschule zum Gebrauch der Officiers von der Artillerie, und Ingenieurs . . . in die deutsche Sprache übersetzt, und mit nöthigen Zusätzen versehen, von J. Th. Bion* (Vienna, 1745).

[9] F. von Rubli, *Artillerie Exercitia, und Experimenten, welche zu Moldau Thein Anno 1749 in Beysein des Feldt Marchal Fürsten Ioseph Wenzel von Liechtenstein, unter der Direktion des Feldt Artillerie Comendanten und Feldt Marchal-Lieutenant von Feuerstein bewürcket worden* (KA, Kriegswissenschaftliche Memoiren, 13/465).

[10] *Artillerie Systeme ab Anno 1753* [*Systeme 1753*] (KA, Altes Artilleriearchiv XVIII.a.). A draft from the previous year, differing only in certain details, also survives. (KA, Altes Artilleriearchiv IV.b.: *Artillerie Systeme de Anno 1752*).

tactical and operational mobility figured prominently. The two qualities Feuerstein highlights in his introduction, presumably those meriting the most attention from his audience, were 'considerable savings of expensive metal and munitions' and 'easier advancing and more flexible operations'.[11]

In the new system the mainstay of the field army's artillery would be light field guns firing 3-, 6- and 12-pound shot. These guns were very similar to the light field pieces introduced during the previous war (although it is difficult to say how similar, as specifications from the earlier guns have not survived). The barrels were considerably shorter and lighter than those of the last officially mandated series of guns, dating from 1716.[12] This reduction in weight provided the main improvement in mobility, but several changes in carriage design enhanced the effect. The axles of the carriages would be moved towards the rear, shifting the gun's balance forward in order to ease the difficulty of moving it in action.[13] Because this position became inconvenient when a gun was limbered, a second pair of trunnion-sockets was added behind the originals to permit adjustment of weight distribution.[14] In addition, each carriage would have a set of four ring-tipped rods, called 'advancing irons' (*Avancier-Eisen*), fixed to its front, providing ideal places to loop ropes for dragging the gun forward by man- or horsepower.[15]

One perhaps partial answer to the objections raised by the critics of light guns lay in the adoption of an elevation screw. This device permitted more rapid and more exact aiming than the older practice of using quoins or chocks, and unlike the quoins apparently kept position during firing.[16] To a similar end, and to save money by protecting the powder, Feuerstein mandated the use of prepared cartridge ammunition wherever possible, although he recognized that the powder-shovel might still have its uses in emergencies.[17]

More humble, perhaps, but of greater interest to our story, is the adoption of precise standards for carriage, limber, cart and wagon wheels. Citing a concern for operational mobility, Feuerstein established two sizes of wheel for all artillery transport use, fixing the dimensions of wheels and axles to within a quarter of an inch so that

[11] *Systeme 1753*, p. 1.
[12] KA, Altes Artilleriearchiv x.a.; Dolleczek, *GöA*, p. 158. Like the Vallière system in France, this order eliminated a more varied array of artillery that included pieces not terribly dissimilar in size from the new Feuerstein models. Op. cit., p. 153; Alder, *Engineering the Revolution*, pp. 29–30.
[13] *Systeme 1753*, p. 4.
[14] Op. cit., p. 5.
[15] Op. cit., p. 8.
[16] Op. cit., pp. 4, 6–7. The elevation screw had already been adopted by the Swedish artillery earlier in the century and the Prussian artillery in 1742, and had apparently been in sporadic use since at least the mid-seventeenth century. See J. Jobé, ed., *Guns: An Illustrated History of Artillery* (New York, 1971), pp. 61, 64; Duffy, *AFG*, p. 175.
[17] *Systeme 1753*, pp. 11–15, 30.

repairs could be made on the march with speed and efficiency.[18] In order to ensure adherence to these standards, as well as those for other parts of the carriage, Feuerstein recommended the use of a set of gauges designed to check the 'thoroughgoing sameness' the new system demanded.[19] The concern for tolerances was hardly new – after all, cannonballs had to fit into the barrels of their guns, and carriage wheels had to match closely enough to keep cargoes level – but the emphasis on interchangeability was. Interchangeable-parts manufacturing had arisen in a number of places in eighteenth-century Europe, but had not been adopted largely owing to the opposition of artisans whose discretion it would have sharply limited; a proposal to introduce the process for flintlock manufacture in France had died quietly in the late 1720s.[20] With the adoption of the Feuerstein plan the Austrian ordnance system took a limited but noteworthy step towards one of the central elements of industrialization.

