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BASIC HISTORICAL STUDIES
ANNEX VOLUME I

HISTORICAL TRENDS RELATED TO
WEAPON LETHALITY

15 October 1964

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HISTORICAL EVALUATION AND RESEARCH ORGANIZATION

2233 WISCONSIN AVENUE, N.W.

WASHINGTON, D. C. 20007

HISTORICAL TRENDS RELATED TO WEAPONS LETHALITY

Basic Historical Studies (Annex I)

A Report prepared for the Advanced Tactics Project of the Combat Developments Command, Headquarters US Army, under Contract No. DA 30-069-AMC-647(X), dated August 28, 1964.

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Historical Evaluation and Research Organization
2233 Wisconsin Avenue, N. W.
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15 October 1964

BASIC HISTORICAL STUDIES
(Annex I)

Table of Contents

INTRODUCTION	1
The Age of Muscle (Part A)	2
THE MACEDONIAN PHALANX	2
THE ROMAN LEGION	3
ARMORED CAVALRY	6
Lance	6
Sword	6
Bow	7
Byzantine Armored Cavalry	7
Cavalry in the West	8
THE MONGOL CAVALRY	9
RISE OF INFANTRY; THE CROSSBOW	11
THE ENGLISH LONGBOW TACTICAL SYSTEM	13
THE SWISS PHALANX	15
The Age of Gunpowder (Part B)	19
EARLY WEAPONS	19
Gunstocks and Corned Powder	20
Matchlock Arquebus	21
Matchlock Musket	22
Flintlock Musket	23
Socket-Bayonet	25
Early Rifle	26
Artillery	27
Cannon	30
Mortars	30
Howitzers	31

TACTICS IN THE 16th CENTURY	31
Early Experimentation	31
The "Spanish Square"	33
16th Century Artillery	35
THE 17th CENTURY	36
Maurice of Nassau, 1567-1625	36
Gustavus Adolphus, 1594-1632	38
17th Century Armies	41
The French System	43
18th CENTURY TACTICS	44
The Nature of the 18th Century War	44
Folard and Saxe, 1704-1750	48
Frederick the Great, 1712-1786	50
The French "Column"	53
Light Infantry	54
19th CENTURY COMBINED-ARMS DIVISIONAL SYSTEM	57
Origin of the Division and the Corps	57
Artillery	58
French Tactics (1800-1815)	59
Logistics	60
Other European Powers	60
Wellington and the English Line	60

The Age of Technological Innovation	63
(Part C)	

THE COMBINED-ARMS DIVISION AFTER NAPOLEON, 1815-1878	63
Tactics and Organization	63
Revolution in Weapons	65
The Operational Record	67
The Crimean War	67
The American Civil War, 1861-1865	67
The Austro-Prussian War, 1866	70
The Franco-Prussian War, 1870-1871	70
Standstill in Tactics and Organization	72
WEAPONS, TACTICS, ORGANIZATION, 1878-1917	72
Weapons Revolution Accelerated	72
Response of Tactics and Organization	73
World War I--Tactics and Weapons Incompatible	75
The New Logistics	76
GERMAN INNOVATION OF THE COMBAT TEAM, 1917-1918	77
GERMAN DEVELOPMENT OF THE PANZER DIVISION IN THE INTERWAR PERIOD	82

THE TANK IN WORLD WAR I	83
Armor Between the Wars--Thought and Practice	86
The German Approach	88
The Panzer Division in World War II	91
Conclusions	95
DEVELOPMENT OF COMBAT AIRCRAFT TO SUPPORT GROUND COMBAT	96
World War I	96
Between the Wars	98
Genesis of Tactical Air Forces	99
Later World War II Tactical Air Developments	100
Air Transport	101
The Impact of Jet Aircraft on Land Warfare	102
Weapons Relating to Tactical Air Support	102
THE AIR ASSAULT TEAM	104
Origins of the Airborne Concept	104
Interwar Development of Airborne Attack Forces	105
Soviet Developments	106
German Work	107
German Success	108
German Failure	108
Observations	109
THE ANGLO-US LANDING TEAM	110
The Wrong Way--Suvla Bay	111
World War II Amphibious Success	113
Developments in Doctrine	113
World War II Innovation	114
Operation Galvanic--Tarawa and Makin	116
Kwajalein	117
JOINT OPERATIONS TASK FORCE SYSTEMS	119
Development of Unified Command Doctrine	120

Basic Historical Studies*
(Annex I)

INTRODUCTION

The origin of many weapons in the arsenal of fighting men for hundreds and thousands of years is lost in the mass of unrecorded history. The first uses of metal, the invention of the sword, of the bow, and of the spear must all have had dramatic effects on the development of combat effectiveness and, ultimately, tactics but these events were not recorded. In later ages, however, major changes were made in these basic weapons and in the ways in which they were used, and new weapons were introduced, again affecting what men did in battle. Annex I discusses the significant changes in weapons that increased their respective lethalties and the resultant, or in some cases the causative, changes in organization and tactics. Part A deals with the relationship of weapons to organization, tactics, and strategy from the 4th Century B.C. to the middle of the 15th Century, when gunpowder began to dominate the battlefield. Part B deals with the Age of Gunpowder, until the Industrial Revolution started to exert its dramatic effect on the implements of war. Part C covers the relationship of weapons and tactics through the 19th and 20th Centuries.

*This Annex is a compilation and condensation, by Gay M. Hammerman and Grace P. Hayes of the HERO Permanent Staff, of papers by Marshall Andrews, Trevor N. Dupuy, Grace P. Hayes, Melvin M. Johnson, Jr., Richard M. Leighton, S. L. A. Marshall, Benjamin S. Mesick, Louis Morton, Wlodzimierz Onacewicz, Peter Paret, Theodore Ropp, Gunther E. Rothenberg, Samuel R. Shaw, Chester G. Starr, and Riley Sunderland. These papers are listed in Appendix B of the report.

The Age of Muscle
(Part A)

THE MACEDONIAN PHALANX

In the 4th Century B.C. Philip of Macedon developed from the basic stock of weapons and ideas that had been used for many centuries before him a military system which, under his son, Alexander, was to conquer the Greek city-states and push deep into Asia and Africa.

The basic weapon of the Macedonian army was the pike, as it had been to the Greeks before them and the Mesopotamians since the third millenium B.C. Philip developed the sarissa, a longer, lighter pike, about 13-14 feet long. This gave the Macedonian hoplite who carried it the advantage of being able to engage his enemy from beyond the latter's reach. This, perhaps the earliest clear example of Research and Development, is one of the few instances in antiquity of the deliberate, intentional change of weapons by a known agent to achieve an advantage in combat. After the time of Alexander the sarissa was lengthened still more, often to 20 feet, and held with both hands.

With the improved pike as its main weapon, Philip modified the traditional Greek tactical unit, the phalanx, also adopted from Mesopotamia, and developed it into a really formidable weapon. He improved his cavalry markedly, but in particular he improved his infantry not only by arming it with the longer spear, but also by intensive training and by grouping his spear-men (hoplites) in battalions (called taxeis) on a geographical basis. The hoplites composing the phalanx were drawn up in long lines, three feet between men and initially eight men deep. With five ranks of pikes pointing forward, the rest at an angle, they advanced in a solid mass, normally at a run, or, on the defensive, stood their ground. In this compact formation individual retreat was impossible.

Formidable indeed from the front, the phalanx was limited in its maneuverability and very vulnerable on the flanks and rear. Hence the wings of the army were normally composed of

highly trained cavalry, armed with a short, thrusting spear, the xyston, and an elite infantry group, probably more lightly armed than the hoplites of the phalanx.

In addition to these elements there were at various times others, armed with bow, javelin, or sling, which served as light infantry. A siege train accompanied the army, as well as supply and support forces with specialists for bridge construction and the other devices which had to be prepared in the field.

There are no meaningful figures available as to numbers involved and numbers of casualties in the battles of the Macedonians. The long series of successes won by Alexander with his army based on the phalanx with cavalry on its wings are sufficient witnesses to the effectiveness of the spear and to his tactical use of forces armed with it.

THE ROMAN LEGION

The sword, found in various forms in remains from the Bronze Age on, remained a secondary weapon, except perhaps among certain barbarian tribes, until Roman times. In the late 3rd Century B.C., the Romans changed from a cutting sword to the short sword known as the gladius, adopted according to Polybius and Livy from the people of Spain. The gladius was about two feet long, with a heavy blade about two inches wide and a sharp point, which sometimes was reinforced. The hilt was of wood, bone, ivory, or metal.

The Roman sword was much easier to handle than a spear. It could cut off the heads of the pikes of the phalanx and it furnished more ways of wounding an enemy than the pure slashing sword, in an era when inflection would make thrust wounds fatal.

In place of the circular shield carried by the Greek hoplite the Roman legionary carried a large rectangular, concave shield covering him well. Unlike a spearsman he could use only limited body armor and he had to have about six feet of space in which to operate. To inflict a wound he had to close with his enemy, so that battle was hand to hand in a very real sense. Such direct combat required unprecedented motivation. Not until the time of the Romans were political and psychological conditions ripe for a warrior using a weapon essentially by himself; the Roman of the Republic was a citizen rather than a subject.

The other significant Roman development in weapons was that of the pilum, a type of javelin, which, like the gladius, appeared in the 3rd Century B.C. Javelins had been used since Palaeolithic times, and the Greeks and Macedonians used them for auxiliary troops. The Romans used many variations of the pilum, but in the 2nd Century B.C. there seems to have been basic standardization on a light javelin, easily handled and with great potential penetration. This was half metal, half wood, a 4½-foot wood shaft into which was inlaid a 4½-foot iron rod, so that the total was about seven feet long. To prevent reuse by an enemy, Marius made one of the two pins that held it together of wood so that it would break off in the enemy's shield; Caesar and others made the iron rod of soft metal with a hard tip so that it would penetrate and then bend.

The pilum was thrown with one hand from a maximum of about 60 feet, usually much less, normally in volley in order to secure maximum psychological effect. To improve accuracy, and sometimes distance, a cord was at times wound around the shaft and jerked to give the weapon a spin. It would disable an enemy shield if well stuck in. It could penetrate a breastplate or a helmet. Held in the hand, it also served to stab the enemy.

At first secondary to the sword, the pilum, in the First Century B.C., became more prominent and virtually as important.

The Roman legion, armed primarily with the sword and the javelin, was the most successful and remarkable tactical formation evolved by any society in the ancient world. Three major variations of the legion can be distinguished. The legion's most significant period of combat effectiveness came with the introduction of the gladius and the development around 200 B.C. of the second type, the highly mobile manipular legion, replacing the early form, which had been a variation of the phalanx. With the manipular legion the Romans moved out of Italy and conquered the entire Mediterranean world in a blaze of wars in which they were very rarely defeated. The rear line was not committed tactically or psychologically to the initial combat and could maneuver or reinforce as needed.

Composed of 4,200 infantry, of whom 3,000 were heavy infantry and 300 cavalry, the manipular legion for the first time liberated the individual warrior from the mass while giving him the necessary support. The tactical formation was of units called maniples, standing apart both in frontal distance and in depth; in each unit each man had 6 feet for action.

The maniples were arranged in checkerboard fashion in three lines of ten maniples each, twenty men wide and six men deep. The manipular legion was thus composed of independent units which could take advantage of gaps in the enemy defenses. In addition, the individual legionnaire was trained to operate by himself in much the same manner. He was the first soldier in history to be placed on the battlefield in a tactical formation in which he could so operate, and he was the first to rely primarily upon the sword. His relative independence and his high degree of training reflected the rise of a more unified Roman state, with troops paid to serve throughout the year and with all property-holding men of Rome subject to the draft.

The expansion of Rome into a Mediterranean empire brought the third type of legion, the cohortal legion, from about 100 B.C. onward. It was consolidated by the general Gaius Marius in the last years of the 2nd Century to suit the needs of the Roman empire and the foreign threats to this vast region.

The cohortal legion had 6,000 infantry and no cavalry within its framework. Cavalry and light infantry were furnished by non-Roman auxiliary units. There were ten cohorts, arranged in as many lines as a commander deemed necessary; three were still common, but one or two might be used and various parts of the battle line could be arranged differently.

All soldiers carried swords and javelins, the latter having as great weight in battle as the sword. Besides the shield and helmet, they wore a leather or metal jerkin.

Militarily the cohortal legion was the most supple unit of ancient times. Julius Caesar, the legion's greatest commander, made no innovations but used it deftly; thanks in part to the reorganization of the logistical train, so that troops carried their own basic necessities, he and other Roman generals could march swiftly. Scouts and cavalry units now reconnoitered up to 20 miles ahead of the main body. Generals preferred to operate on the offensive and attack on the enemy's wings or try to reach his rear.

As in the case of the phalanx, no reliable figures exist to indicate meaningfully the effectiveness of the legion nor the lethality of its weapons. The general picture, however, is clear enough from the tremendous successes of the Roman armies organized in legions. Even when defeated, the Roman technique brought unaccustomed losses to the victor.

ARMORED CAVALRY

From the middle of the 3rd to the middle of the 5th Century A.D. the Roman legion gradually lost its importance and ceded its place to the cavalry, which finally became the supreme arm not only of the Roman army but also of those of other western countries, a position it was to hold for approximately a thousand years.

The change to cavalry necessarily involved changes in weapons, and over the thousand-year period a great variety came into use, the majority of them adaptations of weapons long known.

Lance

One of the main cavalry weapons, as it had been for centuries, was the spear or lance. By the 4th Century A.D. it was generally a stout shaft, nine to eleven feet long, of equal thickness throughout its length, with a small, usually leaf-shaped, spike at the end.

The use of the lance as a thrusting weapon was limited in the early period because of the absence of stirrups. Cavalrymen without stirrups wielded the lance with an overhead thrust. The introduction of stirrups in the Byzantine empire by the second half of the 6th Century and in the western Roman empire somewhat later brought about a major change in tactics, greatly increasing the importance of cavalry. There was developed a style of mounted shock combat with the lance at rest (couched) under the upper arm. This greatly increased the lethality of the thrust, for behind it was the weight and momentum of man and mount together.

Sword

The next most important weapon for the cavalryman was the sword. By the time of Charlemagne a greatly improved sword had been developed. With a hard blade, thanks to improvements in metallurgy, it was nearly 40 inches long, with a simple cross-guarded hilt. By the 10th Century it had assumed its final medieval form, broad near the hilt, more or less tapered to the

point, double edged, about 44 inches from pommel to point. Wielded dismounted as well as mounted, its use required skill and training and further set apart the knightly class.

Bow

In late Roman times, the bow became of increasing importance. It was usually a composite bow, less than four feet long, built up of layers of different material, with horn on the outside. Effective use of the bow required constant practice. It was therefore in ancient times the weapon of professionals, like the Assyrian archers, or the Cretan mercenary archers, highly regarded by the Macedonians and Romans, as well as of nomadic hunting people. A significant increase in the lethality of the hornbow took place when it was furnished to mounted troops, thus creating a combination of mobility and fire which sometimes and on some occasions was hard to counter. This combination was first met by the Romans in their wars against the Sassanid Persians in the First Century B.C.

Bows varied somewhat in range and penetration, but the Turkish hornbow shot well over 300 yards and had considerable penetration. Originally, its power was less than that of the fully developed longbow, for it could not penetrate mail, although later the improved Turkish bow of the 15th Century would.

Byzantine Armored Cavalry

The first great victory of heavy cavalry over the Roman infantry took place in the battle of Adrianople (378 A.D.). Three factors decided its outcome: (1) maneuver, bringing the mass of Gothic cavalry from a distance toward the Romans' flank; (2) surprise; and (3) the violence of the charge of the Gothic lancers. These elements formed the basis of European cavalry tactics during the next four centuries. Appreciating the significance of Adrianople, Emperor Theodosius began at once to enlist in his army Teutonic chiefs with their mounted troops.

By the end of the 6th Century the Byzantine cavalry system had developed into a pattern that was to remain fundamentally unchanged for the next 300 years. The basic organizational unit was the regiment, 300-400 men strong. A brigade comprised from six to eight regiments, or two to three thousand men, and a

division (or turma) consisted of three brigades, or six to eight thousand men.

The strength of the East Roman army lay in its divisions of heavy cavalry. And the principal cavalry weapon was the horn-bow, with the lance used as an important shock weapon only after the bow had done its work of disorganizing the foe. The individual Byzantine armored cavalryman, the cataphract was a formidable warrior, combining weight, skill, training, and discipline to a degree unknown in other armies of the period. Infantry was a subsidiary force, used for the siege of fortresses, holding of mountain passes, digging of defense ditches, etc. Often, however, cavalry and infantry acted together on the battlefield under skillful leadership of Byzantine generals like Belisarius and Nicephorus Phocas.

Such Byzantine armies, using surprise flank attacks and violent charge of lancers, long held back the Slavs and Saracens who increasingly threatened the borders of the empire.

Although the internal conditions and administration of the East Roman Empire had been steadily deteriorating during the 11th Century, the army showed no decline until the battle of Manzikert (1071), where a Byzantine cavalry army was annihilated by an army of Seljuk Turk horse archers. In the chaos of civil wars which followed this disaster, and because of the loss of Asiatic provinces which were the main recruiting ground for the army, especially for the cavalry, the old Byzantine army and its cavalry practically disappeared.

Cavalry in the West

After the death of Charlemagne (814), continuous wars between his successors weakened the central power in the west and led to a far-reaching decentralization of the Frankish empire. Invasions of the Vikings and the necessity for organization of local defenses (castles and fortified towns) accelerated the process of fragmentation of the power and organization of the state and resulted in the emergence of the feudal system in the 9th and 10th Centuries.

The old military organization of Rome had ceased to exist by the 8th Century, and Charlemagne's well-organized army was replaced a century later by comparatively small bands of mailed, mounted knights, a professional class of fighting men who

enrolled in the service of the king or a wealthy noble. It was this force of mailclad horsemen that finally succeeded in the 10th Century in repelling the Viking and the Magyar invasions of Western Europe. These victories assured the supremacy of the feudal cavalry in Europe for the next 400 years.

The era of the feudal cavalry was a period of complete stagnation of strategy and tactics in the west. A feudal army, when assembled, was distinguished by general lack of discipline, insubordination, and the ever-present danger of a willful act by some subordinate commander, which could precipitate a general engagement at an inopportune time, or break a formation at a critical moment. The hierarchy of command was based on social status, not on professional experience. Skill was superseded by shock tactics, by a blind attack when the enemy came into sight, without reconnaissance and without an attempt to conduct an enveloping maneuver or an attack on the enemy's flank. The violent charge of ironclad cavalry was often successful against similar cavalry, but it was bound to fail against an enemy skilled in tactics and maneuvering. Infantry, armed with missile weapons, pikes, swords, and bows, were used mainly at the outset of a battle, before the serious fighting began, and for guarding the camp.

THE MONGOL CAVALRY

A unique type of mounted force was developed in north central Asia in the late 12th and early 13th Century by Jenghiz Khan and maintained by his successors. Unfettered by preconceptions of the European military tradition, the Mongol cavalry became a system which won for its commanders control of the largest contiguous empire the world has ever known.

The primary weapon of the Mongol cavalryman was the bow, a very large one, with a pull considerably heavier than that of the English longbow, and with a range of 200 to 300 yards. He also carried a heavy, curved saber or a mace, a lasso, and sometimes a javelin or a lance with a hook at the end.

Highly trained, the Mongol had astonishing control of both horse and weapon. He carried most of his own food, and his horse could live off the land, summer or winter; go for days without food if necessary; and travel almost incredible distances over the worst terrain in a very short time.

With each man responsible for his own food and equipment and accustomed to a minimum of both, there was no need for the Mongols to have a large supply train or to maintain a base camp. Even the siege artillery which they learned to use in China was kept to a minimum that was easily transportable by yak and camel, the engineers who could construct engines on the spot accompanying the army. Thus the Mongol armies were mobile to a degree that no other major army has ever attained. And they were able to make the most of that mobility through a remarkable intelligence system and a scouting screen that ranged at times well over a hundred miles in advance of the fighting force.

It is not known how the Mongols managed the tremendously effective systems of staff, intelligence, logistics, and communications which they clearly had. With no maps they were able to travel long distances directly to their destinations and plunge immediately into battle without rest. Moreover, they were able to advance on a broad front, in widely dispersed columns, sending separate armies in separate directions many miles apart, and rejoin, apparently according to schedule, coordination being achieved by swift mounted messengers. Sabutai, for example, in 1241, sent three armies into Hungary by different routes, fighting as they went, to reunite on the Danube. En route the main army crushed Bela and 100,00 Hungarians, while the right wing overwhelmed the cavalry of Germany and Poland at Liegnitz and the left wing overran the Balkans.

