

From the House of Orange to the House of Bush: 400 years of 'revolutions in military affairs'

prof. G. Parker*

Introduction¹

A series of important military innovations since the fifteenth century have facilitated and upheld Western global dominance. The development of heavy bronze gunpowder artillery after the 1420s made possible the destruction of almost all fortifications of traditional vertical design, while a century later the creation of fortresses of geometrical design protected by bastions restored the advantage in siege warfare to their defenders. At the same time, naval architects began to place heavy artillery aboard full-rigged sailing vessels, creating floating fortresses that proved virtually impregnable except to others of the same genre, while the invention of infantry volley fire allowed disciplined European troops to defeat far larger enemy forces, whether mounted or on foot, in the field.

By 1775, this combination of 'guns and sails' had allowed relatively small groups of Europeans to create and

In de geschiedenis liggen wijsheid en verrassingen verscholen. Dat er in de loop van de tijd 'militaire revoluties' zijn geweest staat niet ter discussie. Het vliegtuig, de tank, de onderzeeboot en het nucleaire wapen zijn hiervan voorbeelden.

Twee vragen verdienen daarbij antwoord: hoe ontstaan dergelijke revoluties en waarom zijn ze zo beslissend? Slechts weinigen zullen rond dit thema een relatie onderkennen tussen het 'Huis van Oranje' en het 'Huis van Bush'! De auteur gaat op deze relatie in.

Ongeveer vierhonderd jaar geleden veroorzaakten de Oranjes een militaire revolutie. Zij introduceerden het gebruik van opeenvolgende infanterie-salvo's.

Het 'Huis van Bush' wordt vierhonderd jaar later met een andere 'Revolution in Military Affairs' geconfronteerd. Nu gaat het om de interactie tussen systemen die informatie verzamelen, verwerken, samenvoegen en verspreiden om geweld met grote precisie toe te passen. De auteur gaat na welke lessen de eerdere revolutie voor het heden heeft.

defend empires in America, South Asia, Siberia and the Philippines, to establish permanent trading posts in East and West Africa and in Indonesia, and to dominate most of the world's oceans.

Industrial production of precision weapons from the late eighteenth century onwards allowed the Europeans to extend significantly the areas under their control in Africa, India and Southeast Asia, and to humble China. For better or worse the West, which covered only 15 percent of the world's land surface in 1450, dominated 35 percent and all the world's oceans by 1800, and 84 percent of the world's land surface and almost all the world's oceans by 1914.

Military innovations

In that dramatic and sustained expansion, military innovations played an essential role. Although, despite fur-

ther impressive military innovations (including submarines, warplanes, tanks and thermonuclear weapons) the West lost all its colonies in the mid-twentieth century and even, temporarily, the ability to project its armed might worldwide and prevail, 'stealth technology' restored a decisive military edge in the 1990s.

Each of these innovations formed part of a series of linked changes in the forms of combat that created a serious if not crippling disadvantage to those who failed to adopt it. The current acronym of choice for such phenomena is 'RMA', standing for 'Revolution in Military Affairs', a phrase coined by the Office of Net Assessment within the Pentagon to refer to

the interaction between systems that collect, process, fuse and communicate information and those that apply military force →

* Professor Parker is Andreas Dorpalen Professor of History aan de Ohio State University. Hij heeft 31 boeken op zijn naam, waaronder 'The Military Revolution', 'The Dutch Revolt' en 'The Grand strategy of Phillip II'.

¹ An expanded version of this essay, together with full bibliographical references, will appear in the *Acta* of the XXVIIIth International Congress on Military History sponsored by the U.S. Commission on Military History, edited by John A. Lynn. I am grateful to the Commission for permission to publish this streamlined version here.

in order to make possible 'precision violence'.

The Office of Net Assessment uses RMA interchangeably with the term 'Military Revolution', normally applied to those earlier military innovations that created asymmetry in warfare; and this paper does the same.²

The crucial questions are, first, how do they occur; and, second, why do they prove so decisive? This essay

² Lawrence Freedman, *The Revolution in Strategic Affairs* (Oxford: Oxford University Press, 1998), 11.

seeks answers in an early Military Revolution – the invention and implementation of infantry volley fire – and then examines the current Revolution in Military Affairs in the light of that case study.

The birth of volley fire

Volley fire was invented twice in the sixteenth century: first in Japan and then in the Dutch Republic. The first Portuguese visitors to Japan in 1543 brought with them some arquebuses, smoothbore muzzle-loading guns about 1.3 meters long that fired a 20-gram lead ball. They arrived during a

period of civil war that had fragmented the archipelago into dozens of competing states and many local warlords, immediately seeing the advantage of adding a powerful new weapon to their arsenals, ordered their metalworkers to make Western-style arquebuses.

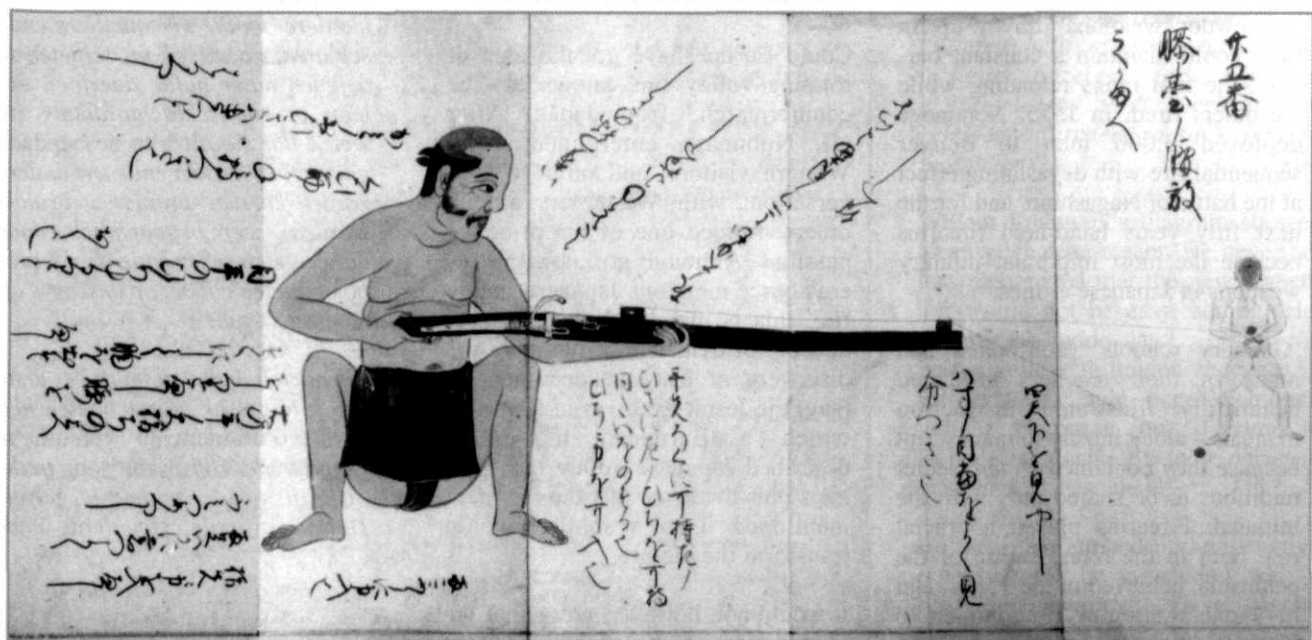
All muzzle-loading weapons suffer from a major problem: they are slow to reload. Moreover, any improvement in accuracy requires a tighter fit between ball and barrel (the 'windage'), which automatically increases reloading time. Early modern warriors therefore experimented to find the best balance between the two. The Japanese privileged accuracy and, from the first, the manuals on firearms produced by their 'gunnery schools' clearly reflect this: for example, the manuscript *Book of 32 positions for steadying a gun*, first composed in the 1550s by instructors of the Inatomi gunnery school, stressed marksmanship. Thirty of its thirty-two images showed different positions for individual sharpshooters, whether engaged in hunting, in fighting or in target practice against bound prisoners.

In the 1560s Oda Nobunaga, one of the warlords struggling for control of the archipelago, perhaps inspired by the standard tactic of Japanese



The Inatomi Gunnery Manual, 'Book of Thirty-Two Positions for Steadying the Gun' (Inatomi-ryu teppō denshō). Thirty of the images show different positions for marksmen – some mounted or on a boat for hunting; others against human targets (including this one involving a prisoner with his hands tied) – together with notes on stance ('Must keep the knees apart') and advice on sighting. Only two – including the one on the left – show how to hold the weapon.