Attention to the logistics of artillery, at least in the matter of ammunition, was another hallmark of the Feuerstein system. Recognizing that a higher rate of fire would place extra strain on supply, Feuerstein outlined an ideal ammunition supply for each type of gun, with so many rounds carried on the limber, so many more on the front-line ammunition carts, and so many more on the wagons stationed to the rear. He further specified the number of rounds of solid shot, hollow shot and canister to be carried for each gun, as well as the number of bombs and canister rounds for the howitzers.[21]

In addition, Feuerstein considered the tactical employment of the guns at two levels: first, on the grand scale, discussing the division of guns among the troops of the army; then on the smallest scale, outlining the duties of each member of the gun crew. The grand-tactical musings are rather vague, but contain a few points of note. First, that 3-pound field guns and 7-pound howitzers would be employed in direct support of the infantry battalions. Second, that batteries from the reserve should be placed to cover the flanks of the army, except when fighting a Turkish army without adequate terrain protection. Third, that the artillery reserve would require no more than six 3-pounders, and that a number of 3-pounders should be assigned to detachments of Croats or other light troops. Fourth, that cavalry would normally be assigned no artillery, but that it might prove advantageous when units of horse were deployed in the main battle line. Finally, Feuerstein suggests using infantry to mask batteries from enemy reconnaissance until the guns are ready to fire.[22] All of these points are interesting, but Feuerstein makes no attempt to tie them together through appeal to an explicit tactical mission, principle of war or other broader context.

[18] Op. cit., pp. 5–6.
[19] Op. cit., pp. 10–11.
[20] Alder, *Engineering the Revolution*, pp. 221–22.
[21] *Systeme 1753*, pp. 12–14, 23–24, 40.
[22] Op. cit., pp. 1–3.

In outlining the responsibilities of men and officers, Feuerstein betrays a similar tendency to favour individual detail over an integrated approach. Although he clearly explains the duties of each member of a gun crew, and relates these to the logistics of ammunition supply in the field, he does not explicitly connect these instructions with the artillery's tactical mission.[23] His description of officers' roles is decidedly hazy: we learn where officers are to be stationed when the army deploys, but almost nothing about what they are supposed to do, except that they are to provide aid and moral support for the gun crews and decide what sort of ammunition a given situation requires.[24] There is no discussion of guidelines for siting guns effectively or of moving them to more advantageous positions as an action develops, and there is certainly no discussion of the reasoning which informs the measures prescribed.

The gaps described above are suggestive. By leaving so much of the context of his work implicit, Feuerstein had either banked heavily on a shared understanding with his audience about battle tactics and the artillery's role therein, or not taken time to reflect upon the assumptions about warfare which lay behind the technical and tactical reforms, or some combination of both. This apparent disinclination to consider the parts in relation to the whole would show itself again in 1756 when the master of the ordnance, Prince Wenzel Liechtenstein, carried out a reorganization of the field artillery corps.

From its establishment in the late seventeenth century until the War of the Austrian Succession, the field artillery corps was almost amoebic in its simplicity and flexibility. The main corps, or *Feld Artillerie Haupt Corpo*, consisted of five groups: the command and administrative staff; the *Feldzeugamt*, which was responsible for maintaining artillery equipment on campaign; the *Roßpartei*, which organized transport; the mining corps; and the gunners and junior officers. The troops were thus divided solely by function, with no internal 'skeleton' of subordinate units within these divisions. The main corps remained with the main army, and other forces were assigned temporary artillery corps drafted from the pool of gunners, officers and staff personnel at the main corps.[25]

In the winter of 1755–56 Liechtenstein adopted a more highly articulated organization for the field artillery corps, dividing the gunners into three brigades of eight companies each.[26] The staff, the miners, the *Feldzeugamt* and the *Roßpartei* remained essentially unchanged. Although scholars have generally interpreted this reform as part of the ongoing 'militarization' of the artillery service, making soldiers out of artisan gunners, correspondence between Liechtenstein and the court war council suggests that the primary motivation was