It appears from the scanty records that the Mongols fought usually in five ranks. The two in front, wearing heavy armor covered with iron scales were usually lancers, though they also carried bows. The three following ranks of cavalrymen wore light, lacquered hide armor; the bow was their primary weapon. Normal procedure was for the light cavalry to advance through the ranks of the heavy in the front, pouring forth volleys of arrows, then, when the enemy was disorganized, to retreat through the heavy cavalry, which sought a quick solution by a fierce, coordinated charge.

A favorite maneuver was a double envelopment, the wings moving around the flanks and to the rear of the enemy, concealing their movements with clouds of dust or behind

hills or valleys. Then, attacking from all sides, they created confusion and chaos and were able to accomplish rout and disastrous defeat. Frequently they would send an advance guard to make contact with the enemy and then retreat, luring the other force behind it. Such a retreat might go on for days, but ultimately the enemy would find himself in a trap, surrounded and ambushed on all sides by Mongol cavalymen.

They pursued a fleeing enemy relentlessly, often for days and over long distances, until their opponents were completely destroyed as a military force. It was customary for these warriors, to whom civilization meant nothing, when they captured a town to destroy everything and everybody in it.

In 1237 the Mongols, having conquered virtually all of the land to the east, advanced into Europe, crossing the Volga. Their commander, Sabutai, had conducted a reconnaissance in force into Russia 15 years earlier, and in the meantime had collected amazingly complete intelligence of European affairs. Spreading terror before them, they rode across Russia, Poland, Silesia, Hungary, Serbia, and Bulgaria, even advancing to the Adriatic and almost to the gates of Vienna. But because of political complications at home, to the surprise of all in Europe, the Mongols disappeared into the mysterious regions whence they had come, leaving complete devastation and economic chaos behind them. Were adequate and reliable figures available they would probably indicate that the proportion of numbers killed to numbers engaged in an average battle with the Mongols was the highest in history. In addition to, and in large part because of, the tremendous degree of lethality, their campaigns had a great and lasting effect on the social and economic life of the lands which they invaded, e.g., their destruction of irrigation systems in the Middle East proved catastrophic. The armies that were unable to stand long against the Mongols in Europe in the 13th Century never learned how to cope with them. Nor did they learn much from them. On the development of military tactics and tradition in Europe the Mongols made no impression.

RISE OF INFANTRY; THE CROSSBOW

The Crusades saw the use of a new weapon, the crossbow. Crossbows had been widely used in China in about 200 B.C. and a small form, the manubalista, had been used by the Romans in the

First or 2nd Century A.D. However, the weapon then disappeared from sight; even the Byzantines, who kept many of the Roman engines, did not know it. It reappeared in western Europe early in the 11th Century. Crossbows are mentioned at Hastings but remained a novelty until the Crusades, where they were used in tactical configurations with heavy cavalry. Perfected and made more powerful, they remained in use in continental Europe into the 16th Century.

The crossbow consisted of a small, very stiff bow set crosswise at the end of a stock. The bow, originally made of pliant wood or horn, after the second third of the 15th Century was made from steel. There was a notch to hold the bowstring, usually with a trigger release. To gain elasticity some crossbows were composite bows.

The crossbow gave its missile greater initial velocity than the hornbow and thus increased range and penetration.

Arrows with short wooden shafts and leaf-shaped arrowheads were used at first; by 1100 A.D., however, quarrels, i.e., bolts with armor-piercing heads, were in common use.

Despite the slowness of loading, crossbowmen were expected to fire a great number of arrows, and as many as 500 quarrels per archer were provided for one campaign. The crossbow penetrated mail and dealt a large, disabling wound, but its effective range was only about 150 yards. Although it was a powerful weapon, crossbow ballistics were fundamentally poor because the heavy string, often weighing as much as the projectile, absorbed nearly half of the available energy.

By the Third Crusade crossbowmen were drawn up to form a screen in front of the cavalry, opening when necessary to let the mounted men charge out. The combination of foot archers (crossbowmen) and heavy cavalry was demonstrated at its best under Richard the Lionhearted at Arsuf in 1191 when 7,000 Moslems and only 700 Christians were killed.

The value of crossbowmen is attested by the fact that they were paid a third more than archers under John of England. The Magna Carta made express prohibition against the employment of foreign crossbowmen.

Despite its relatively slow rate of fire (2 shots a minute, but this could be maintained for long periods) the crossbow was widely accepted in Europe. Its small size made it most useful

to fire from behind slits in walls, it could be aimed at eye level, and unlike the longbow, needed some, but not a great deal of training. In Europe, towns adopted it as their main arm, and mercenaries from Italy, Genoa, Pisa, and others, made it their special weapon.

The experience of the Crusaders in using infantry and archers in support of mailed cavalry had little influence, however, on the tactics of cavalry in Europe. The nobility considered the crossbow a threat to their monopoly on effective fighting, and it was outlawed by the Church for use against Christians. In England, although the crossbow still predominated in the Baron's War (1264-1265), a more effective weapon, the longbow, was rapidly being perfected.

Although inferior tactically to the perfected longbow, the crossbow was a lethal and most effective weapon. In combination with mailed men-at-arms, it formed a deadly tactical combination. Crossbowmen were employed alongside the newer gunners and the older curved hornbows (composite) in the Hussite armies. They were extensively used in the fights of the Italian city-states, but in the feudal monarchies of France and Germany they played but a subordinate role. The fault was not with the weapon, but with the social and political circumstances of class pride and feudal prejudice which prevented its best utilization.

The crossbow was instrumental in initiating the decline of feudal cavalry. At Courtrai (1302), the Flemish army, armed with pikes and some crossbows, not only defended itself against charging heavy cavalry, unsupported by archers, but also counter-attacked and repelled the horsemen. The outcome of the battle shocked the whole of western Europe. Yet its lesson was not understood, and the faith on cavalry in shock tactics remained unshaken.

THE ENGLISH LONGBOW TACTICAL SYSTEM

The 13th Century saw the development in England of a new type of bow, which was to hasten the downfall of cavalry as the predominant arm. This was the longbow.

The longbow's date of origin is unknown. Traditionally, it is believed to have been adopted from the Welsh by English King Edward I. In any event, Edward and his successors, through Henry VIII, made determined efforts to encourage archery and

improve the weapon. The result was the powerful weapon of Crecy and Poitiers. At the same time, mostly in wars against the Scots, appropriate tactics were developed--a combination of dismounted men-at-arms, bowmen, and a mounted reserve.

The longbow was made of elm, later yew, six feet long, propelling a three-foot (cloth-yard) arrow. The bow shaft tapered from an inch and a half wide in the middle where the hand grasped it toward the ends, which were horn capped. Drawing and aiming a longbow required constant training. The string was drawn toward the ear, past the jawbone, and its handling required strength. The bow would shoot an arrow for only about 60 yards in a straight line; beyond that the projectile would drop. To hit at greater range, and the average was 200 yards with a maximum of 400, a long-range aiming point was chosen.

Longbows had a much higher volume of fire than crossbows; 10 to 12 arrows a minute could be shot, although this rate could be sustained only briefly. Individual projectiles had less killing power than the crossbow bolt, however, because the arrow, in contrast to the bolt, penetrated but did not smash and bring down, unless it hit a vital spot. Average velocity of the longbow arrow was 135 feet per second, but at 200 yards its striking force was only about 35 foot pounds. It penetrated mail; but it was not easy to hit vital spots of rapidly approaching armored men and archers often aimed at the more vulnerable horses. The hail of arrows had great moral effect and greatly discomfited the enemy.

The introduction of the longbow by Edward III at Crecy (1346) revealed that, in the hands of properly trained and deployed troops the longbow could stop the feudal cavalry. Figures of the forces engaged at Crecy vary widely, as reported by different authorities. It is clear, however, that the greatly outnumbered English inflicted catastrophic casualties on the French.

The terrible losses caused by the crossbow hastened the introduction of plate armor, which the longbow could not penetrate. Even so, the presence of longbow archers on the field compelled their enemies to advance on foot. Walking in plate armor for a goodly distance, the dismounted French knights arrived tired for combat, at Poitiers (1356) as well as at Agincourt (1415).

King Edward's tactics--essentially defensive, based upon a phalanx of dismounted knights supported by deadly archery fire--produced the strongest impression in Europe and provoked healthy respect for the English bowmen. But Edward's revolutionary tactics were not fully understood by his enemies.

Efforts to copy the English, by dismounting the cavalry, merely resulted in the catastrophes of Poitiers and Agincourt.

Effective as was the longbow, it dominated the battlefield for only a hundred years. Countermeasures--tactics as well as weapons--were soon devised. At Formigny (1450) the French with two fieldpieces so harrassed the English archers that they left their positions and were cut down in the open. Flodden in 1513 was the last battle won by the longbow, and even here the Scottish mistakes were as important as the power of the longbow.

The use of the longbow was limited to the English, for archers had to be trained from childhood. Its effects, while it lasted, made England a great power. It lingered on as a weapon in England, but was abolished in 1595, long after the effect of gunpowder had been felt on the battlefield.

THE SWISS PHALANX

Two technical developments hastened the decline of medieval heavy cavalry--the dilution and dwindling of the fine breeds of horses developed during the period of the Crusades by the blending of European with Arabian stock, and the shift from chain mail to plate armor. Encumbered by full plate armor and similar protection for his charger (perhaps 140 to 150 pounds in all), plus sword and shield and a larger and heavier lance, the 14th-Century man-at-arms became a kind of lumbering tank, capable only of charging straight forward without sudden stops or starts.

In the course of the 14th and 15th Centuries, apart from the disastrous encounters with the English longbow, the prestige of heavy cavalry suffered two other violent shocks, even more ominous for its future. These were the devastating failure of the German cavalry in the face of the firepower of the Hussite Wagenburgen and the repeated defeats administered to, first, Austrian, then Burgundian cavalry over a period of a century and a half by the pike phalanx of the Swiss mountaineers.

From the early part of the 14th Century, starting with their struggle for independence against the dukes of Austria, the Swiss developed the pike as a national weapon. Training of the Swiss pikeman, like that of the English bowman, began in childhood and was aimed at making him a smoothly functioning, anonymous member of the phalanx.

The Swiss pikeman was a sturdy mountaineer, a freeman who, in the earlier heyday of the Swiss phalanx, was motivated primarily by patriotic determination to defend his small country (or canton) against invasion. His pike was progressively lengthened until by the 16th Century it was as long as 20 feet. Extending back from the head three feet along the shank were two iron straps to prevent its being lopped off by sword or ax. The front of the phalanx bristled with the serried pikes of four to six ranks of men, impenetrable except to similar and longer weapons. Swiss pikemen wore very little armor other than small iron or steel helmets; those in the front ranks sometimes wore steel breastplates.

In the attack the pike was held a little above shoulder height with the point slightly lowered. This posture permitted a vigorous downward thrust; it also made it still harder for an adversary to force the point harmlessly upward. Those behind the first four or six ranks held their pikes vertically, ready to step forward into the places of the fallen.

The principal auxiliary weapon of the phalanx was the halberd, which had an older and perhaps equal claim to being the national weapon, and had dominated some of the early battles with the Austrians. This was probably the most lethal individual weapon in the whole medieval arsenal.

The halberd consisted of a pole, varied in length from 6-10 feet, with a heavy axe-head, in its developed form an opposing, sometimes curved, spike, and a spike or spearhead to the top. It was first introduced by the Swiss in the early 14th Century. It could cleave through helmet and armor, sever a sword blade, or fell a horse with a blow. It could also be used as a short pike, and finally the rearward spike could be used to drag mounted men off their horses.

The early Swiss columns used halberds predominantly. This weapon had severe limitations, however, especially against an enemy armored and in unbroken formation. After sustaining heavy losses at Sempach (1386) the Swiss combined the long pike with the halberd. The halberdiers--who advanced in the center of the column--charged in when the enemy line was shaken. Halberds remained in use until the middle of the 16th Century, when they became outmoded by the tactics of shot and pike. As late as the 1630s they were used in Indian fighting in America.

The Swiss phalanx was essentially an offensive weapon system, possessing also the defensive capabilities traditional in

pike-bearing infantry. The advancing wall of bristling pike points struck an opposing line not merely with the tremendous weight of the great disciplined mass behind it, but also with a momentum and speed which no other infantry of its day could equal. Indeed, the tough, agile, and unarmored Swiss could move in formation at a pace only slightly less than that of the overweighted mailed cavalry against which they were often pitted. Incessant drill was required to enable the close-ordered ranks to maintain their alignment in a rapid advance even over smooth terrain. The Swiss drilled, marched, and even advanced to the attack to the sound of the drum, according to some authorities marching in cadence. The phalanx could quickly change direction, flow over or around obstacles, form a virtually impregnable square (the "hedgehog") for defense, and retire in good order with its wounded. Like all massed infantry, it was limited by terrain, but less so than most; the Swiss gained the reputation of being able to surmount almost any physical obstacle, and they did not hesitate to attack across ditches, up steep hills, or against field fortifications--sometimes, to be sure, with disastrous results.

A Swiss army (as opposed to a Swiss contingent in a multinational army) normally was grouped in two or three masses, each consisting of variable numbers of "battles"--company cells; some 256 men arrayed in squares of 16 ranks and 16 files. The troops were formed out of sight of the enemy and then rolled swiftly forward, without the traditional time-consuming ritual of marshaling in line of battle on the field. In this way, the Swiss were sometimes able, as at Morat (1476) and Novara (1513), to strike the enemy before his lines were formed. The "battles" normally advanced in echelon, rather than abreast or one behind the other, and sometimes the second or third would be held back, or execute a wide turning movement, while the van battle held the enemy pinned down; sometimes the center battle would make the initial attack; sometimes the two wings would attack simultaneously.

Both in attack and in defense, the Swiss fought with a ferocity that appalled their adversaries in a ferocious age. Their established rule was that quarter should be neither asked nor given. The patriotic fervor animating the Swiss in their battles against the Austrians and to some degree against the Burgundians, became, in the later mercenary period, a professional pride in their unique prowess that provided an almost equally strong motivation. Poverty led them, from the late 15th Century on, to make soldiering for hire virtually the national occupation--a pursuit imitated, on a smaller scale, by

the Irish, Scots, and German princelings. As mercenaries, the Swiss pursued their calling with a dedication to pecuniary gain which was of a piece with their intensity and tenacity in combat.

The decline of Swiss military supremacy using these tactics began with the Italian Wars, in which they played a prominent part, mainly in the employ of France. Causes of the decline were many, but among them perhaps was the circumstance that in these wars the Swiss always fought as contingents in other armies, a role in which they seldom enjoyed numerical superiority, and where their special tactics could not always be exploited to their best advantage. In the Italian Wars also the Swiss to an increasing degree found themselves pitted against weapons and tactics that had rendered their own obsolete. It was arquebus fire, mainly from behind entrenchments--as at Cerignola (1503) and, above all, Bicocca (1522)--that really sounded the knell of the Swiss pike phalanx as a self-contained weapon system. As a weapon used in coordination with other weapons, however, the pike would continue to play an active part of European battlefields until replaced by the bayonet late in the 17th Century.

The Age of Gunpowder (Part B)

EARLY WEAPONS

With the introduction of gunpowder weapons into European warfare in the 14th Century, a new phenomenon appears in military history. The use of the explosive power of burning gases in an enclosed space, produced by igniting a mixture of potassium nitrate (saltpeter), sulphur, and wood charcoal, provided a basis for weapons and weapon systems of potentially greater lethality than any hitherto known. Since the earliest firearms were inaccurate, short of range, slow to fire, heavy, and awkward, however, it was only after a long period of development that firearms became the preeminent weapon of the battlefield.

In the long period of development of individual gunpowder weapons 11 major developments which increased lethality may be distinguished:

1. The gunstock (c. 1360-1380).
2. Corned powder (c. 1400-1425).
3. The matchlock arquebus (c. 1475).
4. The wheel-lock for cavalry (c. 1530).
5. The matchlock musket (c. 1530).
6. The flintlock musket (c. 1615-1630).
7. The socket bayonet (c. 1700).
8. The rifled musket (late 18th Century).
9. The percussion cap (c. 1816-1830).

10. The cylindro-conoidal shape rifle bullet (c. 1830-1850).

11. The breechloader (c. 1840-1870).

Guns first appeared in Europe around 1312. In the 1320s they were used in warfare, and by 1350 guns of very large caliber were common. The production and development of small handguns probably commenced at the same time as the production of larger pieces, since it was easier to forge a barrel or cast it when the measurements were small. The earliest handguns were merely short barrels, tubes of iron or brass, commonly less than ten inches long, with a caliber between 25 to 45 millimeters, held in one hand and fired with the other. The touchhole was usually on top. Such small guns were extremely difficult to control or aim, and the barrel would soon get too hot to hold. From this rudimentary barrel (hand cannon) developed the various forms of hand firearms.

Gunstocks and Corned Powder

About the middle of the 14th Century a stock or tiller had been invented to control the barrel of the handgun. At first, the barrels were clamped to simple poles, four to five feet average in length. Even with the stock, accuracy was poor. Since gunpowder was weak, an alarming quantity was used, often as much as three-quarters of the barrel would hold. This was rammed down, then a wooden plug (sabot) placed on top, followed finally by the ball, which was practically at the muzzle.

The effectiveness of the weapon was further compromised by the poor powder. During transport the heavier saltpeter went to the bottom; the lighter charcoal came to the top. Thus powder had to be mixed shortly before the engagement. In addition, the lack of sufficient airspace between the powder particles retarded the explosion. Slow and inefficient combustion forced gunners to pack in the shot with rags or clay to obtain enough shooting pressure. This problem was solved in the 15th Century with the invention of corned gunpowder. By holding the three components in steady relationship and by providing equal distribution of air space, corned powder made explosion more uniform and nearly instantaneous. The fact that loading became less elaborate raised the handgun from a psychological instrument to a lethal weapon. At the same time, the noise, smoke, and fire of the explosion retained considerable value in frightening cavalry horses.

With the new powder, the early handguns had a potential range of nearly 200 yards, although their effective range was only 50. They delivered a much heavier punch than the longbow. Thus almost from the outset the stopping power of firearms was greater, although the longbow was long superior in speed, volume of fire, accuracy, and mobility.

Although gunpowder was used by the feudal nobility, it was primarily a weapon of the towns. All previous missile weapons required intensive training over prolonged periods; the handgun, because it could not be precisely aimed, required much less training. Also, the provision of firearms, powder, and balls required industry and money, and both of these were in the hands of the townsmen and their allies, the centralizing princes.

Firearms did not overthrow the domination of heavy cavalry on the battlefield; this had already been achieved. Firearms, however, provided an excellent auxiliary weapon, slowly replacing other missile-throwing weapons.

While effective, the handguns were still immobile. They were ignited by a red hot coal or a piece of red hot iron thrust into the touchhole. Thus the gunner was forced to stay near a fire and pick up his coal or iron at the last minute.

Matchlock Arquebus

The inaccuracy of the earliest handguns was due in part to the difficulty of holding the stock. Usually it was held in the left hand, directly behind the barrel, with the butt clamped between the left arm and the body; ignition was applied with the other hand. Obviously, the gunner had to keep his eye on the touchhole so he would not miss it or burn his hand. Consequently he could not look where he was shooting. Sometimes he braced the gunstock on the ground or used a forked rest. In neither case, however, could he take aim.

In the 15th Century devices were invented to make ignition more secure and aiming more accurate, increasing the lethality of the weapon. The touchhole was moved from the top to the right side of the barrel and a little ledge or pan was added to hold priming powder to make ignition more certain. Barrels were lengthened and stocks shortened. But the most important development was the introduction of a glowing match and a device for holding it.

The earliest device was a simple pivoting serpentine to be lowered and raised by hand, but this was soon connected with a trigger, to become the matchlock. When the gunner pulled the trigger he raised the lower end of the serpentine while the upper end holding the match in its clamp was lowered into the pan. The gunner could now look where he was pointing his piece while firing.

The shortened stocks, curved to be brought up against the cheek, shoulder, or breast, also aided in taking aim. This new type of weapon is commonly called an arquebus (with variants of the name at different times and different places).