(Credit: The New York Public Library, Spencer Collection, Japanese Ms 53, a copy made in 1607. Printed with permission)



archers, who normally fired in rotation, realized that sharpshooters with gunpowder weapons drawn up in lines could maintain a constant barrage, the first ranks reloading while the others fired. In 1575, Nobunaga deployed 3,000 men to deliver sequential fire with devastating effect at the battle of Nagashino, and for the next fifty years hand-held firearms became the most important infantry weapons in Japanese armies.

'Gunnery schools' proliferated and many of their teachers produced beautifully illustrated instruction manuals – albeit mostly in manuscript because they contained *Hiden*: secret traditions to be shared only with the initiated. Firearms played a crucial role both in the reunification of the peninsula, achieved in the 1580s, and in Japan's attempt to conquer Korea in the following decade.

Despite the reduced 'windage,' Japanese marksmen evidently achieved fairly rapid rates of fire because, according to the *Zōhyō Monogatari* ('The Soldier's Tale'), a military manual composed in the later seventeenth century,

When five or six rounds have been fired there will be scorching inside the barrel and there may be difficulty with the bullets getting stuck or with loading. So make a note of the bullets' weight and keep them separate when you put them in the bullet box, and you can quickly identify the bullets made to a particular weight, which cannot be used if the barrel has become too narrow.

Otherwise, the manual warned, soldiers would have to gnaw their lead bullets down to size (as in Europe: page 190 below).³ After the 1630s, however, Japan 'gave up the gun:' the government ordered the confiscation of all firearms and sought to store them all in arsenals. The samurai sword became the standard weapon of warriors once again until the nineteenth century.

The genesis of 'the countermarch' in Europe

Could Europe have got the idea of rotating volley fire, known as 'the countermarch,' from Japan? After all, Nobunaga entertained many Western visitors; and military conversation, with Westerners among others, formed one of his principal passions. Although no known Western source mentions Japanese volley fire, this is merely absence of evidence, not evidence of absence: the discovery of just one document in (say) the Jesuit Archives in Rome, in which a European missionary described Japanese volley fire, perhaps plus evidence that the recipient mentioned it to a soldier, would transform the picture.

It would not, however, prove that *the Dutch* learned the technique from Japan because its genesis from another source is demonstrated beyond all doubt by a long letter written to Count Maurice of Nassau by his cousin and brother-in-law, Willem Lodewijk, on 8 December 1594.⁴

Like any self-respecting Renaissance man of letters, Willem Lodewijk never used just one language when he could deploy several. He began in French, discussing the use of ranks by the soldiers of Imperial Rome, as summarized in the *Tactica* attributed to the ninth-century Byzantine Emperor, Leo VI. In the two pages following he provided the German or Dutch equivalents of 34 Latin terms in a Roman military treatise of the first century, the *Tactica* of Aelian.

Next came three more pages in Dutch about Aelian's discussion of various types of 'countermarch,' in which ranks of infantry hurled spears and javelins in sequence. Then, on the last page of his letter (in Dutch, with liberal injections of French, German, Latin and Spanish), Willem Lodewijk took a crucial leap: he described how he had adapted the same technique for men carrying firearms.

Ich hebbe gevonden ex evolutionibus [namely those of Aelian] een maniere om die musquetiers ende schutten, nit alleen int schieten te oefenen maer holde daerfoer, dat man in ene schlachtordnung (te weten dat sie nit a la desbendada gaen off in hecken ende uyt andere vordel kunnen propiss gebruickt worden) seer bequaemlick, ende dat een elck seker ende bien à propos schieten conne, op dese wys aff te voeren syn...

Als naemlick dat so baldt het erste gelidit te gelyck affgeschoeten heft per evolutionem et versum te rugge trede. Het tweede voor trede, ofte stilstaende, schiete te gelyck. Daerna afftrede. Het derde ende

³ Stephen Turnbull, *The Samurai Sourcebook* (London: Cassell & Co, 1998), 182, quoting *Zōhyō Monogatari*, written some time between 1657 and 1683 perhaps by Matsu-daira Nobuoki.

⁴ Koninklijke Huisarchief, 's Gravenhage [hereafter KHA], A22-1XE-79, Willem Lodewijk of Nassau to Maurice of Nassau, Groningen, 8 Dec. 1594, draft in the hand of Everart van Reyd with a holograph correction by Willem Lodewijk. (Note that the count often used the Julian Calendar, so the 'true' date may be 8 Dec. 1594 OS or 18 Dec. 1594 NS: I have been unable to determine this from internal evidence.) G. Groen van Prinsterer, *Archives ou correspondance inédite de la maison d'Orange-Nassau*, 2e série I (Utrecht, 1857), 334-6, printed parts: L. Mulder, *Journal van Anthonis Duyck, Advokaat-Fiscaal van den Raad van State*, (3 vols., 's Gravenhage, 1862-5), 1:717-23, printed it all, followed by an 'afzonderlijke aantekening' on how to change an army on the march into battle order, Roman-style (*ibid.*, pp. 723-4.) The letter was again published twice in its entirety by Werner Hahlweg (who noted that the 'afzonderlijke aantekening' had disappeared since Mulder's day): Hahlweg, *Die Heeresreform der Oranier und die Antike. Studien zur Geschichte des Kriegswesens der Niederlande, Deutschlands, Frankreichs, Englands, Italiens, Spaniens und der Schweiz vom Jahre 1589 bis zum Dreissigjährigen Krieg* (Berlin, 1941; reprinted Osnabrück, 1987; hereafter *Antike*), 255-64; and Hahlweg, *Die Heeresreform der Oranier. Das Kriegsbuch des Grafen Johann von Nassau-Siegen* (Wiesbaden, 1973; Veröffentlichungen der historischen Kommission für Nassau, XX, hereafter *Kriegsbuch*), 606-10. I have followed the *Kriegsbuch* version, collated with the original.

'In all battles,' Lipsius declared (echoing Classical writers), 'skill and drill, rather than numbers and blind courage, normally bring victory.'⁶

The very next year, 1590, Willem Lodewijk began to implement these suggestions. According to his secretary, Everhart van Reyd,

siende dat de oude krijghs-konsten ende voordeelen van slacht ordeninghen, snellicheyt van swencken, keeren, wenden, dichten, stercken, sonder de gheleerder ende ryen te breecken, daer door de Greecken en Romeynen so heerlijcke daden hadden uytgericht t'eenemaal uytter weerelt, ende in verghetenheyt begraven waren; ende dat hy niemants onder den ouden oversten en hopluyden vant, daer van hij 't mochte leeren... heeft hy gheen tijt noch arbeyt (so dickmen met voor den vyant lagh) hem verdrieten laten, om op te soecken watter af inde oude boecken te vinden was, volghende principalijck de leeringhen van den Griecxschen Keyser Leo, en oeffende daer nae zijn Regiment ghestadelijc, makende lang-worpighe ende kleynne schare, in plaets van de groote vierkante, ende deselve africhten-de tot verscheyden manieren van keeren ende wenden.

It took a while. According to van Reyd, 'D'eerste beginselen vielen seer swaer, ende scheenen by veelen om d'onghewoonheydt wille vreemt ende lacherlijck'.⁷

The Roman style

Maurice, for his part, also began to drill some of his troops 'à l'exemple des Romains,' and when the two men and the troops they commanded joined forces at Arnhem in October 1594 Maurice staged a demonstration. Underwhelmed, Willem Lodewijk tactfully suggested that the process might be improved by using the commands and maneuvers given by Aelian, just as his own troops did.

Maurice asked his cousin to share these with him, and doing so took up most of his letter of 8 December.

Meanwhile Maurice persisted with his own Classically-inspired experiments. A young scholar from the Spanish Netherlands residing in 's Gravenhage described another demonstration in a letter to Lipsius, by then a professor at the Catholic University of Leuven. In spring 1595, the count made two groups of soldiers fight against each other 'in the Roman style:' 60 men equipped as 'pedites hastati' (probably meaning with pikes, as some thought the front rank of the legions had fought) closed with 40 bearing Roman-style shields (presumably like the *triarii*, the third rank of the legion who used their shields as a weapon).⁸

Although gratified by the interest in Roman military practice shown by his former pupil, Lipsius remained unimpressed: 'The Roman legions always defeated the Phalanxes, but they did so in formation' he chided. They did not pit warriors against each other as individuals, but in maniples.⁹

Lipsius's critique drew on his reading and research for *De Militia Romana*, a book that included a whole section on drill, with many quotes from Classical authors (including the celebrated aphorism of Josephus that the Romans' 'drills were bloodless battles, and their battles were bloody drills').