[23] Op. cit., pp. 16–19.
[24] Op. cit., pp. 20–22.
[25] Dolleczek, *GöA*, pp. 212–19; *ÖEK* vol. 1, part 1, pp. 430–33.
[26] KA, HKR Protocolle in Publicis [Prot.] 1756 Jan 503.

simply administrative rationalization.[27] Although Liechtenstein was apparently more concerned with justifying the additional staff positions and increased salaries his plan entailed than with selling the plan itself, he essentially argued that the new system would increase administrative efficiency.[28]

The performance of the Austrian artillery in the Seven Years War handily demonstrated the value of the inter-war reforms. The new field artillery, designed for mobility and high volume of fire, inflicted heavy losses on its Prussian opponents in both victory and defeat, at Lobositz, at Prague and Kolin, at Hochkirch and Torgau.[29] In response Frederick the Great complimented Liechtenstein and copied the Feuerstein 12-pounder; he also raided his own fortresses for heavy guns to use in the field.[30]

While the Austrian artillery earned plaudits in the Seven Years War, the French artillery, along with the entire French army, suffered a grievous blow to its reputation. The defeat at Rossbach was only the most dramatic of French failures in the conflict, and even before the war had ended French military authorities began to take a long, hard look at the work required to restore the lustre gained under Louis XIV.[31]

The French artillery of the mid-eighteenth century suffered from a variety of flaws: internal rivalry, glacially slow promotion and low morale among its officers, and frequent institutional change which, though intended to solve the former problems, merely added organizational instability to the mix.[32] Technologically, however, the French had since 1732 possessed one of the most intellectually coherent artillery systems in Europe. Implemented by the director-general of artillery, Jean-Florent de Vallière, the French artillery system of the mid-eighteenth century established five standard sizes of cannon, each designed for use either in the field or in siege warfare. These were heavy guns, with long barrels for use in embrasures and thick walls to contain the blast

[27] Dolleczek, *GöA*, pp. 291, 356; Duffy, *AMT*, pp. 106–7. Compare KA, HKR Prot. 1756 Jan 503, which contains Liechtenstein's memorandum and a loose sketch of the plan, the war commissariat's comments, and the war council's reply to Liechtenstein. Liechtenstein's argument rests entirely on administrative efficiency, economy and fairness to the officers whose salaries would rise under the new plan.

[28] Although neither Liechtenstein's memorandum nor the commissariat and war council commentaries on it explain how said efficiency was to be realized, it is not hard to see that, by shifting the burden of paperwork to a lower level and dividing it up among company clerks, an administrative bottleneck at the main corps staff could be eliminated.

[29] C. von Decker, *Schlachten und Hauptgefechte des Siebenjährigen Krieges, mit vorherrschender Bezugnahme auf den Gebrauch der Artillerie, in Verbindung mit den beiden anderen Hauptwaffen der Armee* (Berlin, 1837); Duffy, *AMT*, pp. 170–205, *Instrument of War*, pp. 415–16, and *AFG*, pp. 248–311; D. Showalter, *The Wars of Frederick the Great* (London, 1996), pp. 135–320.

[30] Falke, *Geschichte*, vol. III, p. 205; Duffy, *AFG*, p. 174.

[31] L. Kennett, *The French Armies in the Seven Years' War* (Durham, NC, 1967), p. 139; Rosen, 'Système Gribeauval', pp. 23–26.

[32] Picard and Jouan, *L'artillerie française*, pp. 6–22; Rosen, 'Système Gribeauval', pp. 57–72.

of large powder charges, and though partially intended for use in the open field, they were clearly designed for a war dominated by sieges, the kind of war that France had fought through most of Louis XIV's personal reign, and the kind of war that Vallière, among others, wished to maintain as the rule rather than the exception.[33] This technological system was supported by the foremost programme of military-technical education in Europe, with regional artillery schools teaching both theoretical and practical knowledge from a curriculum standardized throughout the kingdom.[34]