The arquebus weighed about 10 to 15 pounds and fired a ball weighing somewhat less than an ounce for a range of about 100 to 200 yards. Its firing speed was still slow; about 2 shots in 3 minutes was considered exceptionally good by the 1570s. It reached a velocity of 800 feet per second. But the arquebus was limited by its relatively low power of penetration, and, as body armor came into increasing use, there arose the need for a weapon capable of piercing plate armor and also of stopping heavy cavalry.

Matchlock Musket

The matchlock musket, a heavier weapon with improved ballistic properties, was developed by the Spaniards and first used as a defensive position weapon in the Italian Wars (c. 1530-1540). It had a longer barrel and fired a heavier ball, which could pierce armor and stop a cavalry charge. The longer barrel and improved powder gave somewhat higher velocities and further range.

In its earliest form the musket was six or seven feet long and weighed 25 pounds or more, firing bullets with a weight of 10 to 14 to the pound. Although its proponents claimed that the matchlock could kill at 600 paces if the powder was good, its effective range was well under 200 yards. Although gradually modified until it replaced the arquebus, the musket remained heavy, 14 pounds or more, and had to be fired from a forked rest.

The musket used by Gustavus Adolphus about 1620 was lighter, about 11 pounds, and did not require a rest. Its ball weighed little more than 14 to the pound and was propelled by a

heavy charge of coarse powder. This was a very powerful weapon, in fact more powerful than the 18th and 19th Century flintlock muskets.

Although the matchlock musket was a simple mechanism, actual operation was complex, and loading required some 90 different steps. Gustavus Adolphus increased the rate of fire by issuing measured paper-wrapper powder charges, with the ball attached. This made possible nearly one shot per minute and allowed him to decrease the depth of his musketeer formations from ten to six deep, and occasionally, when on the offensive, in order to gain the greatest volume of fire for a short period, to only three deep.

The increased lethality of the musket brought a further decline in the ratio of shot to pike. Fire gradually became the dominant factor in battle and the main tactical problem became how to combine fire and mobility.

Matchlocks functioned only in dry weather and consumed great quantities of match. Moreover, the need to have the match smoldering during and before action created hazards. It gave away night operations, sometimes exploded the ammunition carried by individuals, and always presented a great danger to the powder supply of the artillery. The necessity of lighting matches before action sometimes delayed troops from firing when attacked by surprise.

Flintlock Musket

In the 16th Century there appeared mechanical devices in which pyrite or flint was struck against steel, producing sparks to ignite the priming powder in the pan. One such device, the wheel-lock, had important influence on cavalry arms and tactics, but it was too expensive and delicate a device for general issue. Cavalry and special infantry units employed it, but it never supplanted the matchlock as the principal infantry weapon.

A second system utilizing flint and steel was the snaphance lock. A carefully sharpened piece of flint was held in the jaws of a cock which, when released by trigger action, was forced by a heavy v-shaped spring to strike against a hinged piece of steel called a battery or frizzen. The frizzen was arched over the priming pan and the shower of sparks discharged the weapon.

A cover protecting the pan from rain and spilling was opened mechanically before firing and closed by hand after each reloading.

From this prototype there evolved a great number of regional models and modifications. The most important was the true flintlock, which combined various systems. It featured a combined frizzen and pan cover, which uncovered automatically when the flint hit the frizzen, with a half-cock safety catch allowing the weapon to be carried loaded with reasonable safety. The early snaphance came in use about the same time as the wheel-lock; the true flintlock or fusil was invented by Marin Le Bourgeois, a French gunsmith, about 1615, and was perfected as a sporting weapon by 1630.

Its adoption as a military weapon was slow. In part this was due to the expense of conversion or new manufacture (and most European states were in poor financial shape after the Thirty Years' War); in part it was due to the conservatism of military leaders. In 1670 the first regiment entirely armed with fusils was raised in France and by 1699 the weapon had become standard. All of Europe was using it by the time of the War of the Spanish Succession.

The flintlock underwent no substantial change for well over 100 years. The US Musket, Model 1795, a copy of the French pattern of 1763, may be taken as a typical example. A .69 caliber smoothbore, with a 44-inch barrel and over-all length of 59.5 inches, weighing about ten pounds, it had a small bead front-sight but no rear sights. Weapons in other countries varied only in small detail. In Germany large calibers up to .80 were popular; the British "Brown Bess" musket had a caliber of .75. Muzzle velocities depended on the quality of the powder and ranged from 1,200 to 1,400 feet per second. A great disadvantage of all flintlocks was the slow lock time, and there was an appreciable delay between the fall of the cock and the ignition of the main charge.

The flintlock musket was quite inaccurate. Against formations it was effective up to 150 yards, and the main object was to lay down as great a volume of fire as possible in the shortest time. Massed fire at command was the practice, and well-drilled troops, equipped with iron ramrods, could load and fire up to five times a minute. When tested, the Prussian issue musket of 1782 hit a 100-foot wide and 6-foot high target about 60 times out of 100 at 100 paces, only 40 times at 200 paces, only 25 times at 300 paces, and only 20 times at 400 paces. In combat the results were poorer. Prussian infantry, using iron

ramrods and paper cartridges, could fire up to five shots a minute in exercises, although in actual battle the speed declined to about three.

A well-maintained flintlock was a fairly reliable weapon. If the soldier took care to see that his flint was sharp and his frizzen in good condition, neither worn nor greasy, and if the touchhole was open and the priming powder dry, he had few worries about misfires. Even so, the average flintlock misfired about every seventh shot.

It must be noted that in terms of ballistic performance, i.e., range, accuracy, penetration, there was little progress from the matchlock to the flintlock and none in the flintlock period (rifles excluded here). The main use of the flintlock was the controlled salvo, or volley, at short range, some 50 paces. The weight of such a volley could be decisive. Frederick's infantry opened fire at 100 yards when advancing and kept up a marching fire by platoons up to 30 yards. Thereafter the bayonet came into use. In defense, ordinarily battalion fire was employed. Usually only a few volleys were fired during a battle. At Borodino (1812) in the course of nearly nine hours of bitter fighting, the French infantry fired an average of only 10-12 rounds.

That the massed, controlled, and rapid volley with the flintlock greatly increased lethality can be seen in the increased frontage held by troops. In the mid-17th Century musketeers formed in battle groups of 100 to 300, with a depth of 6 to 10 ranks, and a front of 10 to 25 men, separated usually by three to four feet. A Swedish musketeer company could hold a front of some 36 yards. By 1750, a Prussian platoon, 70 to 80 strong, could hold a front of 20 to 24 yards. Adjusted in numbers, this means that half the number of men could hold the same frontage, roughly a double increase in lethality. And this was again increased by one-third in Wellington's Peninsular army with its two firing ranks.

Ring-Bayonet

The utility of the musket was greatly enhanced by the adoption of the ring-bayonet. For some time musketeers had commonly plugged the ends of their muskets with daggers and used

them as a sort of pike. A plug bayonet, designed for the purpose, was widely used, with the obvious disadvantage of rendering the plugged musket inoperable as a firearm.

In the 17th Century the ring-bayonet was invented, possibly by the French engineer, Vauban. It consisted of a simple metal ring to which a bayonet blade was fixed. Slipped over the muzzle, it still allowed the weapon to be fired. The socket-bayonet had an important shortcoming, however. Since barrels and sockets tended to be of different sizes, bayonets often fell off when the weapon was fired or when it was used as a thrust instrument. Therefore, bayonets usually were fixed only shortly before they were in actual use. Only when there was danger of a cavalry attack were muskets fired with fixed bayonets.

After 1742 Prussian infantry always carried fixed bayonets, and with its common use as a thrusting weapon came the end of need for the pike. In the 18th Century bayonets were either triangular or double-edged, about 14-18 inches long.

Early Rifle

The flintlock with its limitations finally gave way to a new type of gun, the rifle. Rifling of handguns is said to have been invented in Germany and Italy toward the end of the 15th Century. For many years the rifle was purely a sporting arm, until in the 17th Century some elite troops were equipped with rifled arms. In the wars in America rifle-equipped troops fought in the British, French, and American services. In Europe, sharpshooters and special units were equipped with this weapon as early as 1711. However, since rifles were expensive and slow to load, they were not generally adopted.

By the 18th Century two major types of rifle had evolved. These were the long-barrelled and relatively small-caliber (.45" to .40") American "Kentucky," and the short-barrelled, heavy and large-caliber continental European rifle. In order to facilitate loading, a greased patch was wrapped around the ball, although sometimes an oversize bullet was hammered down the barrel. Although companies of riflemen were used in the Continental Army, and although the Kentucky rifle proved effective for sniping at ranges up to 300 yards, it did not constitute a major military weapon. It was slow to load--its firing

speed was only one-third that of the musket--it required a skilled man to use it effectively, and it also lacked a bayonet.

The first major power to adopt a rifle for a large unit was England, which in 1800 adopted the Baker rifle for use in the newly formed rifle units under Sir John Moore, although there were not enough rifles to go around. The Baker flintlock rifle was 3 feet 9 1/3 inches long and weighed, without bayonet, 9.5 pounds. Its 30-inch barrel, caliber .615, had seven-grooved rifling making one-quarter of a turn in the length of the bore. This slow twist produced a flatter trajectory and made it easier for the gunner to ram the bullet down. Even so, during the Peninsular War British riflemen were supplied with balls of two sizes; the smaller could be simply dropped down the bore for faster loading. The standard 350-grain lead ball had a muzzle velocity of about 1,200 feet per second and was accurate up to 300 yards. The rifle carried a triangular bayonet, with a 17-inch blade, later replaced with a broad blade sword bayonet.

The advantages of the rifle were primarily in its greater accuracy, flatter trajectory, and greater range. Its principal drawbacks were its low rate of fire, the fatigue caused by ramming a tight-fitting ball down, especially since the bore became rapidly encrusted with fouling, and the special ammunition required.

Rifles were cumbersome and they remained expensive; therefore they were not often replaced, which in turn created ammunition problems. Rifling had to be "freshened," i.e., recut after some 100 rounds, and this made a larger bore. So riflemen commonly carried their own ammunition supply calibrated for their own individual weapons. There were subcaliber bullets in paper cartridges for rapid fire, as well as true caliber balls to be used with a patch and loaded from a pouch and powderhorn.

Artillery

It was in artillery that the introduction of gunpowder first had a significant impact, for from the start artillery weapons were easier to use and more effective than handguns. The Greeks and Romans had developed an artillery based on torsion, that is the twisting of fibers, mainly hair, as well as small tension machines. These devices were severely limited both in usability and in projectile weights. In the 11th

Century the trebuchet appeared in China and spread into Europe, replacing the older engines. Trebuchets, using counterweights, could hurl heavy loads and were still used after the introduction of gunpowder.

Whereas hand firearms were adopted only gradually on the battlefield, the impact of the new artillery weapons on siegecraft and on the defense of fortifications was shattering. Even the crude bombards, mortars, and cannon of the early 15th Century were more potent than pregunpowder siege weapons. The most solid medieval masonry crumbled before crude cannon firing stone balls.

Most important of the various types of heavy artillery pieces appearing in the 14th Century were enormous guns called bombards. They were rather short-barrelled, and since their stone shot weighed as much as 300 pounds, enormous quantities of powder, almost filling the entire barrel, had to be used. The shot often protruded from the barrel and thus could attain almost no accuracy and little velocity. To be effective, bombards had to be moved up to the walls to be battered, usually under the protection of movable shields or mantlets.

Siege artillery made great progress during the 15th Century. Initially it was still very much more a morale than a lethal instrument. Edward III used some 20 guns in the siege of Calais (1356), but even though the city was cut off from all help, it held out for over 11 months. And when the Hussites besieged Castle Karlstein in 1422 they emplaced 46 small cannon, 5 large cannon--including a medium quick firer--and 5 trebuchets. After about 11,000 cannon balls, 932 stone missiles, 13 fire barrels, and some 32 tons of rotting carcasses had been fired, the castle still held out and the Hussites lifted the siege.

During the siege of Constantinople in 1453 the Turks emplaced giant bombards, hurling 600-pound stone balls about seven times a day. The breach thus made in the massive walls of the city after a siege of nearly two months illustrated pointedly the power of the new weapons and permitted an assault which overcame the stubborn defenders.

The effectiveness of siege artillery improved greatly when barrels lengthened and the art of iron casting was improved. Around 1450, cast iron shot replaced stone. Cast iron balls had

less "windage"* and therefore greater velocity and impact energy. From 1470 on, siege artillery was able to reduce walled fortifications in short order.

The impact of the new artillery on siege warfare was immediate and pronounced precisely because its role and its potential effects were, from the beginning, hardly open to question. On the battlefield, by contrast, the role of artillery was for a long time somewhat ambiguous. Field artillery, indeed, appeared at first to have formidable possibilities. Few new weapons in history have achieved such spectacular success and devastating impact in battle as did the miscellaneous collection of primitive pieces that the embattled Hussites of Bohemia mounted in their Wagenburgen in the 1420s and 1430s. Yet the exploits of the Hussites were apparently unknown in western Europe and their tactical system disappeared with the collapse of their movement.

In western Europe the first effective use of artillery in the field was in the final stages of the Hundred Years' War. The new French artillery designed by the brothers Bureau for Charles VII was sufficiently mobile to play a leading role in several battles. At Formigny (1450) a small English force, well positioned for defense, was so plagued by French artillery that it attacked under unfavorable conditions and was annihilated. Three years later, at Castillon, the English frontally attacked the French camp, defended by emplaced guns, with similar results. In neither case was true field artillery involved. The guns were transported to the battlefield and emplaced in position; they could not be maneuvered on the field.

With the opening of the Italian Wars in 1494, elementary field artillery began to emerge. The French artillery train in the army that invaded Italy, while primarily a siege train, had many pieces permanently mounted on wheeled carriages with a trail. They moved at marching pace, could be quickly unlimbered, and could be adjusted in elevation for aimed fire.

By this time artillery weapons had begun to coalesce into three distinct types:

* Space between projectile and interior of bore.

Cannon

This was the genesis of the modern field gun, its principal characteristics being a relatively long barrel and a high muzzle velocity which, in turn, resulted in a flatter trajectory and a high order of accuracy. In order to achieve such velocities, without danger of the tube exploding and killing or injuring the gun-crew, the barrels of cannon had to be rather thick, which resulted in a heavy, relatively immobile weapon. Thus heavy-caliber cannon were used almost exclusively for siege-craft. Small cannon, however, could be moved to the battlefield on wagons, as we have seen was done both by the Hussites and French. At first they had to be placed on stands or scaffolding constructed on the spot, and could not be moved once the battle began. About 1460, however, the French introduced two-wheeled gun carriages, with trails, the genesis of the modern fieldpiece. Soon after this they introduced trunnions, allowing elevation and depression of the barrel without having to raise the whole gun.

The invention of corned powder, combined with lengthened barrels, resulted in higher velocities and improved aim. But lengthening the barrels still further increased the weight of cannon, thus precluding the use of any large pieces on the battlefield.

Mortars

Short-barrelled weapons throwing projectiles with parabolic trajectories were known from the very beginning of the gunpowder period. As fortifications changed to resist the new artillery, weapons that could lob explosive shells over walls to reach magazines, barracks, reserve formations, etc., became most useful. Mortars became a prime weapon of siege or position warfare. The principal advantage of the mortar was that its short barrel and thin tube (because of small powder charges) permitted it to be light in weight and very mobile. Its range was short, however, and it was not very accurate.

Mortars came in all sizes, some very large, some very small and designed to hurl hand grenades. The mortar usually was a wide-mouthed, short-barrelled piece fixed to a square bed, sometimes at a fixed angle of 45 degrees, sometimes adjustable. A popular small weapon of the 17th and 18th Centuries was the Coehorn, a weapon invented by Baron Boehorn in 1673. This type

threw shells weighing up to 24 pounds. There also were monstrous siege pieces, weighing several tons and hurling 10- and even 12-inch shells.

The mortar was important in siege warfare largely because of its explosive shell and parabolic trajectory.

Howitzers

This third type of artillery weapon was Dutch in origin, although it was a lineal descendant of the 15th and 16th Century pedrero, a weapon firing stone projectiles.

Howitzers combined a relatively short, large-bore barrel with the two-wheeled carriage of the field gun. The trail of the gun was rather short to permit higher elevation. The barrel was shorter and lighter than that of the cannon or gun, but longer than that of the mortar, thus permitting a flatter trajectory and greater accuracy. The importance of the howitzer lay in its combination of striking power and relatively light weight, and therefore greater mobility. Where shells could be used and obstacles had to be cleared, both mortar and howitzer had advantages over cannon because of their trajectories.

TACTICS IN THE 16TH CENTURY

Early Experimentation

In the 16th Century, when the use of firearms in battle became practical, battlefields were still dominated by the two rival shock systems--the pike phalanx and heavy, armored cavalry. It was to the defensive armament of the pike phalanx, and, independently, to the defense of entrenchments and fortifications, that firearms made their main battlefield contribution in the 16th Century.

Because of their inaccuracy, short range, slow rate of fire, weight, and unhandiness, early firearms left the soldiers using them more vulnerable than did the longbow and crossbow, even though, when used in mass at short ranges, they attained greater lethality through impact and penetrating power than the earlier missile weapons. Because of this vulnerability, troops

using firearms in massed fire in the 16th Century required the protection of pike formations or entrenchments. For harrassing fire at maximum ranges and for skirmishing preliminary to the main action, their usefulness was limited.

Unable to wield both a firearm and a weapon useful in melée fighting, the arquebusier, musketeer, and artilleryman remained auxiliaries of the dominant shock formations, separate but not independent and organized mostly in small formations attached to heavy masses of pikemen. Yet firepower, even in its still primitive state of development, was indispensable; lacking it, no 16th Century army dared engage one that possessed it. How to combine shot with pike in a single weapon system was the main unsolved tactical and technical problem of warfare at the end of the century.

The early clashes between arquebus and crossbow in the Wars in Italy left little doubt as to the superiority of the former in all the qualities that counted on the battlefield. Competition between the arquebus and the English longbow, on the other hand, was less direct, since the latter had virtually disappeared from the continent with the expulsion of the English in the middle of the preceding century. The record of performance of the two weapons, however, suggests on the whole that hand firearms before the middle of the 16th Century did not surpass the lethality of the longbow. The longbow had obvious advantages over the crude firearms of the period--in accuracy, range, rapidity of fire, handiness, lightness, simplicity of construction. Firearms had advantages in the heavier and more disabling impact (including penetrability) of a one- or two-ounce ball as contrasted with the arrow; the lack of need for long training; and the nasty tendency of gunshot wounds to cause blood poisoning. With little to choose between the weapons, it is not surprising that the longbow was slow to decline in English armament, nor that there were persistent pleas, as late as the 18th Century, for its revival.

The lethality of firearms on the battlefields of the 16th Century was limited by their subordinate and auxiliary role in the armament and tactics of the period. Throughout the century, despite the slowly growing ratio of "shot" to "pike" and the gradual improvement of firearms, most battles were decided in the clash of hand-to-hand combat. By this measure, the most lethal weapons of the age were not the new-fangled firearms but the old-fashioned pike, lance, and sword.

The Spanish, led by their great general, Gonsalvo de Cordova, were the first to appreciate the potentialities of the arquebus, which was a principal weapon in his brilliant campaigns which drove the French from southern Italy, early in the century. It was their eager adoption of the weapon which initiated a century of Spanish military supremacy in Europe, unquestioned (though not unchallenged) after Spanish arquebusiers smashed French cavalry and infantry at Pavia (1525).

It was the French who, despite their slowness in abandoning the crossbow for the arquebus, were the first to establish a tactical organization in which pikemen and arquebusiers were organically combined.* This was the legion, four of which were formed by Francis I in 1531, six years after his disastrous defeat at Pavia. Each legion consisted of six bands of 1,000 men each--600 pikemen, 300 arquebusiers, and 100 halberdiers.

The "Spanish Square"

In 1534 Charles I of Spain developed a small tactical unit, consisting of three coronelas, containing equal numbers of pikemen and arquebusiers. Each coronela had four banderas or companies of about 250 men. The entire unit was called a tercio, a term evidently suggesting a body sufficiently large to serve as one of the three main "battles" (i.e., a third) of an army. The tercio was commanded by an officer titled maestro (or maestre) de campo, with a sargento mayor as second in command. It was significant of the new trends in weaponry that an expert arquebusier might draw up to four escudos per month, whereas no pikeman drew more than three escudos.