The Plantin press of Antwerp printed 1,500 copies in June 1595 and sent several of them to the North Netherlands, either as gifts or purchases. One copy was presented to Maurice of Nassau.¹⁰ A few weeks later, according to a Dutch admirer of Lipsius, Maurice's 'only pleasures' while on campaign consisted of reading *De Militia* and 'drilling his troops frequently' following its precepts.¹¹

Fortunately, we possess an eyewitness account by Antonis Duyck, an observer from the Raad van State, of

the first few drills. On 6 August 1595, as the Dutch army lay encamped in the Rhineland, Maurice brought out the 'groete schilden ofte targes' that he had commissioned 'om te sien off men daer mede een bataillon piecken soude konnen breecken, d'welc hij tot meermaelen in den Haeghe hadde doen besoucken'. Note, however, that this time 'Een bataillon' – several hundred men – took part; not just hundred as in 'den Haeghe'.

The next two days it poured with rain, but on 9 August the sun shone and Maurice, accompanied by Willem Lodewijk, ordered 'een derden deel

⁶ Lipsius, *Politicorum sive Civilis Doctrinae Libri Sex. Qui ad Principatum maxime spectant* (Leiden, 1589), V.13.

⁷ Everhart van Reyd, *Historie der Nederlantscher Oorlogen, begin ende voortganck tot den Jaere 1601* (Leeuwarden, 1650), 162a. Duyck recorded the 'waepenschouwe' and 'slachtordren' by Willem Lodewijk's troops on 15 and 18 July 1592 in considerable detail, which suggests that this was the first time he had seen it (Mulder, *Journal*, 1:104-5.) As H. L. Zwitzer has noted, Willem Lodewijk apparently played the dominant role in these Dutch military reforms: see Zwitzer, 'The Eighty Years War', in Marco van der Hoeven, ed., *The exercise of arms. Warfare in the Netherlands, 1568-1648* (Leiden: Brill, 1997), 36-9.

⁸ P. Burman, ed., *Sylloges epistolarum a viris illustribus scriptarum tomi quinque*, (2 vols., Leiden, 1727), 1:743-4, Sandelin to Lipsius, Amsterdam, 16 July 1595, soon to be republished in *Iusti Lipsi Epistolae*, vol. 8, ed. Jeanine de Landtsheer (Brussels: Koninklijke Vlaamse Academie van België voor Wetenschappen en Kunsten, forthcoming; hereafter *ILE* vol. 8.) I am most grateful to Dr de Landtsheer for sending me an advance copy of her work. Sandelin did not give a date for the drills, stating only that they took place while Maurice resided in 's Gravenhage ('dum Hagae in ocio est'). Antonis Duyck noted that the count left 's Gravenhage 'eyntelijck' on 1 July (Mulder, *Journal*, 1:601), so the exercises must have taken place before that.

⁹ Burman, *Sylloges*, 1:745, Lipsius to Sandelin, Leuven, 8 August 1595. This letter too will soon be republished in *ILE*, vol. 8.

¹⁰ Justus Lipsius, *De Militia Romana libri quinque. Commentarius ad Polybium* (Antwerp, 1595). For the discussion of drill, see *De Militia*, Book V, Dialogue xiv (Josephus quote on p. 306.)

¹¹ *ILE*, vol. 8, Raphelengius to Lipsius, 29 August 1595.

van 't volck' to leave their billets and try out 'verscheyden slachtordren.' According to Antonis Duyck, the two counts had their men 'stellen, keeren, wenden, swencken, breecken ende maecken, bijeenvougen ende separeren, om 't volck te wennen heure fylen ende gelederen te houden' – clearly a good deal more than just shield-drills.

Now one-third of the Dutch army at this point was about 2,000 men. So Maurice had prudently tried out his manoeuvres first at company strength (in 's Gravenhage); then in battalion strength (on 6 August); and finally in army corps strength (on the 9th).¹² After this, 'exerceerde men vast in 't leger alle dagen het volck', but Duyck's eyewitness reports on later drills got progressively shorter.

The length of his descriptions on 6 and 9 August is therefore eloquent: he included so much detail because it was the first time that he or anyone in Europe since the fall of Rome had seen an entire army drill. Within four years, according to another eyewitness, 'The new recruits to the army assemble two or three times a week to learn how to keep rank, change step, wheel, and march like soldiers.' Maurice himself took part, and 'hats dan der Capitein nit recht gemacht oder gewisen, so hat ihms ihr excellenz under sagt, und anderst zeigt'.¹³

The introduction of the musket

Maurice also reorganized the Dutch infantry. He reduced unit size (as Lipsius had recommended) and he employed the latest technology to enhance infantry firepower. Above all, he significantly increased the number of men armed with a musket, a smoothbore, muzzle-loading gun weighing about 7 kilos and about 1.4 meters long (and therefore needing a forked rest to steady it) that fired a 38-gram lead ball.¹⁴ According to Humfrey Barwick in 1594, who boasted

more than forty years of military service in the Dutch army and elsewhere:

The musketes are weapons of great force, and at this day... much feared: for fewe or no armours will or can defend the force thereof, being neere[at]hand, which is as well a terror to the best as to the meanest: it will kill the armed of prooffe at ten skore paces [160 meters], the common armours at twenty score, and the unarmed at thirty score.

Barwick, who in his youth had been a fine archer, also held the musketeer 'who hath his rest to stay his peece upon' to be more accurate than any bowman.¹⁵

At the time, muskets were still a relatively new invention. Spanish garrisons in North Africa had used them for skirmishing since the 1550s, but in 1567 the duke of Alba issued them for the first time to line units – 15 men in each company – when he led an army of Spaniards to suppress the Dutch Revolt. In the Netherlands, the number soon increased: a muster of the veteran Spanish regiments there in 1571 showed that the 5,900 men already included 600 musketeers (over 10 percent, supported by 1,300 men with an arquebus).

Two decades later, Martín de Eguiluz, author of a military treatise and a veteran of Alba's march, hoped that 'no other enemy nation would use it, because we fight with it at great advantage'.¹⁶ He hoped in vain. Although the Provincial Arsenal of Holland at Delft issued only 3 muskets in 1574, it issued 1,078 in 1591 and 1,929 in 1599. Some were made to a standard design because in that year, after extensive tests, Maurice and Willem Lodewijk distributed five 'model' muskets to arms producers in Holland, with orders that all future weapons produced must be of the same design and fire a bullet of standard caliber. Maurice also increased the number of musketeers in each Dutch infantry com-

pany to 30, with 44 more armed with an arquebus and only 40 bearing pikes.¹⁷

Despite massive expenditure (the province of Holland spent more on weapons in 1599 than in any other year between 1585 and 1621), it took some time to implement these changes. In 1601, a muster of Willem Lodewijk's elite Friesland regiment revealed 26 percent of the men armed with muskets and 31 percent with arquebuses, against 41 percent with pikes, while in 1604 the Zeeland regiment had 44 percent of its men armed with muskets and 2 percent with arquebuses, against 41 percent with pikes.

In 1607, however, the same Zeeland regiment had 51 percent musketeers and only 36 percent pikemen, with no arquebuses. Two years later, the

¹² Mulder, *Journal*, 1: 636. Interestingly, the troops involved were 'de Engelsen' of 'Monsieur Veer' – precisely the troops whom Willem Lodewijk had wanted to exclude eight months before! Duyck estimated the size of the army at 7,800 foot and 1,000 cavalry 'at most' on 24 July (*ibid.*, 619).

¹³ Arend van Buchell, *Diarium 1560-1599*, ed., G. Brom and L. A. van Langeraad (3 vols., Amsterdam, 1907: Werken uitgegeven door het Historisch Genootschap gevestigd te Utrecht), 3:470; Kees Zandvliet, ed., *Maurits prins van Oranje* (Zwolle: Waanders, 2000), 251, quoting Filip von Hainhoff.

¹⁴ The *Ordre op de wapeninge* issued by the States-General in 1599 specified that all muskets must have a bore of '10 bullets to the pound' and fire '12 bullets to the pound', or 38 gram balls: Michiel de Jong, 'Staet van Oorlog'. Wapenbedrijf en militaire hervormingen in de Republiek der Verenigde Nederlanden, 1585-1621' (Leiden University Ph. D. thesis, 2002), 14.

¹⁵ Humfrey Barwick, *Breefe discourse concerning the force and effect of all manuell weapons of fire* (London, 1594), fos. 10v-11.