As impressive an achievement as the Vallière system was, it proved itself unable to hold up against the pressures toward offensive, open-field warfare. Even during Saxe's campaigns of the 1740s, in which the French gradually and inexorably conquered the Austrian Netherlands, there were complaints about the unwieldiness of the Vallière guns and experiments with light field artillery. In the Seven Years War, with the well-travelled fortress zones of the Netherlands and northern Italy removed from strategic consideration, the liabilities of the Vallière system were thrown into sharp relief. Faced by enemies with more and lighter cannon, outmanoeuvred and outgunned by the Anglo-Prussian forces, a frustrated Marshal Broglie had his Vallière guns reamed to fire larger shot and commissioned on his own authority a number of light field guns, which he distributed among the infantry as direct support weapons over the objections of the artillery authorities.[35]

In fact, only one French artillery officer earned any significant laurels during the war, and he fought for the Austrians. Jean Baptiste Vacquette de Gribeauval, son of an Amiens legal family, had joined the French artillery as a volunteer in 1732 and risen to the rank of captain by 1749.[36] Finding his advancement stalled, he requested and received permission to offer his services to France's new Austrian allies. Commissioned in the fall of 1758, he proceeded to distinguish himself at the capture of Glatz in 1760 and the defence of Schweidnitz in 1762, ending the war with the rank of lieutenant-general.[37] He further

[33] Alder, *Engineering the Revolution*, pp. 31–35.
[34] Op. cit., pp. 3, 62–69.
[35] Op. cit., p. 36.
[36] There are two modern biographies of Gribeauval, both in French: E. Hennebert, *Gribeauval, lieutenant-général des armées du roy, premier inspecteur-général du corps royal de l'artillerie* (Paris, 1896), and P. Nardin, *Gribeauval, lieutenant-général des armées du roi (1715–1789)* (Paris, 1981). Alder, *Engineering the Revolution*, pp. 36–39, provides biographical data to 1763, as does Rosen, 'Système Gribeauval', pp. 18–23.
[37] Hennebert, *Gribeauval*, pp. 27–55; Nardin, *Gribeauval*, pp. 59–89; Duffy, *Instrument of War*, p. 293. Hennebert and Nardin disagree about Gribeauval's career path during this period: Hennebert claims he was immediately commissioned a major-general (*général de bataille*) in the Austrian artillery and then reluctantly breveted a lieutenant-colonel by the French; Nardin documents Gribeauval's brevet rank as preceding his Austrian commission in a rank he terms *Obristfeldwachtmeister*, which he translates as 'colonel-major'. The Austrian term for major was *Obristwachtmeister* or *Major*, *Oberstückhauptmann* in the artillery, and that for major-general *Generalfeldwachtmeister*, which was Gribeauval's initial Austrian rank according to Duffy. A war council protocol dated 10 March 1759 (KA, HKR Prot. 1759 Mar 224) records a letter to the 'French Colonel' Gribeauval concerning his Austrian commission in the rank of *Generalfeldwachtmeister*, dating from 1 November 1758, and

furnished a detailed report in response to a series of questions posed by the Duc de Choiseul, the new French minister of war, on the differences between the French and Austrian artillery services.[38]

Thoroughly acquainted with the Austrian artillery, and having first-hand knowledge of the Prussian as well, Gribeauval drew upon his experience and education to compose a detailed proposal for the reform of the French artillery. Choiseul not only championed Gribeauval's plan, he also chose Gribeauval to implement it, promoting him over the heads of several senior officers.[39]

The Gribeauval plan, like the Vallière system it was designed to replace, was founded upon a particular vision of war and of artillery's role in it. But that vision was decidedly different from Vallière's. As Ken Alder has noted, the siege-centred concept of warfare that framed the Vallière system treated war almost as a form of theatre: a display of sovereign power in a controlled setting, with the destructiveness of warfare bounded both by conventions of behaviour and by physical laws.[40] The Gribeauval system, however, embraced the risk of battle and accepted the possibilities of open-ended destruction, and it brought a radical functionality to its purpose of providing mobile firepower.[41] Organization, promotion, tactics, technology, training, even production were all to be subordinated to the artillery's mission.

Technologically, the Gribeauval programme produced guns superficially similar to the Austrian Feuerstein system: shorter barrels and thinner walls than the earlier guns, elevation screws to improve accuracy, carriages designed to maximize tactical and operational mobility.[42] Yet on closer inspection the radical nature of the Gribeauval programme becomes apparent. The Liechtenstein–Feuerstein reforms in Austria, though more rigorous than what they supplanted, left gaps and hazy areas in their articulation of and their adaptation to the artillery's changing mission. Gribeauval began with the new mission and designed everything else around it.