The fame of Spanish arms in the latter half of the 16th Century is usually associated with the tercios, which came to be known as "Spanish Squares." On the battlefield, the pikes were massed in a formation somewhat less deep than broad, with

* This was really in imitation, however, of the earlier ad hoc Spanish experiments of combining pikemen, arquebusiers, and sword-and-buckler men in colunelas, or columns. (The word "colunela" was later mistakenly called coronelia; thus the origin of the spelling and pronunciation of our modern word "colonel.")

square clumps of arquebusiers at the four corners and a fringe of arquebusiers outside each face; a separate detail of arquebusiers was thrown forward to skirmish.

The increasing proportion of shot to pike reflected in the emergence of the legion and tercio in the mid-16th Century was accompanied by a tactical development of major significance, the countermarch. This was a maneuver in which successive ranks of arquebusiers or musketeers each fired a volley and then retired between the files to reload. How early this device was generally adopted is not clear, but it remained the basic means of compensating for the slow rate of fire characteristic of contemporary firearms until the appearance and perfection of the flintlock musket more than a century later. By permitting continuous, rolling fire, the countermarch multiplied many times the volume of firepower that a single line of arquebusiers and musketeers could deliver against attacking infantry or even cavalry, and thus made it both feasible and profitable to use them in larger numbers, along with pikemen, in the open field. The countermarch also tended to perpetuate the columnar tactics already characteristic of pike formations; a minimum of ten ranks was needed to maintain continuous fire.

It was the steadiness and training of the Spanish soldier, whether pikeman, arquebusier, or musketeer, that, more than any other factor, enabled Spanish infantry to dominate the battlefields of Europe in the latter part of the 16th and early 17th Centuries. For the tercio, unlike the Swiss phalanx in the century before, was a representative rather than a distinctive tactical system, even though the most efficient in its day. It embodied no novel weaponry of greater lethality than those against which it was pitted, nor any tactical innovations not used by its adversaries which markedly increased the lethality of existing weapons. The sources of its success lay, to a considerable degree--beneath the surface of technological advance or tactical forms--in the slow refinement of the routine mechanisms of individual and group action in battle and in the growth of a body of established procedure for command and administration. The Spanish army of the second half of the 16th Century was the most homogeneous and professional force in Europe, forged by years of campaigning under the same flag and in the same cause, but far from home and the domestic decay that was already sapping the foundations of Spanish power. The Spanish veterans were as tough and well drilled as the Swiss, and far more versatile. Their esprit de corps was probably as good, and their system of command and control was infinitely superior.

Widely used and highly successful as the 17th Century began, the tercio was to meet its match when confronted with new tactical concepts and improved weapons.

16th Century Artillery

The potency of artillery in siegecraft continued into this century, forcing a revolution in the science of fortification, characterized by low-lying, thick earthen ramparts, sharply angled bastions and outworks, and above all, heavy dependence on defensive firepower. In the ensuing interaction of challenge and response, the answer to firepower, for besieger and defender alike, would be found primarily in counterfire rather than barriers to fire.

By the latter part of the century, because of the new fortifications, sieges had again become the slow, elaborate undertakings they had been two centuries earlier. Yet the methodology had been refined and systematized, on both sides, to an unprecedented degree, and the new firepower left the balance of advantage, on the whole, with the offense. A besieger who brought to the task an ample artillery train, expert engineers, and endless patience could, by systematically advancing his guns in zigzag approaches behind protecting earthworks, eventually overwhelm the defending fire and force an entrance.

The battlefield role of artillery in the 16th Century was, however, on the whole, ambiguous and occasional. Not only did it serve in a purely supporting function, but it was an arm which (unlike pikemen and heavy cavalry) no commander of the time regarded as absolutely indispensable. We have little idea of how many casualties artillery could inflict, even under favorable conditions. In the great majority of 16th Century battles, artillery had little or no observable effect on the outcome; except in the Italian Wars, indeed, it was little used. In its existing state of technical development, field artillery was useful mainly, and almost solely, in lengthening the range of defensive firepower in entrenched positions. Its inaccuracy, relatively short range, lack of maneuverability, and slow rate of fire made it highly vulnerable in the open field to attacking cavalry or even swiftly moving infantry like the Swiss. Not until the tactical and technical reforms of Gustavus Adolphus in the next century was artillery used consistently and effectively in coordination with infantry and cavalry.

THE 17TH CENTURY

Maurice of Nassau, 1567-1625

With the Spanish square, a way had been found to make the handgun an effective infantry weapon. The inevitable next step was to seek a tactical system that was more flexible and less costly in manpower. The proper line of development was suggested by a soldier who consciously sought his model in the organization of the Roman legion.

Maurice of Nassau, Prince of Orange, moved on to the stage of European affairs in 1589. With a background of the study of the military classics and experience in the field gained from active campaigning, Maurice and his cousins initiated a series of reforms after 1590 that may be said to have inaugurated a revolution in military organization and tactics in the 17th Century.

The contributions of Maurice to the art of warfare lay in the tactical employment of manpower and in siegecraft. With the Roman model in mind he sought to reduce the depth of the formation, make it more flexible and more effective through discipline and drill. The number of ranks of pikemen in tercio formation was reduced first from 40 to 10 and then to 5--the number who could effectively employ their arms at one time. Five deep, with a front of about 50 men at intervals of about three feet, the deep column of the tercio became in Maurice's hands an elongated oblong. The musketeers were placed on the flanks, in platoons of 40 men facing the enemy in four columns ten deep, to permit the Spanish countermarch. Musketeers and pikemen were still linked in a single unit, but they were no longer mixed in such a way as to make a large portion ineffective. The length of the front was increased and its depth diminished without visibly weakening its impact. This was a move to return to a linear formation.

Maurice reduced the size of units by cutting the company from 150 to 80 men, equally divided between pike and musket. The regiment, or battalion as it was then called, numbered about 550 men--about the size of the Roman cohort. With a maximum depth of ten men and a front of about 750 feet, with pikemen in the center and muskets on the flanks, the formation avoided the waste of manpower inherent in the tercio and gained in

elasticity. Brigaded in groups of six, the battalions were arranged in three distinct lines of battle in checkerboard fashion as the Romans had done.

In frontal engagements against infantry this arrangement worked well, with pikemen effectively engaged and musketeers firing steadily. But against a frontal charge of cavalry, the musketeers had to take shelter under the pikes, a difficult and confusing maneuver. In the case of a flank attack, the battalion had to form front to flank--another difficult feat.

Maurice made a real and perhaps more lasting contribution to siege warfare. He standardized the caliber of the artillery, using 40-, 24-, 16-, and 8-pounders. He adopted the practice of concentrating massive barrages against small sections of the walls, following this up by creating practicable breaches in the fortification. He used long trenches of approach and protected his guns effectively when they were brought up to do their work. He also used mines when he could, although the wet soil of Holland made it difficult. Thus he shortened the duration of the siege.

Maurice encouraged the development of new weapons of an unusual character (gas, shells, steel saws, etc.), patronized military map-makers, used field glasses for observation, and laid down liberal terms to besieged towns--all of which set him apart from his contemporaries. His discipline paid off by reducing plunder and rapine, thus encouraging the citizens of the places he besieged to lay down their arms. He employed field fortifications widely.

The success of Maurice's system rested on discipline achieved through training and intensive drill and on morale. Under Maurice, the men were drilled constantly, to the limit of their endurance, so that they could form quickly and change formation over all kinds of terrain. The system of drill and training was one of Maurice's most lasting contributions. Not only did it alter the duties of the officer corps and make possible the proper handling of the unit, but it gave the military a task in peacetime and between campaigning seasons. Certain practices, such as marching in step, also date from this period.

With all its advantages, Maurice's new linear formation tended toward rigidity. Although the basic infantry unit had become more flexible by a reduction in size, the battalion proved to be too small. Moreover, it proved to be no less

defensive than the system it replaced. The pike retained the same role it had had earlier, and the musketeer was still tied to the pike formation.

Most of Maurice's reforms were completed by 1609. They represent a transition between the earliest forms of warfare in the gunpowder era (the 15th and 16th Centuries), and the 17th Century, which saw the establishment of a system by Gustavus Adolphus that was to last, with modifications, down to the wars of the French Revolution.

Gustavus Adolphus, 1594-1632

At the time Gustavus Adolphus assumed the Swedish crown in 1611, the Swedish army was in deplorable condition; poorly organized, understrength, short on pikes, outfitted with obsolete weapons (arquebus), and badly led. Administration was virtually nonexistent, recruitment at a low ebb, morale low, and war with Denmark threatened. It was Sweden's great fortune at this juncture to come under a ruler of extraordinary capacity, not only as a tactician, but as an administrator and leader of men.

There is little doubt about Gustavus's mastery of the techniques of warfare. Like Maurice he read the classic military works, and he was aware of Maurice's reforms. By the time he fought in Germany he was an accomplished tactician, not only in the use of his infantry units, but in all aspects of warfare --gunnery, horsemanship, fortifications, drilling, and logistics. He had an eye for terrain, and great natural talent for command.

Gustavus's first task when he inherited the throne was to rebuild his army. The reorganization was based in part on the conscription system, recruiting areas being responsible for raising new units. He made the basic tactical unit the squadron, consisting of 408 men--216 pikemen and the remainder musketeers. The pikes were formed in a central block, six deep, and the musketeers in two wings of 96 men, also six deep, on each side of the pikemen. Attached to each squadron was an additional element of 96 musketeers. The squadron, which Gustavus retained throughout his reign, was too small to accomplish all its tasks, but it could be brigaded, three or four squadrons forming a brigade. Since the attached musketeers were employed most frequently for outpost, reconnaissance, etc., they were often not available to the squadron.

The squadron clearly resembled Maurice's battalion but was smaller in size. It was basically defensive in its tactics, as was the battalion, but was capable of offensive action, if properly employed and with the cooperation of cavalry and artillery.

The artillery, which had not been organized into permanent units before Gustavus's time, was placed on a more substantial basis. In 1623 he formed an artillery company, and in 1629 an artillery regiment of six companies, led by 27-year-old Lennart Torstensson, the best artilleryman of his time. Of the six companies of the regiment, four consisted of gunners, one of sappers, and one of men with special exploding devices. Thus, the artillery was organized as a distinct and regular branch of the army, manned almost entirely by Swedish troops (unusual in an era of mercenaries).

In addition to organizational reforms, Gustavus made important changes in weapons and equipment. He had his pikemen wear armor, which was on the way out in other countries. He shortened the pike from 16 to 11 feet and sheathed its foremost part with iron so that it could not be severed by the sword. He replaced the arquebus with the matchlock musket, which he made lighter in weight; and he finally eliminated the fork rest. He standardized the caliber and the powder charge and introduced (though he did not invent) the paper cartridge. The net effect of all these changes was to increase the firepower of the Swedish forces.

It was in artillery weapons that Gustavus made the most important changes. His objective was to increase the effectiveness of his artillery in combination with infantry and cavalry. This meant not so much increasing the rate of fire as having the guns in the right place at the right time. This need for mobility meant decreasing the weight of the gun. To achieve this, he reduced the calibers in his army to three--the 24-pounder, the 12-, and the 3-. By improving the quality of the powder he was able to reduce the thickness of the barrel. Then he shortened the barrel and made wider use of copper in construction, a metal of which Sweden had an ample supply. After some experimentation he adopted the "regimental gun," a sturdy 3-pounder. This piece revolutionized the role of artillery; every regiment in Gustavus's army had one (later two) and thus had an enormous advantage in battle, since it was at first the only army with such a weapon.

The new organization and improved weapons would be of little value without training and discipline. In this respect,

Gustavus was fully the equal of Maurice. He provided for continuous training from the moment of entry into the army. Maneuvers were held on both the small and large unit level. Discipline was strict and every regimental commander read the Articles of War to his troops once a month. Punishment for infraction of these articles was heavy, and Gustavus's soldiers had a reputation for good behavior unusual for troops of that day.

The effect of all these reforms was to fashion an instrument that would win consistently on the battlefield. Gustavus's reforms were designed to improve the cavalry, gain greater firepower, and make use of combined arms. He knew as well as any that firepower alone could not win; he needed shock power, close-in fighting. This was a job for the cavalry, and Gustavus worked hard to get the most out of the small Swedish horse. He got rid of the caracole* and deep formations. First he lined the horse in six ranks, then later in three. The pistol was a gesture; the real effect came from the saber charge. The first rank fired when it was close to the enemy, the other two held fire, retaining the pistol for emergency use. Detached musketeers stationed between cavalry squadrons provided the firepower that shook the enemy line. While the cavalry charged, the musketeers would reload, to be ready to fire another volley for a second charge or to cover a retreat. To this at Lutzen was added the fire from the regimental guns.

There was an obvious disadvantage to this system; by tying the cavalry to the infantry and artillery, Gustavus sacrificed the speed and momentum of the horse except for the final distance of the charge. But it was better than anything yet devised, and it was successful. As a result, it was imitated widely.

In combining firepower with the pike, and missile with shock, Gustavus retained the linear formation and reduced the number of infantry ranks to six. He combined the use of the two weapons and added firepower, having two ranks of musketeers fire

* A system of cavalry pistol fire, similar to the infantry musketeers "countermarch," performed at the trot. Introduced by German heavy cavalry in the 15th Century, it was never very effective, but, since it seemed to be the only way to combine gunpowder weapons with horsemen, it persisted for about a century.

before countermarching. Further, the countermarch was so executed that the formation moved forward, so that the fire was, in effect, a small-arms rolling barrage. During this movement, the musketeers were protected by the pikes while they reloaded. Later, Gustavus introduced the salvo, or salvo, to increase further the firepower of his line. In the salvo, three ranks fired simultaneously.

Since salvo rendered the musketeers impotent while they reloaded, the role of the pike was enhanced in the Gustavian system. But the pike had a broader mission than merely to protect the musketeer. It was to deliver the decisive blow; the salvo itself was but the prelude to the assault by the pike, as it was for the cavalry charge. And the best protection for the musket was the offensive action by the pike. Thus, the pike became in Gustavus's hands an offensive weapon, combined with missile power; this at a time when it was rapidly becoming obsolete.

It is easy and tempting to exaggerate the achievements of Gustavus Adolphus. Most of his innovations were adopted from others, and he was not the only one who improved the military system of the time. But no one else so surely bridged the gap between conception and achievement; none fitted their innovations into a completely integrated system with its own set of unifying principles. His accomplishments were many: he gave to infantry and cavalry the capacity for the offense; he increased firepower and made it the preliminary for shock; he made artillery mobile; he made linear formations more flexible and responsive to the commander's will; he solved the problem of combined arms; and he made the small unit commander the key to action. In him, the military revolution that began in the middle of the 16th Century was most completely realized, although it did not find fullest expression until the time of Louis XIV. Not all his reforms stood the test of time, but his influence on European warfare was profound.

17th Century Armies

The century following the death of Gustavus saw the continued development of his system under the leadership of a number of military men in different countries. Weapons development, especially the introduction of the bayonet, continued to influence tactics and organization. During this period also there were a number of important changes in the size and composition

of the armies of Europe that reflected, and, in turn, affected political, social, and economic developments of the 17th Century.

This was the age of absolute monarchs (except in England), and a military system based on strict discipline, drilling, centralized administration, and long-term, highly trained troops was particularly congenial to such a form of government. The monarch was identified with the military commander, and most rulers of the time placed great stress on their military role, affecting as their normal dress a military uniform. The increasing cost of war demanded centralization of the civilian economy and the establishment of military-type administration for civilians. Moreover, it was war that created the crown's need for money and led to higher taxes and the growth of the power of the monarch.

The effect of military developments on society was equally profound. War ceased to be the concern only of the upper classes, and the steady procession of wars throughout a century which saw few years of peace created its own demands for manpower. The cavalry, once the exclusive domain of the nobility, was opened to all who could ride a horse. Mercenary regiments, including those of Scotland and Ireland, drew heavily on the lower classes. The decline of armor, the appearance of the uniform, the regular pay, all operated to bring into the service many who would formerly not have considered the military life. Also, the emphasis on flexibility and smaller units opened up the ranks of junior officers to commoners--though only of the gentry. The artillery, which became increasingly important, was more open than any other arm, and drew into the service of the military those who had some technical or scientific training. More and more, science and technology were being put to the service of war. Maurice and Gustavus used portable telescopes; cartography was developed for military purposes; submarines, gas shells, armored fighting vehicles, torpedoes, multiple-barrelled guns, and hand-grenades were invented, or conceived, though most of these conceptions were far too advanced for the technology of the day.

Because war was becoming more technical, instruction became more important. The first military academy of modern times was established in 1617 by John of Nassau. The nobility, now content to serve in an army raised by the crown, was forced to learn also, if it was to master the trade of war. Thus there grew up a military class drawn from the nobility and gentry. Military rank was regularized and a professional officer corps, more European than national, was born.

The 17th Century saw a marked increase in the size of armies and the scope of warfare, both made possible by the changes wrought by Maurice, Gustavus, and their followers as well as by political and economic developments. Before the time of Louis XIV, armies rarely numbered more than 50,000 men.

Gustavus had about 30,000 men in 1631; his opponents had more in their pay but rarely employed them in battle. But Louis XIV is said to have maintained a military establishment of 400,000, with field armies sometimes approaching 100,000 men. In the 17th Century, it was estimated that a country could support an army of about one per cent of its population, which was approximately the ratio in France. This trend toward larger armies levelled off in the 18th Century; then, during the wars of the French Revolution, there was another surge forward.

With the increase in size went changes in organization, the scope of war, and the relationship of armies to the state. Men and money were necessary now for war, and in the mercantilist view a large population was as essential as natural resources for war. In the Thirty Years' War most of the armies were mercenary; by the end of the century, they were largely standing armies. The reason can be found partly in financial and political conditions, and partly in military factors. Drill and training was a year-round activity in peace and war, and it was necessary to retain troops on a permanent basis to be sure of an effective force.

The French System

Under Richelieu and Louis XIV, the French army underwent considerable reform. It adopted from the Swedes the basic infantry formation--a battalion (or regiment) of 600-800 men. This unit was usually organized in one line, six deep, with the pikes in the center and the muskets on the flank, and occupied a front of about 100 yards. It was divided in turn into companies, on the model of Gustavus. In battle, several lines were formed, with the battalions in checkerboard fashion. Two-thirds of the men were musketeers, and from this group a detachment supported the cavalry. When a battalion consisted of more than 300 men, the front was maintained but the depth increased. The interval between battalions was supposed to be equal to their front, so that the second line, usually 300 to 400 paces behind, could pass through. The reserve was kept twice that distance behind the second line.

On his accession, Louis XIV possessed an army of 139 regiments, 20 of which were foreign; about 30 were cavalry. But : they were far from disciplined, and administration was poor. The task of reorganizing and training the army was the work of the Minister of War, Louvois. Administrative reforms included control of the purchase system* and frequent reviews and inspections.

Louvois hampered field commanders with his deadening restrictions, but his talents paid off in other ways; in his reorganization of the army and in the fortifications he built. A chain of fortresses, fully equipped and stored with all the supplies needed by an army, was constructed. An army on the march could base at any one of these posts, certain of finding there everything it needed, including heavy artillery. At the same time, an enemy army would find the task of breaching these forts, one after the other, an overwhelming job. Construction of these forts was largely the work of Vauban, the famed engineer. Altogether, Vauban built 33 new fortresses and remodeled 3,000 others.

Louis' cavalry consisted of the gendarmerie (heavy cavalry) carabineers, light cavalry, and dragoons. The carabineers, numbering at the turn of the century about 3,000 men, were armed with rifled carbines and swords; the dragoons used the musket with the newly developed bayonet and carried an entrenching tool in their saddles. They combined the advantages of infantry and cavalry, and, being very mobile, proved very useful. From one regiment in 1650 the number of dragoons increased until, by 1690, there were 43 such regiments in the French army.

18TH CENTURY TACTICS

The Nature of the 18th Century War

The 18th Century saw completion of developments begun in the 16th and 17th Centuries. Armies continued to increase in size but at a slow rate. The centralization of administration, the growth of a higher organization and complex staff systems

* The practice whereby an officer had to purchase his commission from the government.

necessary to maintain the larger armies, the increased complexity and high cost of war, the increased trend toward precise and mathematical maneuvers for military formations--all these and other developments noted in the earlier period reached their fullest development by the middle of the century.

Weapons and tactics also underwent change. The flintlock replaced the matchlock, the pike disappeared, and the bayonet took its place. Linear tactics were perfected and firepower became the key to combat. The science of fortifications, which reached its highest stage with Vauban, was studied closely and applied to all forms of warfare. Fortified lines were used by all armies, and every nation had its system of defenses. Armies became, if anything, less maneuverable than before and more difficult to handle, with the result that war became more deliberate and even pedantic.