¹⁶ Martín de Eguiluz, *Discurso y regla militar* (Madrid, 1592; but written in 1586; new edn., Madrid: Ministerio de Defensa, 2000), 115-16 (fos 62-3 in the original edition).

¹⁷ De Jong, 'Staet van Oorlog,' 14-19. The Nassau cousins also distributed five 'model' arquebuses (*roers*) at the same time with a bore of '20 bullets to the pound' to fire '24 bullets to the pound,' as specified by the 'Ordre op de Wapeninge.'

States-General decided to phase out the arquebus altogether, and in 1616 they decreed that in battle the 'Exercitie van musquetiers' should be: 'De twee voorste gelederen maeckt u gereet, legt aen, geeft vuyr (en soo vervolgens totdat alle de gelederen hebben gelost).'¹⁸ Willem Lodewijk's 'stippelckens' had turned into a production line of death.

Alternative paths

Gunpowder as a passing fad

This account of the development of infantry volley fire as an inexorable linear process is correct but misleading, because this path chosen by the House of Orange constituted only one of numerous alternatives debated by contemporaries. To begin with, some distinguished Classicists saw gunpowder weapons as just a passing fad.

For example, Francesco Patrizi's *La militia romana di Polibio, di Tito Livio, e di Dionigi Alicarnasso* (Ferrara, 1583), of which Maurice owned a copy, assured readers that the 'nuova inventione della artiglieria' made no difference; while Lipsius (who relied heavily on Patrizi) argued in *De Militia Romana* that modern commanders should stick to pikes, javelins, shields and catapults and other weapons whose enduring value had been proved by the Romans. Although Maurice rejected this advice, he continued to patronize the offensive use of shields in the 'Roman fashion', which he had first tried out in 1595; and he continued to arm his lifeguard, and those who protected his senior commanders, with great shields.¹⁹

He also created, alongside a library and map collection, a 'wapenkamer' that served as a sort of laboratory to test new weapons. Maurice filled it with prototypes and models of various weapons, with relief plans of fortresses, and with a set of lead soldiers and their accouterments that he and Willem Lodewijk used when try-

ing to solve various tactical problems.

Gunpowder weapons invalidate everything

Others, by contrast, argued that the advent of gunpowder invalidated *all* Classical precedents. Joseph Scaliger, who would eventually succeed Lipsius at Leiden, predicted in 1581 that 'Si Monsieur le prince d'Orange n'a aultres conseillers que ceux qui ne bougeront jamais de l'entour de Livius, et Spartianus, le duc de Parme lui raserait bientost la barbe'.

After 1595, Scaliger festooned his copy of *De militia romana* (a gift of the author) with cruel and dismissive marginal comments about the lack of critical rigor (for example using Vegetius to establish conditions in the days of Polybius, 500 years before) and the weak overall argument: 'Asinina omnia haec' (This is all rubbish), 'Ridicule errat' (What a stupid mistake), 'Falleris' (You're wrong!).²⁰

Scaliger had a point: the Spanish Army of Flanders continued to increase its firepower. A muster of its field forces in 1601 revealed 19 percent of the infantry armed with muskets, 23 percent with arquebuses and 50 percent with pikes – not much different from the proportions in the Friesland regiment at the same date (above.) Moreover, its Spanish units (at least) also engaged in drill. In 1588 – two years before Willem Lodewijk – the colonel of a Spanish tercio newly arrived in Flanders deployed his troops 'two or three times a week, putting them in formation and drilling them as much as I can'.²¹

The following year, again earlier than Willem Lodewijk, Don Diego de Alava y Viamont (another veteran of the Army of Flanders) argued that infantry should be 'drilled in groups;' while even earlier, in 1586, Martín de Equiluz (a Spanish veteran with 24 years' service, most of them spent fighting the Dutch) advocated forming musketeers into three files of five soldiers, each of which would main-

tain a constant fire during a skirmish. This sounds remarkably like a countermarch.²²

Gunpowder weapons cause change

Although these veterans do not seem to have scoured Classical military treatises for their precepts, many other writers in the service of Spain or its allies did (including Lipsius, who dedicated *De militia Romana* to the future Philip III.) Thus in 1583 Patrizi's *La militia romana*, dedicated to the duke of Urbino (a staunch

¹⁸ ARA, *Stadhouderlijke Secretarie* 1449, 'Orde bij sijne Excellencie, sijne gen. graeff Willem Lodewijck van Nassauw, stadhouder &c... volgens de Resolutie der Ho. Mo. Heeren Staten-Generael van den 2.e may 1616, geraempt om deser landen crichsvolck, soo te peerde als te voete tot derselver landen dienst bequamer te maecken ende te houden als 'tseve tot noch toe is geweest', 5 December 1618. (I thank Olaf van Nimwegen for this reference.)

¹⁹ This supports the view of Kees Schulten, 'Prins Maurits (1567-1625), legerhervormer en vernieuwer van de krijgskunde, of trendvolger,' *Armamentaria. Jaarboek Legermuseum* 35 (2000): 7-22. The evidence is conflicting however, for Maurice pioneered many other innovations. For example, in 1606 he introduced mounted musketeers, soon called dragoons; while in 1622 he asked the States of Holland to provide 'zo secrete mogelijk 100 vierroers', and two years later he created four companies armed with the new flintlocks (Puype, 'Hervorming en uitstraling', 57-8 and 55 respectively). Maurice also introduced innovations for the cavalry (*ibid.*, 68-71.) On balance, he seems to have been more 'hervormer en vernieuwer' than 'trendvolger'.

²⁰ Anthony Grafton, 'Rhetoric, philology and Egyptomania in the 1570s. J. J. Scaliger's invective against M. Guilandinus's Papyrus', *Journal of the Warburg and Courtauld Institutes* 42 (1979): 193-4, quotes Scaliger's letter of 1581 (about Willem of Orange and Lipsius) and the cruel marginalia in Scaliger's personal copy of *De Militia Romana*. Scaliger also assured his students that Lipsius had merely plagiarized Patrizi.

²¹ Archivio di Stato, Naples, *Carte Farnesiane* 1722/II, unfol., Don Luis de Queralt to the duke of Parma, 17 July 1588.

²² Diego de Alava y Viamont, *El perfecto capitán instruido en la disciplina militar y nueva ciencia de la artilleria* (Madrid, 1589; new edn., Madrid: Ministerio de Defensa, 1998), 128-9; Eguluz, *Discurso y regla militar*, 189-90.



The battle of Nieuwpoort, 2 July 1600: the early stages. The print shows the exchange of small arms fire in the Dunes (top center) and, in the center, the Dutch field artillery that would gun down a Spanish cavalry charge at the height of the battle

(Credit: J.J. Orlers and M. van Haesten, *Den Nassausche Lauren-crans* (Leiden, 1610), first print following fo. 156. Printed with permission from the copy in the Library of the Institute of Military History, The Hague)

ally of Spain), drew on Polybius and other Classical authors to advocate a battle order that deployed troops in a checkerboard pattern of small units. In 1594 (a year before Lipsius's more famous work) Patrizi published *De paralleli militari. Ne' quali si fa paragone delle milizie antiche in tutte le parte con le moderne*, which re-examined Roman military practice 'in the light of our firearms' and included a substantial section on the need to drill soldiers regularly, first in small groups and then in larger ones.

Classical precedents also suggested infantry volley fire to Thomas Digges, who served with the English

troops fighting alongside the Dutch. The first edition of his treatise *Stratitocos* (1579) proposed that, although untrained men should still be formed into squares, experienced musketeers should

after the old Romane manner make three or four several fronts, with convenient spaces for the first to retire and unite himselfe with the second, and both these if occasion so require, with the third. The shot having their convenient lanes continually during the fight to discharge their peces.

Digges further proposed a 'ring march', to be maintained by detach-

ments of 25 men who would fire and retire in sequence, 'so as the Head shall be sure always to have charged, before the taile have discharged; and this in a circulare martch, the skirmish all day continued'.

In the second edition of *Stratitocos* of 1590 (four years before Willem Lodewijk's 'stoppelkens') Digges suggested that experienced musketeers should deploy in ranks, with the

²³ Thomas Digges, *An arithmeticall militare treatise named Stratitocos, compendiously teaching the science of numbers... requisite for the profession of a soldiour. Together with the moderne militare discipline* (London, 1579), fos. 103-5, and second edition (1590), 122-3.

first rank firing their 'volee' while the second and other ranks reloaded and passed their recharged weapons forward.²³

Digges admitted, however, that he only described how 'I would have them trained, not how troops actually did train'. He continued sadly: 'I know this opinion of mine, being different from common custome, will be of the common multitude of such men of warre as can brooke nothing but their owne customes, not onely disliked but derided and contemned.'²⁴ By contrast Maurice and Willem Lodewijk – unlike Digges and Scaliger on their own side, and unlike Alava, Eguluz, Lipsius and Patrizi among their opponents – could put the lessons they drew from their readings, or from the readings of others, into practice. Initially it might have been 'occasie... om daervor te lachen', but in the proof of battle all the practice paid off handsomely.