The new organization of the artillery was based strictly on the operational needs of the guns and the technical needs of the service in the context of offensive, field-based warfare.[43] It overturned the existing social and political relations of the artillery service just as it deposed the vision of war around which it had been organized. A definition of merit which leaned heavily on seniority was replaced by one which stressed technical competence, and Gribeauval added an element of peer review to the promotion process as well as instituting limited promotion from the enlisted ranks.[44] Technical competence itself

his assignment to both the engineering and the artillery corps, drawing the full major-general's salary of 4000 fl. from each department.

38 Hennebert, *Gribeauval*, pp. 37–43, presents this report in its entirety.

39 Rosen, 'Système Gribeauval', p. 26; Nardin, *Gribeauval*, pp. 151–53.

40 Alder, *Engineering the Revolution*, pp. 33–35.

41 Op. cit., pp. 39–51.

42 Rosen, 'Système Gribeauval', pp. 13–52, offers an excellent description in English.

43 Op. cit., pp. 42–43; Alder, *Engineering the Revolution*, p. 43.

44 Rosen, 'Système Gribeauval', pp. 44–48; Alder, *Engineering the Revolution*, pp. 56–80.

came to be redefined as Gribeauval revised the curriculum of the artillery schools and the skills demanded of his officers, adding among other subjects analytical calculus and infantry tactics to the fund of knowledge deemed necessary.[45]

Among the most radical measures of the Gribeauvalist programme was the establishment of new, highly rigorous rules for the production of ordnance materials. Using recent advances in casting and boring technology – the most famous being Jean Maritz's solid boring machine – the French could manufacture guns to more exacting tolerances than ever before achieved, thus reducing windage to the advantage of both efficiency and, to a much lesser extent, accuracy. With tightly controlled gauges, all manufactured in the same workshop to the same standards, the ideal of interchangeability which the Austrians applied to carriage wheels could be extended throughout the manufacture of artillery equipment. As Alder has noted, these reforms tended to concentrate control over the production process in the hands of designing engineers and to reduce the influence of manufacturing artisans over the final product – an explicit goal of the Gribeauvalist agenda.[46]

Gribeauval's programme encountered fierce resistance within the French artillery and ordnance system: from officers opposed to the new vision of war and the radical instrumentality of the Gribeauval system, as well as from artisans contesting the engineers' attempts to control the rules of production.[47] The Vallièrists took their cause to the public, criticizing the experiments that favoured the Gribeauval guns, staging their own counter-demonstrations to prove the superiority of the old system, and publishing numerous pamphlets and tracts to sustain their arguments. But, despite a short return to power between 1772 and 1776, the Vallièrists lost in the end. The French military authorities, with the Prussian and Austrian examples firmly in mind, accepted the Gribeauvalist programme and the vision of war that informed it.[48]

Although the Austrian artillery reform served as a key inspiration for the French, the differences between the two cannot simply be ascribed to an evolution from one form to another. Each arose in a different social, political and cultural context and drew on the resources available in that context. In Austria the conditions of the ordnance system, the management style of the military, and the very narrow base of political culture conspired to make the Austrian 'artillery revolution' a quiet one.

[45] Op. cit., pp. 70–75; Rosen, 'Système Gribeauval', p. 46.
[46] Alder, *Engineering the Revolution*, pp. 146–56.
[47] P. Chalmin, 'La querelle des bleus et des rouges dans l'artillerie française à la fin du XVIIIe siècle', *Revue d'histoire economique et sociale* XLVI/4 (1968), pp. 465–505; Rosen, 'Système Gribeauval', pp. 148–87; Alder, *Engineering the Revolution*, pp. 39–40, 92–117, 221–49.
[48] Op. cit., p. 40.

Early eighteenth-century Austria provided few opportunities for access to formal military-technical education. Two institutions for this purpose existed before the Theresian reforms: the state engineering academy, founded in 1717, and the independent Chaotic Foundation, founded by a Baron Chaos in 1663 and considerably expanded in the late 1730s.[49] Neither seems to have produced a sufficient number of engineers for the army until after the Seven Years War.[50] There was no artillery school before Liechtenstein's establishment; would-be officers apparently learned their trade largely by hand and through self-study, though some attended one or the other of the engineering schools.[51] And there were no formal military academies until the establishment of the state school at Wiener Neustadt in 1752. This lack of formal educational institutions – in comparison to France, the acknowledged leader in the field – may have favoured a concept of soldiering as less a profession than a trade, and thus less subject to the rigours of system and analysis.