Warfare in the 18th Century was a formal affair, conducted under well-defined and detailed rules. Maneuver, not combat, seemed to be the objective. Wars became contests among dynastic rulers seeking land, an adjustment of boundary, political advantage, or the rights of some member of the family. It was not to the advantage of either side to destroy the other; objectives were limited, and war was conducted in accordance with these objectives. Nor could it have been otherwise, for the weapons and tactics of the time dictated in large part this formality, as well as the avoidance of pitched battles with their high cost in men and materials.

There were important social and economic reasons also for the limited and formal nature of warfare in the 18th Century. The cost of war was enormously high. The ever-increasing armies had to be equipped, clothed, armed, fed, and housed. The flintlock was a more complex and expensive weapon than the matchlock, and every one had to be of a standard size to take the new ring bayonet. With the increased emphasis on firepower, more artillery was required and more powder and ball. Everywhere in Europe, the manufacture of saltpeter was critical. More men, more materials, more workers, meant higher costs. Prussia spent approximately 80% of its revenue for military purposes in 1752; France, two-thirds of its income for the army alone in 1784.

The large standing armies of the 18th Century were largely professional armies. War had ceased to be a privilege of the nobility, but for the most part, the mass of the people, the productive elements and the middle class, were excluded or

chose to exclude themselves from military service. Enlisted ranks were recruited from the nonproductive elements of society --the unemployed, the vagabonds, the criminals, marginal farmers, the dispossessed. Wars were usually fought in such a way as to interfere as little as possible with normal civilian pursuits. Discipline was essential, for without it desertion would have been prohibitive. There was little foraging; armies carried their own supplies. Effective discipline as well as economic considerations dictated the growth of large commissariats, supply systems, state magazines, fortified bases well supplied for armies on the march.

Not only were the wars of the 18th Century conducted as economically as possible, for limited purposes, and in moderate fashion, but they were also fought by strict rules, customs, precedents, and an accepted code. There were elaborate rules of strategy, siege, surrender, treatment of prisoners and civilians. Operations were precise, rational, and mechanical. Campaigns were fought only during favorable weather; in winter, armies went into winter quarters. Wars of position were the rule, and although prolonged they were not particularly destructive. Fortresses sprouted all over Europe, and operations took place mostly against fortified positions, magazines, and key points. There were precise rules for attacking a fortress and just as precise rules on when and how it could be surrendered with honor. Artillery played an important part in 18th Century siege warfare, with the result that emphasis was placed on heavy siege guns rather than lighter field guns. On the rare occasions when armies met in battle, however, they fought fiercely, and some--like Fontenoy and Blenheim--had exceptionally high proportions of casualties.

Most armies of the 18th Century were built on the same model. At the beginning of the century, the French army was the best in Europe; by the middle of the century it had been surpassed by the Prussian. All armies contained large foreign elements whose loyalty was doubtful. They fought for pay, not for a cause, and had no wish to lay down their lives. The national troops were often pressed into service by recruitment measures that bred no love for the army. Given the slightest opportunity, troops would desert. It was order, discipline, precision, and long training that made from this material a fighting force. Men responded to command; individual will and initiative were undesirable and would have been impossible in the close formations of the time.

Changes in 18th Century tactics and organization were in large part the result of the use of the flintlock and the bayonet, and these in turn established the requirement for parade-ground drill and rigid discipline. It took time to load the flintlock, and the depth of the line was related to the reloading factor. Since the weapon was inaccurate, fire had to be by volley, with lines of soldiers delivering volleys on command. The whole purpose of the drill was to train men to march in step, fire in unison, and reload quickly. The long lines dictated the kind of terrain and weather in which battles would be fought. Hills, ridges, swamps broke the even formations.

Because the flintlock removed the danger from the lighted match, the infantry could be placed closer together, thus increasing the number of men and therefore the volume of fire in a given space. By 1700, the fusilier, who had now virtually replaced the older musketeer, although he still carried a sword was less clumsily accoutred and carried a piece that was somewhat lighter and easier to use. Caliber had been reduced, and the weight of the ball was 18 or 20 to the pound, rather than 12 as before.

The disappearance of the pikeman did not signify the end of different kinds of infantry, for by this time the grenadier had made his appearance. Hand grenades had been widely used during the Thirty Years' War, and in 1670 the French army had a separate grenadier company in the Regiment du Roi, a practice imitated elsewhere. These grenadiers were picked men, tall and strong, and carried, in addition to the grenades, flintlocks and bayonets. The use of the grenade was later discontinued, but the grenadiers remained, a picked corps for especially arduous tasks. Thus, to all intents and purposes, the grenadier became a fusilier.

All infantrymen were now armed with the same weapon, the flintlock and socket bayonet, thereby greatly simplifying formations and tactics, although the full implications of the benefit thus bestowed were not at first fully appreciated. The immediate result was to reduce the number of ranks, initially to four and then to three. Instead of fire by ranks, the divisions (companies) or platoons delivered the fire. In the advance, the battalion halted to allow one group of platoons to fire and then another. One half of the battalion was always loaded and ready to fire. At close quarters, the fire might be followed up with a bayonet charge--one reason for the high casualty rate in battle.

Firepower was now supreme, after more than two centuries of trial and experiment. Shock action was secondary. The abandonment of the pike was offset in part by the bayonet, but something had been lost when the heavy mass of pikes went. The thin line of flintlocks lacked the weight and defensive power of the older formations. Fortifications, entrenchments, and lines of fortified positions provided the protection needed in the 18th Century, not only from cavalry, but from fire as well. But the price paid was heavy. Eighteenth Century warfare was static, positional, and limited, rule-ridden, custom-bound, and indecisive. It would take a political and economic revolution and the genius of a Napoleon to change its nature.

Folard and Saxe: 1704-1750

The 18th-Century system was fully established in the War of the Spanish Succession (1701-1714) and tested at Blenheim in 1704, where the military supremacy of France was successfully challenged. For the next half century there were few changes in the system, but much critical examination by military theorists.

Many thought that the thin line, the ordre mince, was brittle. It moved slowly and was broken by minor terrain obstacles. Moreover, since there was no uniform cadence in marching, it was extremely difficult to keep the line straight. Fire had replaced shock, and some thought it was not yet powerful enough by itself to gain the decision.

The Chevalier Folard, one of those who concerned himself with this problem, sought to evolve a formation that would combine fire and shock. The answer he found was the column, derived from Polybius' description of Alexander's phalanx. He proposed a return to the infantry square; a battalion of 600 men, including 100 grenadiers to guard the flanks. One-fifth of the battalion would be armed with 11-foot pikes. The depth of the formation was to be equal to its front, or greater.

Folard proposed that two lines be drawn up with the cavalry and infantry placed alternately along each line by brigades. The reserves would occupy a third line. Although Folard's battalion normally would attack as a phalanx, because of its organization it could form a line fairly readily for fire action.

Marshal Maurice de Saxe, the victor of Fontenoy and a friend of Folard, also found deficiencies in the existing system

and sought to improve it. He put forward a tactical scheme based on the Roman legion.

Saxe's scheme called for a basic unit composed of a mixed force of 3,600 men. This legion, as he called it, would consist of four regiments, each composed of four centuries of infantry, a half century of light infantry, and a half century of cavalry, and two 12-pounders. Standard arm of the infantry was to be a breech-loading firearm of his own invention and the plug bayonet--revealing Saxe's mistrust of firepower.

The first two ranks of the legion were to be armed with fusil and bayonet, the last two with fusil and 14-foot pikes. In attack, the light infantry was to act as skirmishers, falling back slowly to the main body as the enemy advanced.

The legion was large enough and strong enough to maintain itself against attack and to undertake separate missions. Also, it contained the several arms, the oversized fusils on wheels, being grouped into batteries, and it was capable of a variety of tasks. It was, indeed, the beginning of the division concept.

Cavalry and dragoons were to be formed into regiments, consisting, like the infantry, of four centuries (130 men) each. Cavalry tactics were simple. It was always to act together, in mass, to start at a slow trot and increase speed in the advance, riding boot to boot.

Saxe provided cavalry support for the infantry by attaching elements to the legion. Infantry support for cavalry would be provided by four regiments for each wing of cavalry, formed in a square between the two lines.

Both Folard and Saxe were in a sense reactionaries. They sought to revive old systems or devise new ones that were based on outmoded weapons. Both mistrusted firepower and newer weapons. Although neither system was adopted, their work had influence on later developments.

The armies of France remained pretty much as Louis XIV had left them until after 1750. There was some improvement in armament, and the iron ramrod was adopted. This device, combined with the new cartridge, increased the rate of fire. Some efforts were made to establish the ordre profond for attack with bayonet and to adopt the column of Folard, but the general practice remained the ordre mince. Firepower and the thin line were too firmly entrenched to be replaced.

Frederick the Great: 1712-1736

The changes that had been initiated by Maurice and Gustavus reached their fullest development in the hands of Frederick the Great of Prussia, one of the great captains of all time. No one else accomplished what he was able to do with linear tactics; he achieved the utmost possible within the limits set by technology and by the political and social conditions of Prussia in the 18th Century. Under his rule, Prussia gained an eminence in European affairs out of all proportion to its size and wealth.

When Frederick inherited the throne in 1740, his father had left him a first-rate army, already one of the best in Europe. It numbered nearly 80,000 men, an extraordinary force for a country with a population of two and a half million and an annual revenue of about one million pounds sterling. By 1786, the army was 200,000 strong, and the population double that of 1740. Four-fifths of Prussia's revenue went into the army; defeat in battle would be for her a national disaster, for Prussia was not a state in the sense that France was, but an army.

Frederick was not only an absolute monarch; he was commander in chief. His rule was absolute, and he personally managed all matters relating to the army. All instructions to every part of the army came from him; he demanded immediate obedience and the utmost discipline. He concentrated all his efforts on perfection of the army.

The quality of the Prussian army depended on the officer corps, drawn almost entirely from the rural nobility.

The superiority of the Prussian officer came less from his professional standards or education than from his strict sense of duty and the iron system of discipline. He began his military service at an early age in the cadet school and then spent years on active service. Life consisted of constant drilling and review. The compensation for these sacrifices was membership in the first estate of the realm and companion to the king. Prussian officers took precedence over all other officials and had complete disposition of their men. Failure was often followed by suicide.

More than in any other army of the time, the drill was necessary not only for linear tactics but also for obedience and control. Frederick placed no faith in the loyalty or honor

of the enlisted men. They could not be trusted and must never be detached or allowed away from the army. All the control mechanisms of the army were designed to prevent desertion, and tactics were even shaped by this objective. It was often impossible because of fear of desertion to speed up the march, make skirmishes, or pursue a defeated enemy. Despite all precautions, there was more desertion from the Prussian army than any other, and after an unsuccessful action the number missing was triple that lost in action.

Frederick's father had reduced the line to three ranks and brought them closer together. Iron ramrods, long in use for pistols, had been adopted for the musket. The men had been trained to fire as many as five rounds a minute, as compared to two in most other armies. The Prussian infantrymen advanced steadily and continuously in step in slow time, firing volleys at intervals on command, starting at 100 paces. The men of the first rank, and later of all three, fired with bayonets fixed. Reduction of the number of ranks and the distance between them made it possible to form a column of march with a front that could be accommodated on an ordinary road. Movement before battle was made in column of divisions (companies) or platoons, the marching column deploying into line by wheeling or half-right and half-left march up to the van unit.

The cavalry consisted of cuirassiers, dragoons, and hussars. The first two were organized into 5-squadron regiments, the last into 10-squadron regiments, about 120 men to the squadron. The artillery organization was by battalion, with the customary guns in calibers from 3- to 24-pounders.

Frederick made few changes in his army; what he did was to perfect its movements through discipline and drill to get the utmost from it. Once the order of battle was fixed, there was no changing it; all movements were based upon it. The infantry was formed in two lines, about 300 paces apart. The cavalry, formed into two or three lines, was on the flanks. The army was divided into four commands for control; two wings of infantry and two of cavalry. Maneuver by elements was almost impossible in this rigid system; neither the organization nor the deployment permitted it. The only way, therefore, was to move the army to the oblique in order to outflank the enemy, an extremely difficult maneuver that only Frederick was able to achieve, thanks to the perfection of his drill and the discipline of his troops. The success of the oblique depended also on knowledge of the enemy's dispositions and on surprise to prevent reinforcement of the threatened flank. Reconnaissance

and intelligence were therefore emphasized; and every opportunity that might afford surprise--weather, terrain, etc.--was exploited. An advance guard held the enemy in place to prevent shifts in his line to meet the main attack. The attack itself was characteristically vigorous, fire from infantry and artillery almost continuous.

Under Frederick there was a renewed importance of the shock power of cavalry in battle. Firearms were taken from the horsemen, and they were taught instead to charge at full speed, ignoring the enemy fire, with sword in hand. The cavalrymen's equipment was made as light as possible to increase the fury of the charge. Close order and alignment were achieved by constant drill, and the Prussian cavalry could move with the same precision and perfection as the infantry. Eight to ten thousand mounted men could charge for hundreds of yards in perfect order, then re-form for movement almost immediately. Of 22 battles fought by Frederick, it is said that his cavalry won 15.

Frederick's aim for the artillery was to secure greater mobility so that it could support the fast-moving cavalry and the masses of infantry. The Austrian artillery was particularly effective, and he sought to offset the enemy's advantage by the use of horse artillery, which could accompany the cavalry. The cannoners were individually mounted, instead of going on foot or by wagon. He employed mostly light guns and howitzers that could be moved quickly. These he placed at important points to protect his line and support the advance. The 3- and 6-pounders, moved by horses, went out ahead of the infantry. At 500 paces the gunners dismounted and man-handled their guns, firing at the enemy until the infantry line caught up with them.

Frederick's victories had a powerful effect. Many of the nations of Europe sought to emulate his system. Foreign officers flocked to Potsdam to witness and admire the complicated maneuvers of the Prussians, then went home to train their own troops in these movements. Frederick had developed the linear system to its utmost, and few could rival, much less surpass him at this. It was uniquely his and Prussia's. Without the political, social, and economic institutions of 18th-Century Prussia and the genius of Frederick himself, it was impossible to achieve the same results. Spain adopted Frederick's system, as did Russia, but neither produced outstanding armies.

The French "Column"

In France, the ideas of Saxe had taken hold, and there was a controversy between those who favored his system and those who favored the system of Frederick, modified to meet the special conditions to be found in France. Various reorganizations were made after 1760, and the "column" came to be used generally, although it was really an adaptation of the linear system. The so-called column, in fact, was the deployment of a number of linear units (usually battalions) in depth, to provide physical and psychological weight to an attack. The individual units could still operate in a linear formation, if desired.

The great tactical value of the column lay in its flexibility and versatility. It permitted the commander to move large numbers of men over the battlefield with better control and far more rapidly than had been possible before. The column could operate in hilly terrain. It could easily change into different formations. The deployment from marching column to attack column, in particular, took far less time than had the development of linear formations from the marching column. Skirmishers could be detached without necessitating major readjustments in the formation. Two- or three-rank firing lines and squares could be formed rapidly. The former need to maintain tight flank connections between units in line fell away; the tactical situation opened up and became more dynamic.

The attack column had two main functions. First, it could be used to bring men in close order rapidly to the enemy. The success of such an action was largely dependent on adequate preparation by gunners and skirmishers, and it was they who inflicted most of the casualties rather than the column itself, which possessed little or no firepower once it started to move. Bayonet charges actually driven home against a steady enemy were rare.

The far more common employment of the attack column was as a sustaining force. The column sent out skirmishers to start the firefight and served as a replacement pool for the skirmishers and as their immediate tactical reserve. If it encountered firm resistance the column might deploy into lines to carry on the fight with volleys. Once the enemy wavered, these lines could resume the advance, or they might again reduce their front and move forward in column.

The introduction of the attack column as a standard combat formation in the Wars of the French Revolution did not by itself

lead to a revolution of infantry tactics. The great effects of the column were dependent on other innovations on the battlefield.

By the time of the French Revolution, and in most cases to the end of the 18th Century, European warfare was characterized by the large-scale formal battle waged primarily on the principles of linear tactics, and sieges conducted according to set patterns. No revolutionary new weapons had been introduced during the century and no major change made in the basic linear organization, although there had been a steady development in both. Small arms had improved, and infantry was clearly the dominant arm. Rate of fire had been increased as a result of improvement in the firing mechanism and drill. Rifled firearms had been developed, but were used only by special troops. The flintlock with the bayonet was the standard arm of the infantry. The cavalry primarily used the saber, but some were armed with carbines. Artillery provided support to the extent of its ability. The guns were not yet capable of the rate of fire, accuracy, or trajectory required for close support of troops in the attack. These developments would come later.

Light Infantry

During the first half of the 18th Century light infantry had been reintroduced into European warfare. It was not a new development; light infantry had been used by all ancient armies and in various forms it had accompanied armies throughout the ages. Almost without exception, however, these had been irregular troops; archers, slingers, javelin men, and various others, who usually opened battles and then moved aside during the main action. With the introduction of firearms similar groups were armed with them, but the troops were undisciplined and did not form part of a regular army.

The rigid linear tactics of the early 18th Century prescribed a fixed and inflexible role for the regular infantry. During the considerable time it took infantry battalions to take up their battle stations they were vulnerable and needed to be screened from enemy action. In addition the supply depots and convoys that were needed to support the armies were highly vulnerable to enemy attacks. The regular infantrymen of the enlarged armies, recruited as they were from the rejects of society and subjected to a rigorous discipline, could not be entrusted with detached operations. Consequently, to furnish the necessary support, to carry out operations against the

enemy's line of communications, to raid, and to take prisoners, while at the same time providing for the security of their own depots and convoys, and to screen the main army against surprises, light troops, mainly infantry, were reintroduced into the European armies after 1740. Within a short time additional functions, above all individual or group fire missions in advance or on the flanks of the main line, were added to their tasks.

The first large-scale appearance of light troops occurred during the War of the Austrian Succession (1740-1748). In 1740 Maria Theresa found herself attacked by the superior strength of Frederick of Prussia and his French and Bavarian allies. She had to muster all the forces at her disposal and did not hesitate to call upon the Borderers, the "wild Croats and Pandours" who had been part of the Austrian frontier defenses, to defend her realm. Early in 1741 over 30,000 of these men made their appearance on the battlefields of central and western Europe. The effectiveness of these light troops compelled the other powers to introduce or augment similar forces. Prussia hastily increased her light cavalry and raised some irregular "free" battalions to counter the Croats, and in France several light regiments as well as a number of combined infantry-cavalry units were raised after 1744.

The English army had no light troops until the line battalions serving in America during the 1750s raised some light companies on an ad hoc basis. These units differed significantly from the irregulars, Borderers, free battalions, and free corps, by being trained and disciplined troops, usable in the line as well as on detached operations, such as advance guards, assault parties, and also, occasionally, as raiders. They differed in function, but not in equipment and discipline, from the rest of the army, and more often than not were used as line infantry. The inspiration for the formation of these troops derived in part from the painful experiences of the war in America and in even larger part from the continental European developments. After 1770, a light company as well as a grenadier company became part of the permanent establishment in each line battalion. Both companies rapidly assumed elite status and as "flank companies" were often used for special missions during the American Revolution.

However, light infantry never became a dominant weapon. In Prussia Frederick II retained his reliance on the massed volleys of the line and spent most of his resources to speed up the fire. Prussia formed a number of fusilier units, but these were

trained and equipped as line infantry. The same development took place in Austria where the regiments of Borderers were drilled in linear tactics; in the British army, too, there was a sharp reaction against light infantry and a determined attempt to return to the linear system.

The only country which did not follow this backward evolution was France. Here there was wide agreement that shock action should be delivered by columns. The main controversy concerned the extent of fire preceding and supporting the assault and whether this fire should be delivered by line, line and skirmishers, or skirmisher swarms. Circumstances and combat leaders together ultimately fashioned that combination of close-order columns and loose-order skirmishers which constituted the new tactics of the Revolutionary and Napoleonic infantry. Skirmishers would so occupy the enemy that the assault columns could move up without being unduly exposed to the fire of the enemy line.

In the War of the First Coalition (1792-1795) the habit of skirmishing spread throughout the French infantry, and by 1793 all battalions were acting as light infantry, dissolving into skirmisher swarms as soon as action was joined. These fighting methods, sometimes called "horde tactics," were in turn superseded after 1795 by a tendency to return to properly controlled assault columns, preceded by skirmishers to scout the ground and disturb the enemy by individual aimed fire.