At their meeting in October 1594 (page 182 above), Willem Lodewijk later recalled, 'allant ung iour à Arnheim, en coche proumine, ie contoïs à [Maurice] comme Hannibal avoit, avec quarante mille piétons, environné et defaict septante mille Romains [at the battle of Cannae] et que j'avois prins la peine de calculer combien profond par coniecture l'une et l'autre bataille avoit esté'. Maurice asked how Willem Lodewijk could be so sure, 'Ce que m'a faict cest yver passé, par loisir et quelque fois en place d'exercice [= drilling his troops], rechercher l'ordre et forme de ceste bataille de Cannes'.²⁵

He first consulted the standard Latin translation of the account in Polybius's *Roman Histories*, but found it ambiguous. He therefore commissioned a new translation of the Cannae passage, which clarified somewhat how Hannibal had fought and won. Then, 'J'ay prins la peine de tracer la forme des toutes les deux nations, par le compas, sur le petit pied donnant à chaque soldat 3 pieds en long et 7 en profondeur'.²⁵

In April 1595 the count sent Maurice a copy of the new translation, his calculations, and some sketches of the probable battle order, together with a short treatise on the subject (which naturally cast the Dutch as the victorious Carthaginians and the Spaniards as the annihilated Romans).

Theory becomes practice

Theory gave way to practice in 1600 with the Dutch invasion of Flanders. Willem Lodewijk was not present on 2 July, when Spanish troops suddenly arrived and forced Maurice (much against his will) to put all the new equipment and drills to the test on the beach near Nieuwpoort. A print engraved some time later shows ranks of Dutch and Spanish musketeers in the sand dunes exchanging fire at almost point-blank range, and the accompanying text notes that 't volck op de Duynen vast aende handt quamen ende met musketten roers heel dicht begonnen te schieten, alsoo inde Caert gehesien werdt'.

This could have been simply a protracted fire-fight, rather than the first use of the countermarch volley in Europe. Indeed according to Sir Francis Vere, commander of the vanguard, 'by the situation of the country, that skill and dexterity we presumed to excel our enemies in, which was the apt and agile motions of our battalions, was utterly taken from us'.²⁶ But Vere was severely wounded at an early stage of the two-hour battle and so could not see everything. A detailed account by Mario Stivive, fighting among the infantry that faced the Dutch, noted that Maurice had drawn up his troops:

Very well, placing in front a bloc of 4,000 musketeers, and in front of these musketeers some six pieces of artillery; and behind these musketeers two more blocs of over 1,000 pikemen, each one with 500 pikes, with the cavalry outside on the wings. All were in very good order. In addition, he placed 70 or

80 musketeers on certain sand hills to flank our troops.

Then, through 'the great smoke from the muskets' Stivive saw the Dutch field artillery catch the Spanish cavalry in the flank, 'killing 15 or 20 of our troopers with each round'. The survivors fell back, leaving the infantry (including Stivive) exposed. 'Now the Dutch cavalry, which did its duty in an excellent way, began to charge our infantry, and our pikemen came up against their musketeers.'²⁷

An account by Count Ludwig Günther of Nassau, who commanded the Dutch cavalry, now takes up the story:

Nostre infanterie... s'avanceat à l'ennemy, et la cavallerie de l'ennemy voyant approcher la nostre en si bonne ordre, pour estre bien secondés, se voulurent retirer dans leur infanterie aux dunes et se voians encor pressé de nostre cavallerie, choisirent l'entière fuite. La gresle des harquebusades commençoit à cesser, car chacun des ennemis tâchoit à se sauver.

The emphasis placed by both eye-witness accounts on the constant small-arms fire, which Ludwig Günther specifically called volleys ('harquebusades'), and Stivive's statement that Maurice placed all his muske-

²⁴ Digges, *Stratoticos* (2nd edn., London 1590), 122-4.

²⁵ Werner Hahlweg, 'Wilhelm Ludwig von Nassau und das Cannae-Problem', *Nassauische Annalen* 71 (1960): 240-1 (a transcription of Willem Lodewijk's letter to Maurice, 19 April 1595.)

²⁶ J.J. Orlers and M. van Haesten, *Den Nassausche Lauren-crans* (Leiden, 1610), fo 156 and battle plan; Francis Vere, *Commentaries* (Cambridge, 1657), 87-8.

²⁷ Archivio di Stato, Mantova, *Archivio Gonzaga* 575/30-2, 'Discorso di quello che è pasato qui in Fiandra,' sent by Mario Stivive (in the regiment of Don Alfonso d'Avalos) to the duke of Mantua, Bruges, 16 July 1600.

teers in a single bloc, strongly suggests that the Dutch infantry employed the countermarch, because that is the only way such large numbers could have maintained a steady rate of fire.²⁸

Although the Dutch eventually proved their tactical superiority at Nieuwpoort, their 1600 campaign failed. The Army of Flanders left some 4,000 dead on the field and many more (including their second-in-command) in enemy hands, but most units fell back in good order and Maurice decided to retreat. Nieuwpoort was scarcely Cannae! All this caused Willem Lodewijk to reconsider the wisdom of deliberately seeking battle. Some years later he warned Maurice:

Nous devons conduire nos affaires qu'elles ne soyent pas sujettes à l'hazard d'une bataille, veu que la perte d'icelle tire au mesme instant après soy les trophées des Provinces-Unies; et comme la conservation d'icelles dépend seulement de la direction et constance de V. Excellence, je supplie qu'elle ne se vueille tant laisser gagner par les fausses reproches des ignorans au fait de la guerre... mais que plutôt V. Excellence demeure arrêté à son propre jugement, de ne procéder à bataille, sinon par extrême nécessité.

In 1614, he again reminded Maurice, who had just entered the Rhineland with a powerful army:

d'autant que l'issue de la guerre dépend de la fortune, comme le jeu au dé, et que c'est chose qui importe tant à la conservation de cest estat, et réputation de V. Excellence, je la supplie d'y avoir esguard tel que par sa prudence elle ne sçaura que très bien juger y estre requis.²⁹

Nevertheless, despite the disappointment of Nieuwpoort, the achievement of the Dutch Military Revolution must not be underrated. The young

Republic faced the implacable hostility of the greatest empire the world had ever seen, with incomparably greater resources – including troops reputed, even by its enemies, 'the finest soldiers at this day in Christendom'.³⁰

Although parts of the provinces of Holland and Zealand had successfully defied Spain since 1572, for the first twenty years they failed to capture enemy towns or defeat enemy forces in the field. Even in the early 1590s, the Dutch army succeeded at least as much because Spain placed support for the French Catholic League above the reconquest of the Netherlands as because of its own prowess. From May 1598, however, Spain was free again to concentrate on the Low Countries (and on humbling the Republic's principal ally, England).

It is in this context that the Dutch decision to invade Flanders in 1600, founded at least in part in their confidence in 'that skill and dexterity we presumed to excel our enemies in, which was the apt and agile motions of our battalions', must be seen. They trusted that their Military Revolution would bring victory over adversaries who commanded far greater resources but fought in the traditional way. And they were not mistaken.

Diffusion

The influence of printing

Even without an unequivocal battlefield success, the new Dutch system quickly spread. Initially Willem Lodewijk may have wanted to keep the countermarch with musketeers secret, but before long the House of Orange exported its military innovations far and wide. Perhaps the most effective vehicle for diffusion was a new instructional technique devised by Willem Lodewijk's brother, Johan of Nassau.

In 1596-8, he created a series of draw-

ings that broke up the various 'drills derived from Aelian' into a series of sketches to show how the instructors of his new militia companies in Nassau-Dillingen should teach units armed with pikes, arquebuses and muskets to use weapons together.³¹ He sent his designs to Maurice, who in 1607 authorized the engraver Jacob de Gheyn to publish *Wapenhandeling van roers, musquetten ende spiessen, achtervolgende de ordre van syn excellentie Maurits Prins van Orangie*. It showed, literally step by step, how soldiers should handle each weapon in unison.