Nearly as significant was the manner in which ideas circulated through the Austrian army at large. There was virtually no local publishing in the military sciences – even Rubli's account of the 1749 tests, as official as it seems, was recorded in manuscript. This phenomenon is usually ascribed to the anti-intellectual tendencies of the Austrian officer corps, and not entirely without justice.[52] However, as Erik Lund has more recently noted, discussion and debate about the art of war in its technical and theoretical aspects arose within the army, carried primarily by manuscripts and memoranda circulating within the officer corps.[53]

More important than any alleged shortage of ideas may have been the lack of an open forum for discussion and criticism. In France by mid-century the 'republic of letters' that did so much to spread Enlightenment ideas was highly developed, and theoretical treatments of warfare influenced by those ideas began to appear in France soon

[49] Gatti, *Geschichte der k.u.k. technischen Militärakademie*, vol. 1, pp. 1–44; Duffy, *Instrument of War*, p. 294; *ÖEK*, vol. 1, part 1, p. 442.

[50] Op. cit., p. 443; Duffy, *AMT*, pp. 291–96.

[51] Dolleczek, *GöA*, p. 226.

[52] Duffy, *AMT*, p. 45; M. Rauchensteiner, 'The Development of War Theories in Austria at the End of the Eighteenth Century', in B. Kiraly, G.E. Rothenburg, and P. Sugar, eds, *East Central European Society and War in the Pre-Revolutionary Eighteenth Century* (Boulder, CO, 1982), pp. 75–77; G.E. Rothenburg, 'Some Observations on the Evolution of Technical and Scientific Education in the Austrian Army during the Eighteenth Century' (commentary upon D. Bien, 'Military Education in 18th Century France: Technical and Non-Technical Determinants'), in M.D. Wright and L.J. Paszek, eds, *Science, Technology, and Warfare: The Proceedings of the Third Military History Symposium, United States Air Force Academy, 8–9 May 1969* (Washington, DC, 1970), pp. 75–80.

[53] E. Lund, *War for the Every Day: Generals, Knowledge, and Warfare in Early Modern Europe, 1680–1740* (Westport, CT, 1999), pp. 7–8, 49–50, 143–44.

after the end of the War of the Austrian Succession.[54] In Austria, though the works of early *philosophes* had found a narrow but influential audience in the first decades of the eighteenth century – including Prince Eugene of Savoy and Chancellor Count Philipp Sinzendorf – few had undertaken any serious critical engagement with the Anglo-French intellectual trends of the Enlightenment, and Austria lagged behind England and France in the development of a 'public' characterized by print journalism and coffee-house discussion of political affairs.[55] As noted above, in the Austrian service the primary and almost exclusive vehicle for discussion of the art of war was the circulated manuscript, which reached a limited audience for reasons that included economy as well as security, but had the perhaps unintended effect that it limited participation in debate rather sharply.[56] Where in France political culture (if not power) was beginning to open up to participants outside the existing power structure, in the Habsburg monarchy (as in most of Germany) that culture would remain closed until after 1763.

The particular political circumstances of the Austrian ordnance reforms also favoured a smooth transition and limited any stimulus for debate over them. Throughout his tenure Liechtenstein seems to have enjoyed the full support of the Empress and her consort, and his administrative superiors at the war council rarely took any interest in the ordnance department's internal affairs, except where cost was concerned. Neither Liechtenstein nor Feuerstein faced any serious rivals for their positions; once the two had established a productive working relationship, there was no figure around whom resistance might organize. And none of the Austrian reforms posed a visible threat to the existing social arrangements of the artillery or the army – not even, apparently, the limited introduction of interchangeable-parts manufacturing methods.[57]

In post-Seven Years War France, however, each of the key factors considered above differed. French military-technical education was the

[54] A. Gat, *The Origins of Military Thought from the Enlightenment to Clausewitz* (Oxford, 1989), pp. 25–39. Alder, *Engineering the Revolution*, pp. 111–12, characterizes some of the authors discussed by Gat, most notably the 'Ancients' Folard and Mesnil-Durand, as 'Cartesians', and thus implies allegiance to an earlier a priori rationalism disavowed by Enlightenment thinkers; see P. Gay, *The Enlightenment: An Interpretation*, 2 vols. (New York, 1969), vol. II, pp. 145–50, for discussion of the Cartesian/Newtonian dichotomy.