The important point about the skirmishing action during this period was that it was not performed by special light troops but by integral parts of the regular bodies. Infantry became more flexible and to some observers it appeared as if specialized light troops would soon be eliminated by one all-purpose infantry. But special light troops, not only brought up to the standard of the line but in some cases excelling it in performance and capable of winning a decision in battle, remained in French service for another 50 years.

The most effective answer to the French system, as well as the most effective form of light infantry, was provided by the British. Their system was largely based on the effects of controlled aimed musketry, delivered by troops combining as far as possible the mobility of skirmishers with the steadiness of the line. Under Sir John Moore and Sir Arthur Wellesley, the later Duke of Wellington, the British began to take advantage of cover, usually behind the crest of a ridge, and then, formed only two deep, arose to deliver a devastating fire against the French columns.

The English light infantry, partially armed with rifles which could deliver rapid fire by the use of subcaliber bullets, or individual aimed fire when using regular sized bullets, able to operate individually or in close order, represented in essence the all-purpose infantry of the future.

In their political implications, the new light infantry tactics were revolutionary. Both the French revolutionary armies and the British system abandoned the brutal and degrading discipline of the 18th-Century armies. The light infantryman (or the all-purpose infantryman) fighting often as an individual on detached service, or in open order, was much less under the direct supervision of his officers. Brutal treatment and close control gave way to appeals to regimental pride, revolutionary elan, and the spirit of nationalism.

The character of light infantry and of warfare were greatly changed by the introduction of the rifle. For fighting individually in dispersed order, an accurate missile weapon was of great importance for light infantry. Rifles, however, were expensive and, above all, slow to load. Therefore only select units and select individuals in line companies were thus equipped until well into the 19th Century.

The effectiveness of light troops is hard to envisage numerically. However, at Lobositz (1756) and at Kolin (1757) the casualty figures of the Prussians indicate the accuracy of the Croats' fire. Similarly the effects of the light division can be seen in the Peninsular War. In the action at Sabugal (1811), 10,000 Anglo-Portuguese troops, including 3,000 from the light division, beat a French force of 12,000. The English losses (including Portuguese) were 500 dead and wounded; the French suffered 1,500 men dead and wounded including 63 officers.

19TH CENTURY COMBINED-ARMS DIVISIONAL SYSTEMS

Origin of the Division and the Corps

The infantry division as a large permanent tactical and administrative formation appeared in France in the 18th Century. In 1758, the Duc de Broglie introduced in the French army a divisional organization, permanent mixed bodies of infantry and artillery.

In 1794, Carnot, the Revolutionary minister of war, developed the division embracing all three arms, infantry, cavalry, and artillery, and capable of carrying out independent operations. By 1796, the divisional system became universal in the French army. It was Napoleon Bonaparte, however, who developed all the potentialities of the divisional system and used it in mobile warfare and tactics of fast maneuver. The men were trained in fast marching and the supply system was improved to support them wherever they went. The mobility of the division was also enhanced by its artillery which could follow infantry and maneuver on the battlefield.

When the size of the French army increased to 200,000, it became necessary to group divisions into army corps. The first such organization was made in 1800, when Moreau grouped the 11 divisions of the Army of the Rhine into four corps. It was, however, not until 1804 that Napoleon introduced permanent army corps in the French army, employing them as he had previously used divisions. However, the division remained the major tactical unit, composed of two arms, infantry and artillery, and entrusted with a definite mission. The corps included cavalry as well, which conducted reconnaissance for the whole corps. In addition, Napoleon formed cavalry divisions and cavalry corps.

Napoleon's infantry division consisted of two or three infantry brigades, each comprising two regiments, and of one artillery brigade, consisting of two batteries, each with four field guns and two howitzers.

Artillery

Artillery played a decisive role in Napoleon's battles and was the major factor in the lethality of his warfare.

The French Revolutionary army inherited from the monarchy an excellent field artillery system invented by an artillery officer, Jean-Baptiste Vaquette Gribeauval (1715-1789) and introduced in the French army in 1776.

The main feature of Gribeauval's artillery was mobility, obtained by reducing the length and weight of the barrel and the weight of the gun carriage; the latter was also provided with iron axle-trees and wheels of large diameter. Range and precision were preserved by more precise manufacture of the projectile (balls of true sphericity and correct diameter, which also

made possible a reduction in powder charge). Prefabricated cartridges, which replaced the old loose powder and shot, increased the rate of firing. Draft horses were disposed in double files instead of single. Six horses now sufficed to draw the 12-pounder, while four were used for smaller guns, which included 8- and 4-pounders, and a 6-inch howitzer.

Napoleon took full advantage of the maneuverability of the French artillery and made out of it the most important tool of his conquests.

French Tactics (1800-1815)

In war Napoleon always sought a general battle as a means of destroying the enemy's armed force, after having gained a strategic advantage by maneuver. Tactically, he usually directed his main blow against the enemy's flank while simultaneously attacking his front, or launched his main thrust against the center of the enemy's battle front with the aim of breaking through, while at the same time carrying on an enveloping maneuver against one of his flanks. The divisions attacking important objectives were often supported by massed fire from Napoleon's artillery reserve. Divisions with exposed flanks were protected by corps cavalry or even by the cavalry reserve.

Napoleon's cavalry, provided with horse artillery and used in great but articulate masses and in surprise operations against the enemy's cavalry and infantry, was very effective. It was usually thrown against the infantry after the latter was already shattered by massive artillery fire, or by infantry attacks, or was in retreat. It was less successful against fresh infantry which had the time to form square. Under outstanding leaders and by its impetuous charges, the French cavalry often proved superior to the best cavalry of other European nations. By its lightning action in pursuit, the French cavalry also spared losses to its own army. After a victory, Napoleon would launch an energetic pursuit with his cavalry, followed by the whole army.

Only after destruction of the main armed force of the enemy did Napoleon occupy the principal strategic and political centers of the enemy's country.

Logistics

Napoleon was a master of planned and improvised supply. The division was often billeted in towns and villages, where the local population was required to provide food. The soldiers and supply columns following the troops each carried four days' provisions, to be consumed only in emergency. In addition, provisions were stored at the main base and intermediate depots, the latter moved forward with the advance of the troops.

This system of logistics proved very satisfactory until the Russian campaign of 1812, when it completely broke down because of bad roads in Russia, the poverty and devastation of the country, and activities of the Russian partisans.

Other European Powers

After the first defeats inflicted on them by Napoleon, other European military leaders tried to imitate Napoleon. They gradually introduced divisions and army corps into their armies, replaced linear tactics by deep combat formations, applied concentration of forces on the battlefield in general and in its decisive areas in particular, and formed reserves; but although they learned much and greatly improved their military instruments, their leaders could never match the great master and never really grasped the secrets of his genius. They finally overwhelmed him through numerical superiority and the attrition of war on France, both traceable to Napoleon's diplomatic failures.

Wellington and the English Line

Linear tactics remained in use for a good part of the 19th Century, since it was held by many that Napoleon's defeat by Wellington demonstrated the superiority of the line. Time would prove this conclusion false, especially when improvements in military technology vastly increased firepower, mobility, and communications. But the tactics of Wellington are well worth study, especially since they were used against a system that ultimately replaced them.

The British did not adopt the division until 1807, and Wellington's army in the Peninsula in 1809 was composed of

independent brigades. Despite the early successes of the French system, the British retained the two-deep line--in which every man would employ his weapons--to produce a greater volume of fire than could the column. Wellington's success was due undoubtedly in part to this; but it was due also to his tactics. He decided he could overcome Napoleon's tactics by three means: not expose his line until the action opened; protect it against the skirmishers; and secure his flanks. The first he achieved by placing his infantry whenever possible on reverse slopes; the second by building up his light troops; the third was accomplished by natural obstacles or by his cavalry.

The British army was a volunteer force and necessarily smaller than the French. But it had the advantage of more training and drill. The infantry was also the superior of any other in the excellence of its musketry, an advantage enhanced by its 2-rank line.

During the Peninsular Campaign (1809-1814), Wellington's army at first was organized into eight brigades of two or three battalions each. Reorganized as its size increased, it consisted finally of seven divisions, a light division, and the cavalry under separate command. Although the elements of the divisions varied, they were composed ordinarily of two British brigades and one Portuguese brigade, usually with three battalions, about 6,000 men, each. The cavalry was organized as a division of three brigades of two regiments each. The light division served as a protective screen for the entire army, operating far to the front.

One of the more interesting and important aspects of Wellington's organization grew out of his efforts to secure a strong screen of skirmishers to meet the French tirailleurs. Wellington added to every brigade in his army an extra company of light riflemen to reinforce the three light companies which were by now standard in the British brigade. Further, each of the brigades of the light division had a number of rifle companies.

Light infantry therefore was armed with two different kinds of weapons--the rifle and the musket. The latter was of a special type, a light-weight piece, constructed for this particular purpose. It was a somewhat more accurate weapon than the Brown Bess, with better sights, but shorter in length. The line battalions used the Brown Bess, which was considered superior to those used on the continent. The bayonet was long and

triangular and when fixed made accurate firing difficult. Sergeants did not carry a musket, but a sword and a pike or a halberd.

Cavalry played a minor role in Wellington's Peninsular campaigns, probably because of the difficulty of shipping horses. But Wellington did pay considerable attention to defense against French cavalry. The steady line and accurate fire of the British infantrymen was usually able to repulse a cavalry charge. On one occasion, an infantry line advanced against cavalry and drove it from the field. In a square formation, the British infantry could not be broken, and there is recorded the instance of the light division, formed into five squares, retreating for two miles with only 35 casualties, under attack by four brigades of cavalry.

Wellington employed his artillery selectively, in small numbers and individual batteries, at carefully chosen sites, to be used at critical moments. They were placed all along the front as support for the infantry and played a minor but important role in the battle.

The Age of Technological Innovation
(Part C)

THE COMBINED-ARMS DIVISION AFTER
NAPOLEON, 1815-1878

Tactics and Organization

The marked development of the division and corps during the Napoleonic era was followed by a long period of stagnation, if not retrogression, in organization and tactics. For example, the one notable conflict between 1815 and 1845, the Russo-Turkish War (1828-1829), was remarkable for the obsolescence of infantry tactics employed, and the Russian departure from the Napoleonic principle of concentration of forces. In like respect, the French and British armies reverted to Prussian parade-type drill at the expense of combat training.

However, the weapons of war were undergoing an impressive technological revolution. Weapons of both artillery and infantry were becoming progressively longer ranged, more accurate, and capable of much greater rates of sustained fire. Clearly this called for matching improvements in organization, tactics, and logistical support.

A more or less accidental ally in matching logistical support to the new capabilities and demands of weaponry appeared in the railroad, which armies were quick to use; in the Italian War of 1859 France, in a period of three months, transported some 604,000 men and 129,000 horses by rail. In organization and tactics, however, armies responded slowly to the weapons changes, largely because the new weapons demanded battlefield dispersion, which professional soldiers feared would lead to loss of control.

A large literature sprang up during and immediately after this period, in which these points were thoroughly, and sometimes heatedly, discussed. The end result in all armies, even in those which had recently undergone battle with the new weapons, was the

same: insistence that these weapons need force no basic alterations in organization or tactics and that the role of cavalry was unchanged. This disregard of the clear evidence would have disastrous results in the years ahead.

Throughout Europe and in the United States during this period the division was in general an organization for convenience in administration and maneuver. In most of the armies that were at war during this time either the brigade or the regiment was the tactical element. In addition, the term "division" was rather loosely used in all armies to designate some portion of the battle line, as in medieval practice, or a force of any size under temporary command of a specified officer.

Great Britain and the United States provided by law and regulation for maintenance of divisions, but in peacetime maintained no active organizations larger than regiments. In war these regiments were more or less haphazardly organized into brigades and divisions which were disbanded at the end of hostilities.

Staffs in the armies maintaining the peacetime divisions and corps structure were rudimentary by modern standards. In those armies which did not actively maintain the division organization during peacetime, staffs were nonexistent except at the highest echelon, where they functioned in support of the army as a whole. Even in Prussia, where long strides had been made toward a functioning general staff, this was concentrated primarily at army level. In any event, staffs were predominantly concerned with administration and supply, rather than with planning and directing operations, which were still considered to be the prerogative of the commander, of the council of war, when the commander wanted advice from subordinate commanders (not from his staff).

Theoretically, in all armies where it existed actually or prospectively, the division was a combined-arms force, consisting basically of infantry with artillery, cavalry, and sometimes engineer support organic or attached. Except in Russia, where the infantry regiment contained more than 4,000 men, and in Prussia, where the division totalled about 12,000, the war-strength division ranged from 2,300 to 5,000 effectives. In general it comprised two infantry brigades with two regiments each; its combat support varied from country to country and often from division to division. Strength figures may be deceptive also, since even in those countries which managed to recruit initially to paper strength, sickness, desertion and straggling, and ultimately battle casualties, soon reduced units

far below their authorized complements. Study of the campaigns of this period is hampered by the fact that it is usually difficult, and often impossible, to determine whether strengths given in the accounts are those of effectives actually present, or only the paper strengths of the units involved.

Revolution in Weapons

The crucial innovation in weapons during this period was the widespread adoption of firearms using the rifled barrel. Although rifling had been introduced around 1600, its handicaps long discouraged general adoption. The introduction of methods of mass production permitted standardization and lowered the cost of the piece. But it became a much more useful arm and its adoption was given great impetus as the result of the perfection in 1849 by the Frenchman Claude Etienne Minié and others of the cylindro-conoidal, expansible bullet, after about ten years of experimentation by various men.

Until the development of the new bullet, rifles had been slower firing than smoothbores, because of the difficulty in loading them. The new shape gave less resistance to the air after firing, and the expansible feature, provided by the action of the powder gas on a cavity in the base of the lead bullet, made possible a bullet small enough to load easily, yet large enough upon firing to fit the barrel tightly and acquire maximum spin.

To equal the performance of a rifle musket the smoothbore required twice the quantity of ammunition expenditure at 200 paces, five times the quantity at 300 paces, and at least ten times the quantity at 400 paces. Beyond 400 paces the smoothbore was completely useless, while the rifle could hit larger targets, like troop formations, at 800 yards and at 1,000 yards still penetrated four inches of soft pine.

An improved system of ignition contributed to the rifle revolution. The percussion principle, developed by the Reverend Alexander Forsyth in England, was used to perfect a percussion cap in 1816 by Joshua Shaw, an American. The system used fulminate of mercury in an iron, and later a copper, cap, the fulminate being detonated when the cap was struck. Flintlocks had misfired about every seventh shot; percussion caps reduced the misfires to 4.5 in 1,000 rounds.

The rifle revolution was further accelerated by the development of fixed ammunition--the self-contained cartridge enclosing primer, powder, and projectile in one metal package. This breakthrough took place in the period 1846-1860.

A final significant increase in small-arms lethality during this period was general adoption of the breech-loading principle, which allowed a rifleman to reload more quickly and without standing and exposing himself to enemy fire. The principle had been known since the early days of gunpowder, but Prussia was first to adopt a breechloader on a large scale. This was the "needle gun" perfected by von Dreyse in 1841. Its superiority was clearly demonstrated in the Austro-Prussian War of 1866. This superiority was in rapid fire, not in accuracy or range. The gun did not use a metallic cartridge, and the oblong almost ovoid bullet was theoretically accurate up to 700 yards, but no farther. It has been estimated that the needle gun registered only from 0.65% to 1.5% hits in its early battles. However, at Koniggratz, where the lowest percentage was registered, Austrian dead and wounded totaled 13,232, and Prussian dead and wounded only 8,877. Assuming relatively equal lethality in the opposing artillery, and that small arms accounted for 80-90% of casualties, which was normally the case in this period, this demonstrates clear superiority in effectiveness of the breechloader over the muzzle-loading rifle-musket. Superior Prussian tactics, however, must be given partial credit for the difference.

During the American Civil War the Sharps rifle, a breechloader, was introduced, but few were actually used in that war. After the Franco-Prussian War (1870-1871), France converted its Chassepot breechloaders to metallic cartridges, and within a few years virtually all nations had armed their infantry with breechloaders.

The general introduction of breechloaders ended an important phase in the history of infantry weapons. Since the general introduction of firearms toward the end of the 15th Century, basic infantry fire tactics had rested on two different fire methods--aimed individual fire and massed volume fire. These two methods required different types of weapons. The flintlock muskets of the 18th and 19th Century were able to produce a high volume of fire, but were deficient in accuracy. To provide accuracy, selected individuals, and later selected units, had been armed with rifles which provided aimed fire, but at a much reduced volume. The development of light infantry had been the culmination of this specialization.

With the general introduction of breech-loading rifles, soon followed by magazine weapons, it became possible to create a general purpose infantry, armed with weapons combining high fire speed with excellent accuracy.

While the changes in small arms were most significant in the period 1815-1878, rifled artillery had also appeared by the time of the American Civil War, often in the form of converted smoothbore guns. By 1870 Prussia had breech-loading rifled artillery in numbers great enough to play an important part in the defeat of France, notably in the Battle of Sedan.

The Operational Record

Notable conflicts of the period include the Crimean War (1853-1856), the American Civil War (1861-1865), the Austro-Prussian War (1866), and the Franco-Prussian War (1870-1871).

The Crimean War

Most of the lessons of the Crimean War were negative; it presented no radical, or even evolutionary, departures in weapons, organization, and tactics. In fact, standards of tactics were generally abominable. Nevertheless, it provided an almost unnoticed indication of the efficacy of field fortifications against the weapons of the time, demonstrated at the siege of Sebastopol. There the British and French fired 2,381,042 rounds of artillery ammunition from 2,587 guns over a 12-month period. This rate of consumption and relative paucity of results were contrary to all current military expectation, yet they aroused only passing professional interest.

The American Civil War, 1861-1865

Many historians have termed the American Civil War the last of the old and the first of the modern wars. This does not overstate the case; in this war occurred a revolution in weaponry and tactics which, although not perceived by European soldiers, was to come to bloody fruition in 1914.

In this war the rifled musket firing the minié ball was widely used. By the end of the war, breech-loading carbines were in use by the Union cavalry and magazine carbines were

becoming familiar. The new fixed ammunition affected the use of all weapons. In artillery the wrought iron rifled gun of 3-inch bore, still muzzle-loaded, had come generally into use as a Union fieldpiece. Percussion and time-fused shells, of low fragmentation, were commonly employed by both sides, and shrapnel was in general use. Counterbattery fires were employed extensively, with large-caliber guns dedicated to this purpose. Mining was common on both sides, especially toward the end of the war when the increasing lethality of their weapons had forced both to resort to dispersal and field fortifications.

At the outset both armies were equipped principally with muzzle loading percussion-cap smoothbore muskets of various makes and calibers. The universal infantry weapon of the Union armies ultimately became the Springfield caliber .58 rifle firing the minié ball but still a percussion-cap muzzle-loader. This weapon was sufficiently available in the South and produced by Southern arsenals in such quantity that it also became the standard Confederate infantry arm, supplemented by relatively small numbers of rifled muskets purchased abroad. Captured Union equipment also added a small number to the Confederate inventory.

Some special units, such as Col. Hiram Berdan's two regiments of sharpshooters, were armed with the Sharps breech-loading rifle of .58 caliber. And in the last two years the Union cavalry was increasingly armed with the Sharps breech-loading carbine and the Spencer and Henry magazine carbines. Some Spencer rifles were also issued to the Union infantry. When captured by the Confederates, these arms could not be adapted to their own use, since they took metallic rimfire cartridges unobtainable in the South. It may be speculated that, had these weapons been introduced earlier or the war lasted long enough for their use to become widespread, the tactical revolution might have progressed sufficiently to forestall the costly trials of World War I.

Infantry tactics in the Civil War were linear at the outset and continued so to the end, but with some marked alterations with the passage of time. In the early battles both sides stood in close ranks and fired, by volley or at will, until one or the other launched a charge to bring the issue to bayonet point. As the use of rifled muskets increased, these charges became so costly that dispersal was the general procedure on the defensive, and rudimentary systems of infiltration were being tried on the offensive as the war ended. Entrenchments became the rule and provided firepower bases for maneuver on both offensive and defensive.