A brief introduction provided the words of command, followed by 117 striking engravings in folio format that illustrated each stage. Whereas the *Inatome* manuals of the same era (page 178 above) illustrated '32 positions' for individual marksmen, Johan of Nassau and Jacob de Gheyn showed 42 positions for firing and loading in unison. Dutch and English editions of *The exercise of arms* – the first illustrated 'how to' book ever published – came out simultaneously;

²⁸ Groen van Prinsterer, *Archives*, 2e série 2:33, Ludwig Günther of Nassau to his father Johan, 20 July 1600. In his reconstruction of the battle, Jan Piet Puype, 'Victory at Nieuwpoort, 2 July 1600,' in van der Hoeven, *The exercise of arms*, 69-112, also concludes that the Dutch infantry 'could not have done otherwise' than countermarch.

²⁹ Groen van Prinsterer, *Archives*, 2e série 2:378-9, Willem Lodewijk to Maurice, 15 February 1607; KHA A22 IX E/352, same to same, 4 August 1614.

³⁰ H. Brugmans, *Correspondentie van Robert Dudley, graaf van Leycester*, (3 vols., Utrecht, 1931), 3:284-6, Leicester to Burghley, 15 November 1587 NS.

³¹ Hahlweg, *Kriegsbuch*, 216-48, 'Ein büchlein vor krieges und Bevelches leüthe,' with 85 coloured illustrations; and *ibid.*, 256-61 (a different system, with the drill sergeant in the middle.) Count Johan claimed in 1608 that he had prepared the sketches ('abreissen') 10 or 12 years earlier (*ibid.*, 613-16.) He also mentioned a set of sketches showing cavalry manoeuvres, which de Gheyn did not publish until 1640.

translations into Danish, French and German soon appeared.³²

Other official publications followed. In 1618 Adam van Breen published the handsomely illustrated *De Nas-sausche Wapen-handelinghe van schilt, spies, rappier ende targe; beyde figuerlick afgebeelt ende gestelt na de nieu ordening des Door-luchtigen ende Hoochgeboren Vorstes Maurits van Nassau*. It paid special attention to the shieldmen of Maurice's lifeguard, armed just like Roman legionaries.

Admirers abroad also published accounts of the Dutch way of war. In 1603, book IV of *La milice françoise réduite à l'ancien ordre et discipline militaire* by Louis de Montgommery, lord of Corbouson, described 'Les evolutions et les exercices qui se font en la milice de Hollande avec les mots dont il faut user'. In 1616 John Bingham, an English soldier serving in the Dutch army, appended to his translation of *The Tactiks of Aelian* a special description of 'The exercise of the English in the service of the... United Provinces of the Low Countries'.

Plagiarism, already apparently a hallmark of military history, likewise spread the innovations. In 1609 the Frankfurt printer Wilhelm Hoffmann published *Bericht von den Soldaten in drei Theilen*, in quarto format, which contained cheap woodblock copies of de Gheyn's elegant copperplate engravings. In 1615, *Kriegskunst zu Fuss* by Johan Jakob von Wallhausen, military commandant of Danzig in Poland, provided 130 pages that described composite images of de Gheyn's exquisite illustrations.

A portrait of Maurice headed the title page. That same year, *Kurtzer Begriff und Anleitung des Kriegs Exercitij*, also based on de Gheyn, appeared at Bern, perhaps prepared by the city's military engineer Valentin Friedrich, who later declared himself to be 'Discipulos nach der Holendischen Militia, mit aller treüw Instituiert'.



In addition, the Dutch spread their innovations to their allies directly. On the one hand, the Republic's arms manufacturers accepted foreign commissions and exported vast quantities of new weapons and munitions, even 'package deals' that included everything a new regiment required, turning the Republic into 'het arsenaal van de wereld'.

On the other hand, in 1610 Brandenburg asked for and received 'zwei holländischen Drillmeistern aus dem Heere des Moritz von Oranien', and Dutch drill sergeants soon arrived to train the militias of Baden, Braunschweig, Hessen-Kassel, the Palatinate, Saxony and Württemberg. In 1616, Count Johan of Nassau opened a military academy at his capital, Siegen, to educate young gentlemen in the art of war. Training at the *Schola Militaris* took six months and students received arms, armor, relief

models and other instructional aids. They learned only the Dutch system.

Even to America

The Dutch way of war also spread to America. Archeologists at Martin's Hundred, Virginia, one of the earliest English colonies along the Chesapeake, found a silver medallion depicting Maurice of Nassau. No doubt it belonged to Sir George Yardley, one of Maurice's companions-in-arms and the first owner of the settle-

³² *Wapenhandelinghe van roers, musquetten ende spiessen, achtervolgende de ordre van syn excellentie Maurits Prins van Oranje... figuirlyck uitgebeelt door Jacob de Gheyn* ('s Gravenhage, 1607; Facsimile edn. with an introduction by J. B. Kist, Lochem: De Tijdstroom, 1971). Kist argues convincingly that de Gheyn did not execute the engravings personally (p. 14).



Jacob de Gheyn, *Wapenhandlinghe van roers, musquerren ende spiessen* ('s Gravenhage, 1607). After a short introduction, de Gheyn provided a series of 117 engravings showing each different stage required to fire and reload a musket and arquebus, and to handle the pike. Note that whereas the Inatomi manual of the same year showed 30 positions for firing and only two on how to handle the weapon, de Gheyn showed 41 positions for handling and only one for firing.

(Credit: Printed with permission from the copy in the Library of the Institute of Military History, The Hague)

ment, who served twice as Governor of Virginia. He was not alone: every governor of Virginia between 1610 and 1621 had served as an officer under Maurice.

Indeed, the Virginia Company in London actively recruited Englishmen in the Dutch army and appointed those who accepted their terms to positions of command. Many leaders of other English colonies had also served in the Dutch army, including Miles Standish, who began drilling his forces in the Dutch fashion as soon as they disembarked from the *Mayflower* at Plymouth; John Winthrop, who entrusted each of Massachusetts

Bay's four militia companies to the veterans of the Dutch army whom he had persuaded to join him; and Thomas Dudley, who organized the defenses of the 'other Puritan colony' at Providence Island in the Caribbean.

The House of Orange even shared their military innovations with non-Protestant allies. In 1649 it supplied the engraved copper plates for a Russian translation of Wallhausen's *Kriegskunst zu Fuss*, commissioned by the tsar, who presented a copy to every colonel in his army. It was only the third secular work ever published there and the first book in Russian to use copper engravings. In addition,

according to a foreign ambassador, Dutch officers in the service of the tsar drilled veteran cadres 'almost daily, because they must remain capable of training the others who are to be enlisted'.³³

Not foolproof

Naturally, the new system was not foolproof, especially when imperfect-

³³ Riksarchivet, Stockholm, *Diplomatica: Muscovitica* 39 unfol., Ambassador Karl Anders Pommerening to Queen Christina, Moscow, 7 Nov. 1649, concerning Colonel Isaac van Boekhoven's troops.

ly learned. Thus in Ireland, shortly after the outbreak of rebellion in 1641, a 'fatal conjuncture of rawe men, young officers, and the first occasion' brought disaster on some English troops because 'Upon the unseasonable word of *Countermarche* given out by the officer', the infantry stood 'in doubt which way they were to turn their faces'. This allowed their enemies to attack, causing the musketeers to 'cast away their armes' and flee.

Shortly afterwards, another detachment almost perished because the 'barrels of musket bullets being opened, few of the shot in them would fit the muskets, but were a size too large... So the soldiers were forced to gnaw off much of the lead' (just like the Japanese soldiers described in the *Zōhyō Monogatori* at the same time: page 180 above).³⁴ Over the following decade, however, the return of veterans serving in continental armies quickly increased the use of musketry salvos and other Dutch innovations.

Ancient and Modern Revolutions in Military Affairs

In the early 21st century, the enthusiasm of the House of Orange for spreading their military revolution seems surprising. Boeing does not currently sell Stealth Bombers on the open market, nor does the House of Bush send out experts to show its allies how to make and use smart bombs. Modern governments, rather like early modern Japanese gunnery schools, regard military technology as *Hiden*: secrets to be shared (if at all) only with the initiated.