[55] G. Klingenstein, *Staatsverwaltung und kirchliche Autorität im 18. Jahrhundert* (Vienna, 1970), pp. 136–38, 153–57; D. McKay, *Prince Eugene of Savoy* (London, 1977), pp. 197–203.

[56] Lund, *War for the Every Day*, pp. 143–44. The smaller audience, all sharing the same institutional affiliation, might also have made it easier to identify and squelch or deter critics, although the army's usually deleterious factionalism would have provided them with some room for expression.

[57] The absence of reports from the period discussing anything that might be construed as resistance by arsenal workers to the reforms does not constitute proof that no resistance occurred, but it does suggest that – for whatever reasons – if it did occur it was not considered particularly serious.

most advanced in Europe during the early eighteenth century, and relied heavily on both theoretical and practical knowledge.[58] It offered a coherent vision of war and of the world in which it operated, and Vallière had developed a rational system to fit that vision. This 'absolutist rationality', as Alder names it, emphasized stability and balance: it was 'a science of containment, a Cartesian geometrization that circumscribed the possible'.[59] And because it was a coherent system, it would require considerable effort – indeed, a complete alternative system – to dethrone.

France was also, as we have noted, one of the most important centres of the military 'republic of letters'. French military authors debated tactics, technology and strategy in print, and their partisans took up cudgels for them in the salons. A relatively widespread print culture allowed room for a public space to discuss not only military matters but science, mores, customs and politics, all outside the framework of government.[60] It opened political culture to those outside or on the fringes of the state and provided a relatively open arena for competition among ideas. It also gave scope for greater intellectual cross-fertilization: Gribeauval's system, with its readiness to abandon tradition and privilege in favour of utility, and to hand the centralized state more power in the same cause, showed the direct influence of the *philosophes'* critique of French society.[61]

This political, social and intellectual climate favoured the emergence of a coherent, purposeful and thoroughly systematic alternative to the Vallière system. But it also guaranteed controversy as the new programme challenged deeply held assumptions about warfare, about technology, and even about the shape of state and society. In this respect it resembled many of the reforms advocated and implemented in France after the Seven Years War.[62] Conflict was exacerbated by political circumstance: Gribeauval's leapfrog promotion rankled, and no one was more offended than Joseph-Florent de Vallière, son and heir apparent of the old system's founder.[63] Resistance to Gribeauval within the officer corps clustered around the younger Vallière, but though personal considerations lent extra bile to the struggle, it was essentially a contest between visions of the future.

France's reformist engineers, as Alder describes them, struggled to introduce a new kind of rationality into military technology, tactics, production, and in the end into social and political relations. So radical an alteration of means–ends equations was the intention of neither the Theresian reform programme nor the Liechtenstein ord-

[58] Alder, *Engineering the Revolution*, pp. 60–65.
[59] Op. cit., p. 34.
[60] Op. cit., p. 53; C.B.A. Behrens, *Society, Government, and the Enlightenment* (New York, 1985), pp. 152–75.
[61] Alder, *Engineering the Revolution*, pp. 53–54.
[62] Op. cit., pp. 46–55.
[63] Rosen, 'Système Gribeauval', pp. 148–49.

nance agenda. The pursuit of uniformity was restricted to a few particular circumstances, and the ideal of 'God-pleasing equality' articulated by Maria Theresa's minister Haugwitz was worlds away from either the instrumentality of the French technocrats or the radical egalitarianism of the Jacobins and sans-culottes.[64]

[64] The phrase 'God-pleasing equality' (*gottgefällige Gleichheit*) appears several times in Haugwitz's memoranda. See J. Kallbrunner and M. Winkler, eds, *ÖZV* II.2, *Veröffentlichungen der Kommission für neuere Geschichte Österreichs*, vol. XVIII (Vienna, 1925), p. 185.