This was a logical development from the tendency of both sides, without sanction of the manuals, to seek cover; at first behind walls and fences, then in hasty field works, and finally in elaborate fortifications, as at Vicksburg, Petersburg, Richmond, and Knoxville. Nevertheless, no officially sanctioned innovation in infantry tactics took place during the war. //

By the end of the first year the Union forces had been re-organized into divisions and corps, each corps consisting of two or three divisions and each division of two or three brigades of four (occasionally three) regiments each. Artillery, generally four batteries, was assigned to each division and one regiment of cavalry was assigned to each corps with a troop or squadron sometimes at division level. This organization, with two major exceptions, persisted to the end of the war. The exceptions were: (1) cavalry eventually was concentrated in its own divisions and corps, where its value was tremendously increased;* and (2) artillery reserves were created at corps and army, significantly enhancing the usefulness of that arm.

Organization of the Confederate armies into divisions took place during the winter of 1861-1862. There was lack of uniformity in divisions as well as in brigades; divisions consisting of two to six brigades and brigades of three to six regiments. Occasionally a battery of artillery was assigned to a brigade, but, in general, this arm was concentrated under corps or "wing" command. In the Confederate armies of the West, corps were organized in temporary "wings" under one of the division commanders until after the battle of Antietam (September 17, 1862), when a permanent corps organization was adopted.

In both armies throughout the war the tactical infantry element was the brigade disposed in line. The Confederate armies from the first tended to concentrate cavalry and artillery, a practice adopted by the Union armies after its utility had been repeatedly demonstrated by Confederate successes. In no way did this conflict revolutionize the division structure nor did the division organization itself directly affect the conduct of war.

* This was a reversion to the Napoleonic concept of mass employment, and for the same reasons which had motivated him. The comparison with modern practices of employment of armor is obvious.

The marked increase in lethality in the hand weapons used in the Civil War was probably offset to some extent by the increasing tendency of both sides to defend themselves by taking cover. There were, however, no significant changes in tactics and organization. Hence there is good basis for the assumption that the casualty figures for the Union Army reflect the advance that was made in weapon lethality but not assimilated to the extent of significantly changing tactics or organization.

The rate of killed in action for the Union army (Confederate figures are hopelessly incomplete) was 21.3 per 1,000 per year,* the highest ever suffered by US forces in any war for which credible figures are available. It was nearly twice that for World War I and 2.5 times that for World War II. This discrepancy must be placed against an exponential increase in theoretical weapon lethality in the last two conflicts.

The Austro-Prussian War, 1866

In the seven weeks during which this war in Bohemia lasted, the breech-loading rifle was given its first full-scale test in battle. Despite a serious shortcoming in design, it met this test so well that objections to breech-loading arms were thenceforth silenced in all armies.

The Franco-Prussian War, 1870-1871

With characteristic thoroughness the Prussians had applied to their army the lessons of 1866 and entered this conflict better prepared in organization, equipment, command, and tactical doctrine than any army up to that time. The result was a surprisingly quick and overwhelming victory over Imperial France.

The French, as well as the Prussians, had taken cognizance of the lessons of 1861-1865, and of 1866 but had grossly misread them. From the devastating effects of rifle fire used in defense they had reasoned that the proper tactic was to defend in place, allowing the enemy to waste himself against their rifle fire. The Prussians also had noted the power of the defense but had reasoned farther, looking to a well-conducted defense as the proper base for attack against a weakened enemy.

* Gilbert W. Beebe and Michael A. DeBakey, Battle Casualties, Thomas, Springfield, Illinois. 1952, p. 21.

Both armies were armed with breech-loading rifles, the Prussians with their needle gun and the French with the new .51 caliber Chassepot, a bolt-action piece with a rubber ring which sealed the breech against the escape of gas. It was a much more effective weapon in all respects than the needle gun. Like the latter, it employed paper cartridges with the cylindro-conoidal bullet.

The Prussian field artillery had been completely equipped with Krupp steel breech-loading rifles, while the French still depended on rifled muzzle-loading guns. In addition, the French had adopted the mitrailleuse, a crank-operated machine gun which they had cloaked in secrecy so impenetrable that no tactics for its employment had been developed. It was used as artillery rather than as an infantry weapon. Its adoption was in essence a calamity, for it aroused in the French high command an unwarranted sense of superiority. Substituted for artillery, it was a dismal failure. Unfortunately, this failure would be so misread by many observers (except the Germans) as to delay the later adoption of the machine gun in the French and British armies--a cruel handicap at the opening of World War I.

Cavalry continued to be the elite arm of both armies, its traditional role in shock action unaltered by its failure in 1866. Again it was to fail against the new infantry weapons, even more dismally than in Bohemia, but still with no effect on the ardor of its proponents.

The organization of the Prussian army was the same with which it had fought in 1866, with the exception that the staff better understood its function and the staff concept had begun to filter down to the division level. French organization was centered on the army corps as the administrative and maneuver element. Each corps contained two divisions, the divisions being composed of two brigades of two regiments each, with attached artillery, usually four batteries.

Tactics of both sides were a combination of linear and columnar, drill being designed to convert from one to the other as required at or just before contact. The French continued to use clouds of skirmishers, who greatly reduced their effectiveness by opening fire at excessive ranges and by failure to press their attacks in advantageous circumstances.

The railroad had shown its value in 1859, and its absolute necessity for logistical purposes, if armies were to remain in the field for protracted periods, in the American Civil War. Its

use was further developed in 1870-1871. This mode of transport had become so much a part of war that the huge armies of the late 19th and early 20th Centuries could not have been mobilized, maneuvered, and supplied without it.

Standstill in Tactics and Organization

Nothing in the organization or employment of the combined-arms division during this period had any appreciable effect on the conduct of war, strategically or tactically. It is true that from 1845, when the smoothbore musket was still largely in use, to 1878, when the breech-loading rifle had become commonplace, a major revolution had occurred. But it was technological, not organizational or tactical. The rifled percussion-cap musket had indeed driven artillery out of the infantry line, forcing artillery to adopt rifling and breechloading, and these ultimately were vastly to enhance artillery's utility on the battlefield. The rifled musket, and later the breech-loading rifle, had rendered linear tactics in battle unacceptably costly, a lesson most clearly demonstrated by the American Civil War. Yet linear tactics persisted at great and unnecessary expense in casualties.

Exactly what were the effects of greatly increased weapon lethality together with incompatible tactics and organization is almost impossible to ascertain with reasonable confidence. Casualty figures that are obtainable must be treated with utmost caution. Strength figures are often unreliable, as are casualty figures deriving from inadequate record-keeping and lack of uniformity in standards of reporting, and the unknowns of surgical competence and pre-operative and post-operative care are qualitative factors that seriously confuse the figures for those killed in action (KIA) and died of wounds (DOW).

WEAPONS, TACTICS, ORGANIZATION, 1878-1917

Weapons Revolution Accelerated

The half-century which followed the American Civil War spawned a series of technical innovations which greatly increased the potential lethality of weapons while undermining the raison d'être of contemporary tactical doctrines. The perfection of smokeless powder in 1885 eliminated the smoke clouds which had

previously betrayed one's own position, while obscuring the vision of the enemy. Smokeless powder, together with the development of recoil-absorbing devices and the non-recoil carriage, made possible quick-firing artillery which, by 1905, had become the dominant battlefield weapon. The high-explosive artillery shell, first introduced in 1886, proved to be fantastically more lethal, as well as more effective against material, than the old black-powder shell. A 3-inch high-explosive shell of the kind standard in World War I burst into about 1,000 high-velocity fragments, while a black-powder shell of the Civil War period burst into two to five fragments, that of the Franco-Prussian War into 20 to 30.

Between 1886 and 1895, most armies had abandoned infantry weapons using black-powder cartridges with soft-lead bullets and had adopted bolt-action, clip-fed, magazine (Mauser-type) rifles firing smokeless-powder cartridges whose bullets were covered with hard metal and were of relatively small caliber. The new ammunition gave a leap in velocity of over two to one, from approximately 1,300 foot seconds to as much as 2,700-2,800 foot seconds muzzle velocity, and the higher velocity caused higher impact and far greater damage to the body of the target. The bolt-action feature, by which the spent cartridge was ejected and a new one moved from magazine to firing position by one movement of the rifleman, greatly speeded reloading and rate of fire. The same period witnessed the introduction of the modern machine gun (Maxim, and later the Nordenfeldt and Hotchkiss). Attempts to produce multiple-firing weapons had been made as far back as the 15th Century. But development of the true automatic machine gun had to await perfection of the metallic cartridge. The modern machine gun used the energy of the gun's recoil (Maxim, about 1885) or the energy of the gas from the powder combustion (Hotchkiss, 1897) to reload the gun. The automatic machine gun when perfected had a theoretical rate of fire many times the bolt-action magazine rifle's theoretical rate of 30 shots per minute. This and the high-explosive shell combined to create one of the crucial lethality breakthroughs of history.

Response of Tactics and Organization

Technological advances generally failed to elicit corresponding innovations in tactics. Neither the South African War (1899-1902) nor the Russo-Japanese War (1904-1905), with their implicit lessons--regarding the potential efficacy of the machine gun, bolt-action and clip-fed rifle, entrenchments, and quick-firing

artillery in defensive action--stirred military thought to an adequate reappraisal of the presumed effectiveness of mass attacks and the traditional overruling value of the offensive. Germany had the advantages of the Prussian general staff system and of more flexible tactics that made use of smaller maneuvering forces, with great success, as early as the Austro-Prussian War of 1866. Even German tactics, however, did not adequately take into account the greatly increased firepower of the new weapons.

In the decades preceding 1914, the European states engaged in a race for numerical supremacy in arms on the Prussian model, with all but Britain adopting short-term national conscription. All powers also adopted some version of the Prussian general staff system. The universal assumption of the various general staffs--reflected in the lack of long-range economic planning--was that, because of the power of new weapons, war, if it should occur, would probably be brief, its course decisively determined by an heroic offensive thrust.

[The] theorists' picture of the next war was surprisingly like that of the wars of 1866 and 1870, which had been decided by a series of initial shocks from which the defeated armies had never recovered. Then, arguing from these historical examples, these theorists had built mass armies which seemed capable, to their builders, only of fighting the kind of war which had been posited by these historical examples.*

Neither the German strategy of staving off Russia while making a wide sweep through Belgium and into France (introduced in 1905 by von Schlieffen and unsuccessfully modified by his successor, Moltke), nor the French Plan XVII, envisaged a protracted war of attrition. Schlieffen, however, had obviously considered such a possibility, since his plan was specifically designed to avoid it. Mostly because of Moltke's modifications, but partly because the tactics that were to carry it out were incompatible with the new weapons, the German plan failed, and a long, bloody stalemate was fought.**

* Ropp, War in the Modern World, p. 204.

** French Plan XVII had never had a chance of success.

World War I--Tactics and Weapons Incompatible

The war opened with the Germans pushing through Belgium into France in accordance with the modified Schlieffen plan. The small (100,000 men) but highly trained British force, equipped with the Lee-Enfield rifle, fired with such accuracy at the Battle of Mons, near the French-Belgian frontier, that successive German assaults were mowed down by what some Germans mistook for machine-gun fire. The British high command was also misled into underestimating the necessity of immediately procuring large numbers of machine guns. They were not needed by the men at Mons, but these men were soon gone. British losses in the first three months of the war were 85,000 killed, wounded, and captured. French losses were 854,000 for this same period, and German losses 677,000. The combat lethality of the machine gun, the French 75, a quick-firing artillery piece, and the modern rifle were amply demonstrated. Stalemate ensued for three bloody years.

In the period 1915-1917 it was usually the Allies who attempted to break the stalemate, always with appalling casualties and only a few miles gained. The Germans' one offensive was the unsuccessful and costly assault on the fortress area of Verdun from February to December 1916. And in this the losses of the defenders--resulting mainly from costly counterattacks--were higher than theirs. These offensives were direct frontal attacks on strong field fortifications, which included machine guns, protected and made more lethal by barbed wire entanglements. Because of the way these attacks were conducted, surprise was impossible. Concentration of men and materiel and preliminary bombardments lasting as long as two weeks indicated clearly where the attack was to be directed, and to some extent when. The obvious response to these indications was to concentrate reserves within one or two days' march of the threatened point and use these for defense in depth and counterattack. The heavy British casualties of the Somme offensive of July-November 1916 (about 410,000) brought protests in British government circles and from the British public. The costly Aisne offensive of 1917 brought a wave of mutinies involving 54 French divisions. In assault, casualties were frequently twice those of the defender, despite the preliminary artillery bombardments.

Two new weapons, gas (in 1915) and the tank (in 1916), were introduced by the Germans and British respectively, but did not prove decisive because of technical imperfections, inadequate quantities, failure to adopt appropriate tactics for their use, and the lack of adequate reserves to exploit breakthroughs.

The New Logistics

The tremendous potential lethality of automatic weapons and quick-firing artillery could receive very considerable exploitation because the industry and technology that had provided them also provided the means to supply them with ammunition and to supply the millions of men who were their users and their targets with food, fuel, clothing, and a wide range of other goods and services. The railroad made it possible to keep large armies in contact for long periods of time because it could bring up food from great distances as wagon trains never could, and it brought up the millions of rounds that mass production poured out of the factories.

Thus, where lack of ammunition would have silenced the guns and cut the casualties in an earlier war, the French and British in one month of World War I averaged an ammunition consumption twice that fired off by the North in the whole four years of the Civil War. In seven days at the Somme the British expended about 125 times as many rounds of artillery ammunition as the North did in the three days of Gettysburg.

The internal combustion engine also contributed to the exploitation of lethality. Had it not been for trucks, the forward railheads would have been constricting bottlenecks, for horse transport, with its limited capacity and its great demands for forage, would have limited what could be brought forward. As it was, trucks could bring supplies to a point where the horse could finally take over local distribution. In all, in World War I, fuel for truck, train, and horse was about half of the supplies shipped to the British Army in France.

The possibility of more fully exploiting lethality by increased consumption of ammunition was also a constraint on armies, for the army with a conspicuously better ammunition supply had what could be a decisive advantage. This introduced a new complication to strategy and operations, for a commander might gamble that he could cut himself off from his base and overrun a too-cautious opponent before the need for resupply would cripple him. This need for resupply, plus the inability of millions of men to live off the countryside, and the inability of tanks and trucks to forage as Napoleon's and Jenghiz Khan's horses had done, introduced a paradox into 20th Century operations. Armies were never before so deadly and so mobile, yet never before so tied to their bases.

GERMAN INNOVATION OF THE COMBAT TEAM, 1917-1918

By the end of 1917 Germany had succeeded in eliminating Russia and Rumania from the war and had dealt Italy a crippling blow in the Caporetto offensive of November. (These successes had been due in large part to the emergence of new tactical concepts of fire and movement.) The coming year promised Germany certain advantages which had not before obtained and which called for prompt measures to end the war by a clear-cut military victory or by forcing a negotiated peace favorable to Germany. On the other hand there were certain disadvantages--which for the most part increased the pressure for an early decision. Among the advantages and disadvantages were these:

1. Advantages

- a. Release of large forces from the Eastern Front and of smaller, but considerable, forces from Italy.
- b. Exhaustion of the French Army by the defense of Verdun and the Nivelle 1917 offensive, and of the British by the 1917 Flanders offensive.
- c. Success of the submarine campaign, which had placed severe stress on Great Britain.
- d. The knowledge that the British army was overextended on its southern flank at its junction with the French.

2. Disadvantages

- a. The marked decrease in quality of recruits and the lack of time for their proper training, the diminished morale of veteran troops, and the steady drainage of experienced officers and noncommissioned officers.
- b. The entry of the United States into the war with an eventual, though unpredictable, increase in Allied strength.
- c. Worsening economic conditions in Germany as a result of the Allied blockade, with growing social and political unrest.
- d. Indications of successful Allied countermeasures against the submarine.

It was recognized by German military authorities not only that positive military results should be obtained, which were possible only through offensive action, but that a strategy of attrition would not suffice. The only possible solution was a deep tactical penetration at some point where the strategic results would be decisive, such as separation of the British from the French and their subsequent defeat in detail.

Yet the means of carrying out such a penetration had not been developed so far in the war; even the British tank attacks had developed only limited successes and Germany possessed a totally inadequate supply of these new weapons, even including those captured from the enemy. The problem had not so far been solved by any of the combatant armies regardless of the force applied, the weaponry employed, or the frontage attacked. The missing factor, although this was not generally recognized, was tactical. However, the successes of General Hutier in his offensive against Riga in 1917, followed by successful employment of similar tactics at Caporetto, were promising.

Under direction of General Erich Ludendorff, Quartermaster General (in effect, Chief of Staff), the German army staff undertook a study of means for meeting the requirements for 1918. These planners concluded, as inevitably they must have done, that a tactical solution was demanded which would make optimum use of the weapons and manpower available without extensive re-equipment or reorganization. They found their solution in infiltration, following the concepts pioneered by Hutier at Riga.

The tactic of infiltration was not, in itself, an innovation in 1917, or for that matter, in World War I. Infiltration had been used with considerable success in local limited-objective attacks by both the Germans and the French at Verdun in 1916. But this infiltration had been by individuals and patrols from the conventional skirmish line. In some cases special "assault groups" of two or three rifle squads with supporting pioneers, machine guns, and mortars had been used. In no case was large-scale exploitation attempted either by the infiltrators or by closely following reserves.

The factors deemed requisite for success in the 1917 study were the following: (1) surprise; (2) finding and penetrating weak points in the enemy defenses and avoiding prolonged attack against formidable defenses; (3) rapid, violent, and deep exploitation of penetrations; (4) maximum fire support at all times; and (5) maintaining momentum of attack.

The following measures were adopted to achieve these factors:

1. Surprise

- a. Elimination of the long premonitory bombardment by limiting artillery preparation to not more than four hours, and other measures to minimize indications of the time of attack.

b. Concealing buildup of artillery by limiting registration fire of newly arrived batteries.

c. Moving troops forward at night and holding them in concealed assembly areas.

d. Maintenance of deception by false preparations along the entire front.

2. Penetration at weak points

a. Establishing and training in the tactical doctrine that attacks were not to be pressed against areas of strong resistance but were to be pushed to the limit and closely followed up where resistance was weak or ineffective. This doctrine was to apply at all echelons from the squad to the field army.

b. Points of strong resistance were to be bypassed by the assault elements and dealt with later by successive echelons.

3. Exploitation

a. Where penetrations occurred the penetrating units, of whatever size, were to continue the attack straight ahead.

b. Units in close support were to follow the penetrating unit and exert pressure against the flanks of the penetration.

c. Forces of regimental and division size were to widen the gaps by increased pressure against their flanks and rear, using the same infiltration and weak-point tactics by which the gaps were created.

4. Maximum fire support

a. The infantry squad (a 14-18 man half-platoon in the German army) was to be reinforced with an automatic rifle (or light machine gun) and a light mortar. (The automatic rifle generally was the 20-lb. Madsen, though some Bergmann (26 lbs.) and Parabellum (22 lbs.) rifles no doubt were used.) The automatic rifle and the mortar were to serve as bases of fire on which the riflemen in the squad maneuvered.

b. The rifle grenade launcher (recently adapted from the French Vivien Bessieres grenade cup) was distributed to the rifle squad and the allotment of hand grenades increased.

c. Light artillery pieces were attached to the infantry to displace forward with the rifle battalions and provide immediate close fire support.

d. Battalion machine-gun companies were assembled close behind the assault infantry and individual guns detailed to move ahead, find cover, and provide supporting fire overhead and through the intervals between infantry formations.

e. Supporting light, medium, and heavy guns were not to be emplaced rigidly in line as had been customary, but irregularly in covered positions, from which they were to displace forward by bounds providing uninterrupted fire support.

f. Direct support of fighter and light bomber aircraft delivering fires on targets of opportunity such as enemy pockets of resistance and enemy reserves moving up and reconnaissance aircraft adjusting artillery fires.

5. Maintaining momentum of attack

a. Engineers were attached to the assault elements with hasty bridging materials to facilitate the advance of accompanying artillery and supply vehicles.

b. Leading assault elements were given no objective points but rather were instructed to push straight ahead regardless of delays to flank elements.

c. Reinforcements and replacements, especially of automatic rifles and mortars, were to be fed directly from rear to front and replacements of exhausted or decimated assault units was to be accomplished in the same way. In addition, local successes were to be promptly and strongly developed and expanded by closely following reserves of infantry, machine guns, and artillery.

If the foregoing appears to be a summary of modern battlefield tactics, that impression is correct. Ludendorff's innovations of 1918, especially in the organization, equipment, and tactical employment of the squad, were the basis for current organization and battlefield tactics. The modern combat team concept is an extension of Ludendorff's squad organization, and combat team tactics are, on a larger scale, those of Ludendorff's squads.