Nevertheless the current climate of 'obsessive military and industrial secrecy' (in the words of Holger Herwig) is relatively new, and it stems from the present asymmetry of research, technology and resources, with only one country (the United States) able to finance the invention, development and deployment of state-of-the-art weaponry.³⁵

In the early seventeenth century, by contrast, with the same Classical texts available to all and so many armies at roughly the same stage of development, each and every successful military invention was likely to spread fast. As a Lithuanian noble who had served with Prince Maurice reminded his king in 1622: 'Antiquity has its virtues... [but] every century teaches soldiers some new trick. Every campaign has its own discoveries; each school of war seeks its own remedies.' He therefore recommended that the army of the Polish Commonwealth should increase its infantry component according to the Dutch model.³⁶

This would long remain the pattern in Europe: until relatively recently, military research and technology readily crossed frontiers. In the early twentieth century, Britain purchased Krupp patents for armour and fuses while the German Imperial Navy used British-designed Schultz-Thornycroft boilers and Parsons turbines. Similar exchanges also occurred beyond Europe. In 1900, Chinese Imperial infantry killed German colonial troops with Mauser rifles; in 1902, Venezuela met German intervention with Krupp guns; most spectacular of all, in 1905, Japan defeated Russia at the battle of Tsushima with ships and guns made in Glasgow and Newcastle.

An even more striking example of the open transfer of ideas and technology with important military applications occurred in the 1930s. Throughout the decade, defense experts as well as scientists closely followed the dramatic developments made by atomic physicists around the world. Nothing was concealed. In March 1939, just as Hitler's forces entered Prague, at a meeting in Princeton the Danish physicist Niels Bohr admonished his American colleagues trying to conceal their research to create an atomic chain reaction that 'secrecy must never be introduced into physics'.

German, Soviet and Japanese atomic scientists therefore eagerly awaited

the arrival of the *Physical Review*, bringing reports of the latest American research on the fissile properties of uranium, right down to the issue dated June 15, 1940 – the day after the German army occupied Paris.³⁷

Reasons for openness

Two reasons explain this openness. First, 'big science' is enormously costly and, at least in peacetime, no single group can raise the funds to do all of it alone. Each must therefore share its research and development specialties with others. At their Princeton meeting in March 1939, Niels Bohr assured his American colleagues that '[you will] never succeed in producing nuclear energy... unless you turn the United States into one huge factory'.

Two years later James B. Conant, President of Harvard University and the man chosen to head of the National Defense Research Council, still felt the same. 'To me,' he later wrote, 'the defense of the free world was in such a dangerous state that only efforts which were likely to yield results within a matter of months or, at most, a year or two were worthy of serious consideration.'

Fortunately, Adolf Hitler adopted a similarly short-sighted view and so invested little money in atomic research. Even more fortunately, Franklin Roosevelt decided that the

³⁴ John T. Gilbert, ed., *History of the Irish Confederation and the War in Ireland by Richard Bellings* (7 vols., Dublin, 1882-91), 1:34; Roger Boyle, earl of Orrery, *A Treatise on the Art of War* (London, 1677), 29.

³⁵ Holger H. Herwig, 'The Battlefleet Revolution, 1885-1914,' in MacGregor Knox and Williamson Murray, eds., *The Dynamics of Military Revolution, 1300-2050* (Cambridge: Cambridge University Press, 2001), 126.

³⁶ Krzysztof Radziwill quoted by Robert I. Frost, *The Northern Wars. War, State and Society in Northeastern Europe, 1558-1721* (London: Longman, 2000), 107.

³⁷ See Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon and Schuster, 1986), 294.

United States could afford both to pursue 'efforts which were likely to yield results within a matter of months' and to pour \$2 billion into the 'Manhattan Project'. When he eventually visited Los Alamos, Niels Bohr puckishly reminded one of the scientists whom he had met at Princeton in 1939: 'You see, I told you it couldn't be done without turning the whole country into a factory. You have done just that.' Without those prodigious resources, there could have been no atomic bomb.³⁸

The second reason for the 'openness' in defense research and development lay in its complexity. No single mind, no single group, could master all of it. Despite the prodigious spending, an atomic bomb could have been developed so quickly had the US government not listened to a multitude of gifted if distinctly odd scholars from around the world – British, Danish, German, Italian, Polish and, above all, Hungarian as well as American – each with their own expertise and each speaking a variety of arcane scientific languages.

The rapid success of the 'Manhattan Project' reflected the genius of Leo Szilard (the Hungarian theoretical physicist who first thought of a nuclear chain reaction), Enrico Fermi (the Italian physicist who first made it happen) and John von Neumann (the Hungarian mathematician whose calculation of 'implosion' underlay the plutonium bomb) as well as Ernest Lawrence (the American experimental physicist who invented the cyclotron) and Robert Oppenheimer (who put together a brilliant team of physicists and then headed the Los Alamos Laboratory.)

Western traditions

The complexity of 'big science' in turn reflects two distinctive, probably unique, Western traditions that connect the House of Orange directly with the House of Bush. First, research and technology have almost

always exercised a critical influence on Western warfare because the West has normally lacked a numerical edge. From the Persian Wars in the fifth century B.C. down to the Gulf War in the late twentieth and the Afghan campaign in the early twenty-first century, the enemies of the West have almost always enjoyed marked numerical superiority. This has forced the West to adopt a capital-intensive way of war, investing heavily in research and technology in order to create a succession of Military Revolutions.

The second distinctive, probably unique, Western tradition is that this research and technology, at least since the days of Maurice of Nassau, has been remarkably broad-based. It depends upon understanding, controlling and exploiting the perceived regularities and irregularities *throughout* nature in order to create a broad background knowledge that expands in a path-dependent, sequential way. This enables individuals to formulate questions, and eventually to come up with answers, in many different fields of inquiry at the same time. As Francis Bacon wrote in 1620, 'the path to science is not, like that of philosophy, such that only one man can tread it at a time'.

Six years earlier, his *New Atlantis* had suggested that experimental science should take place in research institutes. His philosophical romance described 'Solomon's House', with a staff of thirty-three (not counting research assistants) divided into observers, experimenters, compilers, interpreters and 'merchants of light' – those who traveled in order to bring back knowledge. Before long, natural philosophers had formed societies along the lines suggested by Bacon, such as the 'Invisible College' which would later become the Royal Society.

By 1646 one of its leading lights, Robert Boyle, could boast that he carried out parallel research in three distinct disciplines: 'natural philosophy,

the mechanics, and husbandry, according to the principles of our new philosophical college, that values no knowledge, but as it has a tendency to use.'³⁹

The shared background knowledge of Western science has included many components since Bacon's day – some science and, in the early days, some pseudo-science; some history and some philosophy – and these components have normally determined which discoveries were made. Moreover, the shared background knowledge among practitioners in many different fields often meant that discoveries occurred in clusters and therefore became self-reinforcing.

Sometimes the clusters occurred through competition, when several warring states all sought a technological edge; at other times practitioners in different places reached the same conclusion almost simultaneously simply because they started from similar premises. Often the advances could not be predicted, because (much to the irritation of governments through the ages) discoveries are seldom made to order; nevertheless, as Bacon predicted, the patient research and the soulless experiments that support them have steadily increased the sum of Western scientific knowledge.

Cultures that lack this broad base – for example, those endorsing 'Fundamentalist' beliefs that seek truth in revelation or instinct rather than in experiment; or those where the state micromanages all research – can still make scientific advances; but those advances will tend to be (in the phrase of Robert Merton) 'singleton techniques'.

³⁸ See Rhodes, *Making*, 294 (Bohr's prediction), 367 (Conant), and 500 (Bohr's satisfaction).

³⁹ Francis Bacon, *Novum Organum* (London, 1620), book I, aphorism CXIII; Charles Webster, 'New light on the Invisible College: the social relations of English science in the 17th century,' *Transactions of the Royal Historical Society*, 5th series 24 (1974): 19, Boyle to Isaac Marcombes, 22 October 1646.

'Singletons' are normally discovered by chance and, 'while their impact can at times be significant, further refinements and adaptations tend to be limited and soon run into diminishing returns'.⁴⁰ That partly explains why Oda Nobunaga's invention of the countermarch remained a 'singleton technique', abandoned when Japan 'gave up the gun' in the mid-seventeenth century.

'Trade-offs'

The dependence of the West's various Military Revolutions on research and technology by many practitioners nevertheless involved three important consequences (or, in current parlance, 'trade-offs.'). First, each revolution takes a long time to complete. It required six years to perfect the countermarch (from Willem Lodewijk's 'stoppelckens' in 1594 to Nieuwpoort in 1600) and eleven years to develop the atomic bomb (from July 4, 1934, when Leo Szilard patented the idea of an atomic chain reaction in London – specifying that one of its consequences would be an 'explosion' – until August 6, 1945 when 'Little Boy' exploded over Hiroshima).

Likewise, all the components of the current RMA – remote precision guidance and control; enhanced target identification and acquisition; electronic warfare – have been present for decades. Satellites were first used for reconnaissance in 1961 and for communications in 1965; the first tactical computers came into use in 1966 and tactical missiles in 1967.

The first e-mail was sent in 1972, and the same year saw the first use of 'smart' weapons against a fixed target (against moving targets from 1973). The use of each element remained limited, however, until the collapse of the Soviet Union ended the nuclear threat (at least temporarily) in 1989; only then, just in time for the Gulf War, did the military integrate them into a system, thereby creating the latest Military Revolu-

tion. It remains a work in progress.

The second 'trade-off' of the Western Way of War is that such heavy dependence on research and technology requires the extensive involvement of 'outside' expertise. First, in the words of Andrew Krepinevich, 'Technologies that underwrite a military revolution are often developed outside the military sector, and then "imported" and exploited for their military applications'.⁴¹

Moreover, some components are developed, or receive their first use, abroad: of the components of the RMA mentioned above, Egyptian forces first used both tactical missiles and smart weapons against a moving target. Finally, no single country can entirely supply the legion of components required by the various weapons systems (the United States currently depends on Germany, Japan and South Korea to provide 'spare parts' for its principal armaments). The involvement of experts from so many backgrounds and specialties naturally imperils security. Chinese Imperial infantry killing German colonial troops with Mauser rifles is one thing; distributing 'Make Your Own Smart Bomb' kits is quite another. Most militaries therefore favor the current climate of 'obsessive military and industrial secrecy'.

Furthermore, many if not most members of the United States armed forces today display a strong antipathy towards the involvement of civilians in military affairs, including politicians, doubtless rooted in the immeasurable harm done to them by Robert Strange McNamara and his 'coterie of civilian whiz kids' during the 1960s.⁴²

In this, they have achieved considerable success because the complexity of the current military 'system of systems' is extremely hard for outsiders to grasp, especially for politicians with little or no military experience.

Nevertheless, as Georges Clemenceau memorably remarked, 'War is

too important to be left to the generals', and a brilliant new book by Eliot Cohen entitled *Supreme Command* demonstrates that leaving the conduct of modern war to professional soldiers has rarely produced lasting victories. In particular, contrary to the received view, successive US administrations between 1965 and 2001 largely abandoned the conduct of war to their senior military advisers.

They failed to pick the right generals; they failed to conduct a meaningful strategic and operational dialogue with them; and they failed to set priorities and maintain proportion in what were, after all, secondary conflicts. In short, the politicians lost sight of what they needed to do to run a war – whether in Vietnam, which saw a 'deadly combination of inept strategy and excessively weak civilian control', or in the Gulf War, where the politicians disastrously accepted the military's narrow definition of 'victory' as 'success on the battlefield' rather than as 'ensuring the stability of the Persian Gulf'.⁴³

The third consequence or 'trade-off' of the West's reliance on Military Revolutions is therefore not only the full participation of civilians but also what Eliot Cohen calls an 'unequal dialogue' between the military and their civilian masters. Cohen shows that successful Western wartime leaders have listened not only to their military advisers but also to linguists; not

⁴⁰ Robert K. Merton, 'Singletons and Multiples in Scientific Discovery,' *Proceedings of the American Philosophical Society*, 105 (1961): 470-86; and Joel Mokyr, 'King Kong and Cold Fusion: Counterfactual Analysis and the History of Technology,' in Philip Tetlock, Ned Lebow and Geoffrey Parker, eds., *Unmaking the West. Exploring Alternative Histories of Counterfactual Worlds* (forthcoming.)

⁴¹ Andrew F. Krepinevich, 'Cavalry to Computer. The Pattern of Military Revolution', *The National Interest* (Fall, 1994), 39.

⁴² Eliot Cohen, *Supreme Command. Soldiers, Statesmen, and Leadership in Wartime* (New York: Simon & Schuster, 2002), 179 (quoting Charles Cooper on McNamara).

⁴³ Cohen, *Supreme Command*, 185, 198.

only to defense analysts but also to philosophers; not only to rocket scientists but also to historians.

Yes, historians: remember that the re-introduction of drill originated when Willem Lodewijk read Justus Lipsius. Remember, too, that Count Alfred von Schlieffen derived his celebrated 'double envelopment' strategy from reading Hans Delbrück's vivid account of the battle of Cannae in volume I of his *History of the Art of War*.

Finally, remember the impact of Barbara Tuchman's *Guns of August* during the Cuban Missile Crisis. On 13 October 1962, the President's special envoy Chester Bowles, asked the Russian ambassador in Washington if he had read it (and when Dobrynin said 'No', Bowles proceeded to summarize the first few chapters). Two weeks later, President Kennedy told his brother Bobby, 'I am not going to follow a course which will allow anyone to write a comparable book about this time, *The Missiles of October*'. ('If,' he added wistfully, 'anybody is around to write after this.')

Cohen also stresses that victorious Western war leaders have insisted on an 'unequal dialogue' with their military. It is 'a dialogue, in that both sides expressed their views bluntly, indeed, sometimes offensively, and not once but repeatedly – and unequal, in that the final authority of the civilian leader was unambiguous and unquestioned'.⁴⁵

A consideration of four outstandingly successful supreme commanders – Lincoln, Clemenceau, Churchill and Ben-Gurion – reveals that the 'unequal dialogue' requires not only gathering and digesting pertinent information from all available sources, including civilian experts, even those of one's allies, but also fashioning from it a stream of inquiries, probes and suggestions to the military. Although they rarely overruled their generals and admirals, each of the four leaders became a world-class nag. And each of them won their war.

Nagging questions

As the House of Bush stands poised to wage its second Gulf War, one might ask what nagging questions the famous four (if they were alive today) might address to their senior military advisers. Perhaps they would run along these lines. First, since all previous attempts to eliminate determined enemy forces by aerial bombardment alone have failed (most recently in Kosovo and Afghanistan), why do you think it will work now in Iraq?

Second, since all history books show that it is better to go to war supported by allies rather than alone, why does the United States push its technological edge so far ahead of everyone else that even its NATO allies now find it difficult to fight alongside?

Third, since Bismarck once warned 'Never create a power vacuum unless you are prepared to fill it,' how do you propose to fill the power vacuum created by the removal of Saddam Hussein? Finally, because history teaches that military expenditure in peacetime never suffices for all military goals, the famous four might ask the Pentagon why it wants to create a missile shield of vast cost but dubious efficacy against a remote possibility, rather than teaching more troops the guerrilla, linguistic and intelligence skills required to deal more effectively with the immediate high-concept/low-tech threats?

(Or, to put it another way, why does the US not spend more time learning from the experience of allies, like Spain and Great Britain, which have spent decades fighting terrorist organizations until recently supported and financed by groups living elsewhere – in France for ETA, in the United States for the IRA?)

The House of Bush has thus much to learn from the Past – above all that victory in war comes not only from superior research and technology but also from listening and learning. It is

essential for the President to consult far beyond those empowered by the current Revolution in Military Affairs and, like the 'famous four', to use the information thus gained to probe the military relentlessly on what they are doing and why. Naturally, the unequal dialogue will not endear the President to his military advisers. It did not endear the 'famous four' to theirs.

Sir Alan Brooke, chairman of the Chiefs of Staff, wrote of Churchill in his diary, two months after D-Day: 'Never have I admired and despised a man simultaneously to the same extent.' Churchill did not care, and neither should President Bush. He can take comfort in an exchange between Churchill and another senior officer who apologized after disagreeing 'very forcibly' with one of the Prime Minister's proposals. Winston just smiled and said: 'You know, in war you don't have to be nice, you only have to be right'.⁴⁶

Willem Lodewijk no doubt felt the same about those who laughed at his early drills. At the dawn of the twenty-first century, as at the end of the sixteenth, this seems a small price to pay for effective use of the latest military technology. For those who laugh at the West's military revolutions seldom laugh for long.

⁴⁴ US Department of State, *Foreign Relations of the United States, 1961-63. XI Cuban Missile Crisis* (Washington DC: US Printing Office, 1988), 26-8, 'Report of conversation with Ambassador Dobrynin on Saturday, October 13 [1962];' Robert F. Kennedy, *Thirteen Days: a Memoir of the Cuban Missile Crisis* (New York: Norton, 1969), 105. JFK also quoted the lessons he drew from Tuchman's book in a conversation with his brother on 23 October 1962 (*ibid.*, 40.)

⁴⁵ Cohen, *Supreme Command*, 209.

⁴⁶ Cohen, *Supreme Command*, 98, 128. It is gratifying to learn that in June 2002 the White House requested three copies of Cohen's book, and even more gratifying that in August President Bush said he was reading one of them: *The Times* [London], 10 October 2002, p. 12, interview with Eliot Cohen.