It is perhaps of interest to note that this innovation went contrary to some fundamental concepts held by German officers of that period. First, by breaking up the company and battalion into small, semiautonomous units it nullified the tight control on which German doctrine long had insisted. Second, it affronted German thought by giving great tactical responsibility to non-commissioned officers and soldiers. Nevertheless, the German army already had shown its receptiveness to the lessons of combat when it triangularized the infantry division in 1916, years ahead of any other.

Upon adoption of the Ludendorff theories by the German army, far-reaching measures were instituted to put them into effect. All men over 35 were transferred from active infantry organizations

to those on occupation duty, and men under 35 were transferred from the latter to active units. All divisions, including those on the Eastern Front were put through a program of intensive training in the new tactics during the winter of 1917-1918. It was stressed in this training that the task of unit infiltration was not one for specialists but a function of all infantry. In addition, artillery was trained not only in firing from defilade but in map registration, the use of forward observers with improvised signalling, and maintenance of a creeping barrage moving at about 40 meters (44 yards) a minute.

The new tactics were put into effect against the British First, Third, and Fifth Armies on March 21, 1918, between Noyon and Arras. The attack was preceded by a short but heavy artillery preparation, using about 50% gas, against artillery positions, command posts, road junctions, vehicle parks, and other sensitive areas behind the front. After about two hours the bulk of these fires were shifted to the British front and support lines and, after another two hours, the German infantry began moving forward behind a creeping barrage. A feature of this barrage was that it was delivered by specially designated batteries, so that there was no abrupt cessation of fires, with consequent warning that the infantry assault was starting.

The infantry squads performed as expected, assisted in surprise by a heavy fog which, however, prevented the planned air support until after it had lifted and, to some extent, hindered machine-gun and close artillery support. The ultimate result of the new tactics was a maximum German penetration of some 40 miles in 15 days, which took the German Second Army within nine miles of Amiens, a crucial rail center. No such penetration had been achieved by any of the belligerents on the Western Front since September 1914.

It seems probable that the German strategic objectives would have been attained had their logistical capabilities measured up to those they had developed tactically. By April 5, when the advance finally was halted, their troops were exhausted, without food and ammunition, and had far outrun their artillery support. This logistical failure has been generally attributed to the German election to conduct the offensive over terrain they themselves had utterly devastated in their withdrawal to the "Hindenburg Line" in 1917. In it they found nothing whatever to sustain themselves or to help themselves forward, having to depend entirely on what they could move forward by their own efforts over a wide extent of shell-ravaged, roadless ground cut laterally by deep trench systems and heavily laced with wire.

Ludendorff tried four more offensives in subsequent months. All failed, not only because of the inability of German artillery and supply to keep up with the infantry advance, but also because losses were exhausting and discouraging the German infantry, and because the Allies (specifically Foch) quickly perceived what the Germans were doing, and took adequate countermeasures.

Despite strategic failure, the tactical lessons of the 1918 German offensives impressed themselves deeply on the Allied commanders. Using adaptations of the same tactics, on August 8, 1918, the Allies launched their own counteroffensive, which was to continue without cessation until the Armistice of November 11, 1918. Postwar reorganizations of all armies were based in some degree on the German 1918 tactics.

Perhaps the salient feature of this tactical innovation was its revolutionary use of the squad. Prior to 1918 the squad universally had been an internal element organized for low-echelon administration and for convenience in maneuvering from column into line and back into column. Since 1918 the infantry squad has been a tactical element, organized for fire and movement within the platoon and company. The squad organization and tactics devised by Ludendorff have been extended to the battalion, regiment, and division, so that each is now a tactical element capable of maneuver on its own base of fire. In 1937 field experiments under direction of Brigadier General Leslie J. McNair led to adoption by the US Army of the triangular division, itself a combat team capable of fragmentation into various combat teams of lesser magnitude and specific capabilities.

The Ludendorff innovations of 1918 may thus justly be regarded as revolutionary, with an impact on the conduct of battle comparable to those imposed by the Macedonian phalanx, the Roman legion, compact bodies of archers in defense, and the advent of gunpowder.

GERMAN DEVELOPMENT OF THE PANZER DIVISION IN THE INTERWAR PERIOD

The period following World War I proved to be a 20-year interwar period. It provided an opportunity for armies to assimilate fully the advances in weapon lethality that had been introduced during the war--notably the tank and military aircraft. The means of assimilation was the concept, based on the German innovations of 1918, which this study has named the 20th-Century

Combat Team. This is the combination of a base of fire and a maneuvering element, each given a composition related to the other and to the over-all plan. The armored division of 1940, the air assault team, and the Anglo-American landing team, demonstrate the application of the base of fire and the maneuvering element in a way that fully exploits the capabilities of air transport, combat aviation, armored vehicles, landing craft, and naval gunfire. The joint service task force is an attempt to concentrate the lethality of two or more services on the execution of a single mission.

The Tank in World War I

The modern armored and tracked weapon carrier, known generally as the "tank," had been developed during World War I for a single specific purpose. It was designed to beat a path for infantry in frontal attacks against entrenched and wired-in rifles and machine guns. Thus the tank was developed and employed solely as an instrument of rupture.

Tanks were developed in England and France more or less concurrently. It was the British who first introduced them into battle, on September 15, 1916, in the hope of revitalizing the British offensive which had bogged down on the Somme.

In France at the time were two companies with 60 tanks, few of whose officers and men had ever before seen a battlefield. The tanks were distributed without regard to organization among nine divisions attacking on a three-mile front. Of the 60 tanks available, only 49 were able to leave their parks, of which number 36 reached the line of departure. These 36 tanks attacked ahead of or with the infantry with excellent local results, only nine returned under their own power. The rest were disabled by mechanical breakdown, ditched, or put out of commission by enemy fire.

Seven months before the first commitment of British tanks, Colonel Ernest Swinton, one of the early protagonists of the tank, had prepared a draft doctrine for employment of armor. In it he made these points:

1. Some means of communication other than through the accompanying infantry should be worked out.

2. Artillery and mines were most to be feared. The former should be taken under counterbattery fire, but no means was suggested--or then existed--for rapid communication and fire adjustment from a moving vehicle.

3. These machines should not be used in driblets (emphasis Swinton's), in order to keep their existence secret until sufficient were ready and their crews trained for "one great combined operation."

4. The sector of attack should be carefully chosen to comply with the tank's limitations and enhance its capabilities.

5. Approach to the line of departure should be at night from assembly areas not more than two miles back. The attack should start just before dawn.

6. The tanks should precede the infantry by a distance sufficient to allow the enemy's rifle and machine-gun fire to be concentrated on the tanks when the infantry reached its attack objectives.

7. Once the infantry arrived, the tanks should move on to the next trench line, bringing it under enfilade fire and attacking reserves and bombing-parties moving up.

8. The tank attack should be in such force that it could continue without halting through the enemy's artillery positions (about 12 miles).

9. The momentum necessary to achieve deep penetration in a single attack would require carefully planned logistical support to assure a continuing adequate supply of fuel, ammunition, and other necessities.

10. Aircraft should accompany the tank attack to take under fire hostile batteries threatening the armor advance.

11. Smoke should be used to conceal the tank attack to the maximum extent possible.

To the armor officer today these rules must come as truisms with perhaps a sententious taint. But in 1916, and for a long time thereafter, they seemed radical, based on undemonstrated theory, and contrary to the lessons of experience. As a matter of fact, many of these rules did fail to take into account the limitations of the contemporary tank. They were as far ahead of World War I tank performance as the tank itself was ahead of that war's weaponry.

The first attack was not very successful. Then at Cambrai on November 20, 1917, the tankmen were given an opportunity to put their theories to the test in a limited-objective attack on a six-mile front. Of more than 450 tanks available, about 300 reached the line of departure. More than half of those committed were disabled or broke down in the first 12 hours and most of those then remaining were either mechanically incapable of going on at the end of 24 hours or their crews were exhausted. Nevertheless a few tanks were collected for another day's fighting.* By the end of a second 24 hours of attack a salient 12 miles wide at its base had been driven six miles into German territory, the most spectacular penetration since 1914 and achieved in what was then an incredibly short time.

Since the battle, and especially after the German armored force exploits of 1940, much recrimination has been heaped on the British high command for its failure to appreciate the tactical virtues of the tank and to convert the Cambrai battle into a decisive penetration. Most of this criticism is frivolous and emotional. The World War I tank was not mechanically capable of sustained operation, it lacked the speed and range necessary for armor penetration, and its lack of other than visual communication made unplanned mass maneuver on the battlefield impossible. In other words, the tank of 1917 was no more capable of 1940 performance than was the 1917 airplane of 1940 performance, a point overlooked by both professional enthusiasts and amateur critics in both areas of weaponry.

Most frivolous of all is the allegation that "improper armor tactics" were used at Cambrai. The tactical mission of the tanks there was rupture, and this they achieved. Any failure adequately to exploit the rupture resulted from many factors, some of them within the control of the British command, some of them not.

* The numbers used in the foregoing compilation of tank strengths at Cambrai are necessarily approximate. There is much disagreement over these numbers among the authorities and no complete statistical tabulation has been found of commitments and losses on the basis of time or other phasing. Even Liddell Hart (The Tanks, I, pp. 128-153), who presents a detailed and circumstantial account, does not attempt to detail losses beyond the first 12 hours and nowhere summarizes statistically total tank commitments and numbers or categories of casualties.

Perhaps the most valid lesson of Cambrai, but one that was not to impress itself on the world's soldiers for many years, was that the prime virtue of the tank was its ability to control ground without necessarily occupying it. Recognition of this factor was to be the basis for later audacious exploitation of tank successes which some thought (erroneously) violated the classic principles of security and mass.

A lesson which did impress itself, although too narrowly, was the overwhelming moral effect of tank attack. Major General J. F. C. Fuller observed of the tank at Cambrai that its "pre-dominant value was its moral effect. It showed clearly that terror and not destruction was the true aim of armed forces." Of all the nations to go to war in 1939 the Germans alone had written this lesson into their armor doctrine.

Armor Between the Wars--Thought and Practice

The years between the World Wars saw a peculiar ambivalence in military thinking about armor among the western nations. The enthusiasts, among them Fuller in England and Major General J. B. Estienne in France, were remarkably prophetic, although their theories were beyond the capabilities of the contemporary tank. Perhaps this fact, coupled with their sometimes impetuous prosecution of their cause, contributed to underestimation of the latent capabilities of armor by their superiors. On the other hand, there was an understandable reluctance to supplant proven weapons and doctrine with those that still were experimental. And the existence in all western armies of a degree of apathy toward innovation itself cannot be denied. In France, for instance, Defense Minister Paul Reynaud sought to introduce armored formations in 1935, a proposition successfully opposed by military as well as political leaders.

This summary estimate of course oversimplifies the problem. There were many factors operating against the armored force concept, some of them basic and some stemming from national temperament and politics. Among these were French reliance on powerful static defense and Britain's faith that its Air Force and Navy would render land warfare obsolete. And throughout the West had swept a wave of militant pacifism that, especially in the United States, simply denied the relevance of war to international intercourse.

In all of the major western armies the tank continued to be considered solely as an instrument of rupture, tied closely to the infantry, to which it was merely an auxiliary. This concept was supported not only by the experience of World War I but by the fact that there was a residue of thousands of tanks from the war for whose replacement funds were rarely available. The slow speed (4-8 mph), limited range (12-25 miles), mechanical unreliability and inadequate armor and armament of these tanks held the armored units to the pace and doctrine of infantry until the old tanks were worn out.

Improvements in tank design and performance, especially in suspension armor, power plants, transmissions and communication facilities, resulted between the wars in a series of tanks of increasingly better speed, range, trafficability, mechanical toughness, and maneuverability in mass. Nevertheless, the doctrinal fixation on the tank as an infantry support weapon continued to restrict its armament to antipersonnel automatic weapons and small-bore cannon. Very few tanks in any army at the outbreak of World War II possessed an antitank capability, although the doctrine espoused by the exponents of armor must inevitably have resulted in tank vs. tank battles. This possibility was vaguely foreseen and provided for, in the general sense, by heavy armor in France and high mobility in England. The eventuality does not seem to have impressed itself on planners in the United States, where armor was restricted by law to employment as an infantry weapon.*

England maintained its Royal Tank Corps at greatly reduced strength and developed armor along two distinct lines: the "cruiser" tank to operate in all-tank units and the "cooperation" tank to work directly with and under control of the infantry. The United States experimented with mechanized combined-arms forces at Fort George G. Meade in 1928; at Fort Eustis, Virginia, in 1930; and in 1932 established the 7th Cavalry Brigade (mcz) at Fort Knox, Kentucky. In order to accomplish the last the Army found it necessary to adopt the absurd expedient of designing cavalry tanks as "combat cars" to circumvent the statutory restriction on tanks as infantry weapons. France maintained tank battalions for the sole purpose of infantry support, and even when, just before World War II, it began to organize armored divisions, could not resist the temptation to fragment these for distribution within its infantry.

* This was the result of an interservice squabble between Infantry and Cavalry, with the Infantry proving better lobbyists.

The German Approach

In Germany the story was quite different, although at first for reasons of necessity rather than because of superior foresight and imagination. The Versailles Treaty limited Germany to an army of 100,000 men and specifically prohibited to it armor and combat aircraft. Although Germany had undervalued the tank in World War I, largely no doubt because of industrial constraints, much stress was placed on armor and armor doctrine in its surreptitious postwar training in Russia under General Hans von Seeckt. It is true that German attention was directed toward mechanization primarily by the need for some substitute, such as high mobility, for the manpower denied it at Versailles. Nevertheless, its experience with experimental application of armor in field training led ultimately to a means of meeting this requirement that was to produce vast and impressive military results.

In its training areas in Russia the German army evolved the armored division with organic motorized infantry and engineers. Development of self-propelled artillery, except as a short-range infantry arm (assault gun), was slow. Training initially with mocked-up trucks in lieu of the tanks denied them by the treaty, the Germans developed a doctrine of surprise and speed in armored operations far ahead of anything envisaged by the former Allied countries.

This development did not come about with the universal approbation and support of the German military hierarchy. Armor enthusiasts in postwar Germany met with much the same obstacles of inertia, parochialism, and downright antagonism that were frustrating those in the Western armies. But in Germany certain powerful factors were working for them which were denied their Western counterparts:

1. Absence of a rigid tactical doctrine inherited from World War I;
2. Complete lack of any surplus World War tanks requiring doctrinal conformity to their limitations.
3. The fact that the first tanks the Germans were able to buy or build possessed performance characteristics closely approximating those essential to realization of the most advanced theories of armor employment;

4. Development of voice radio to the point where it was available for command and control at the time the first German tanks were built; and

5. The recognition at all echelons of the requirement for some substitute for, or augmentation of, the army's treaty-limited military manpower.

Farsighted as the German doctrine and organization were relative to those of the Allies, armor remained with them an instrument of rupture. To make optimum use of this concept, armored corps were formed, with motorized infantry divisions designed to exploit the successes of the rapidly moving tanks. In the absence of organic self-propelled artillery, the Luftwaffe was induced (not without difficulty) to provide dive-bomber (Ju-87) formations to substitute for mobile artillery under the relevant group commander. Ultimately these dive-bombers were equipped with screaming devices to maximize the moral effect stressed by Fuller.

This employment of aircraft did not originate with the Germans. Swinton pointed out its utility in his 1916 draft armor doctrine. Fuller wrote in his Lectures on FSR III (1932) that "the tank and the aeroplane are complementary machines and for a long time to come the one is unlikely to be able to operate safely without the other . . . in future warfare cooperation between tanks and aeroplane is likely to prove far more important than cooperation between tanks and infantry." And in the British offensive at Amiens in August 1918 a squadron of two-seater Armstrong-Whitworth aircraft was allotted to the Tank Corps for close support. Yet it was the Germans, under the dual pressures of necessity and field experience, who really developed the tank-air team.

By the early 1930s the German Army had placed orders for construction of 37mm gun light tanks and 75mm gun medium tanks, to be built of mild steel rather than armor plate. Under the impetus provided by Lt. Col. Heinz Guderian, an armored force began to take shape in 1931, and in 1932 training tanks were constructed on a number of Carden-Lloyd tracked antiaircraft mounts purchased in England. These vehicles actually went into battle in 1939-1940 as the Mark I tank.

With the advent of Adolf Hitler as chancellor in 1933 the fortunes of the young German armored force brightened immediately. Not only did Hitler approve and support its aims, but in 1934, he began overt construction of tanks fully armored and designed

to conform to the new doctrinal requirements. So energetically was this work pressed that on October 15, 1935, Germany's first three panzer divisions were organized.*

These 1935 panzer divisions were constituted as follows:

One panzer brigade consisting of two panzer regiments, each of two 4-company tank battalions. Average company strength in combat tanks was 15.

One motorized rifle brigade of one rifle regiment and one motorcycle battalion.

One antitank battalion of three companies.

One armored reconnaissance battalion of two armored car companies, one motorcycle company, and one mixed company.

An artillery regiment of two battalions (six batteries) of truck-drawn light howitzers.

A signal battalion.

A light engineer company.

(As reorganized after the 1939 Polish campaign, the panzer division was strengthened by addition of an antiaircraft battalion, an air reconnaissance squadron, and a supply battalion, and the engineer company was strengthened to a battalion. As will be seen, this table of organization was not rigidly observed.)

This organization and the doctrine for which it was designed were tested and confirmed in the Spanish Civil War (1936-1939), producing vivid evidence which the Western powers either failed to discern or ignored. Air reconnaissance and the use of dive-bombers as long-range artillery were tested and succeeded brilliantly. The German tactics of 1940 were clearly forecast for all who cared to see.

* Hitler realistically sought to avoid a long and costly war on the 1914-1918 model, which he called "a degenerate form of war."

The Panzer Division in World War II

At the outbreak of World War II in 1939 Germany mustered six armored divisions and four motorized infantry divisions designed for exploitation. In addition, three "light divisions" had been organized at cavalry insistence for the traditional cavalry roles of reconnaissance and exploitation. In the Polish campaign the panzer divisions were used, as were tanks in World War I, as instruments of rupture, and the nature of this campaign was such that the true exploitation potential of armor formations was not fully realized. The "light division," however, was found not to justify its existence, and the three were converted after the campaign into panzer divisions. A new panzer division was formed, so that for the 1940 invasion of France ten panzer divisions were available.

These ten divisions were equipped with 2,574 tanks, all but 135 of which (used for command) were combat vehicles. The 2,439 combat tanks represented four German and two Czech models, of which the German Mark II, armed with 20mm guns, was by far the most numerous (40%). Their fighting capabilities were estimated by General Franz Halder, Army Chief of Staff, as follows:

Tank I can be employed only against a weak and demoralized enemy.

Tank II is but little stronger; not good against tanks.

Tank III effective against enemy tanks.

Relatively ineffective against infantry

Tank IV effective against enemy tanks.

Good effect also against enemy infantry.

Sixth and Eighth Armed Divisions, which have Czech tanks, are considered outstanding.

The German strategic concept for operations in the west had at first been a modification of the Schlieffen Plan of 1905: a sweep by a very heavy right flank hinging on Metz to cut off the French army from Paris and crush it against a static left flank in Alsace-Lorraine. The 1940 plan differed from that conceived in 1905 and executed in 1914 in that the neutrality of Holland, as well as of Luxemburg and Belgium, would be violated and the mobile right wing would be mechanized and armored.

The French and British, who anticipated just such an operation, were handicapped in their efforts to meet it by the refusal of the three threatened neutrals to permit any preparatory

coordination or even joint planning. To add to the Allied difficulties, a German air courier carrying a copy of the plan landed by error January 11, 1940, on a Belgian airfield. The British were given clandestine access to these documents, with the result that the Allies were confirmed in their expectation of a Schlieffen operation, were looking in the direction of the Low Countries, and deserted prepared defensive positions to move that way when the German attack was launched. Meanwhile, the Germans had changed their plan, to place their main effort through the Ardennes. So, when the Allies moved northward into Belgium, they were encouraged by the Germans, who imposed no opposition to their advance.

During the fall and winter of 1939-1940 General Erich von Manstein, Chief of Staff of Army Group A, with the support of his commander, Col. General Gerd von Runstedt, suggested a penetration attack through the Ardennes Forest. This suggestion met with much opposition within the Army, but on February 17, 1940, Manstein was able to put it personally before Hitler. The result (partly because of the suspected compromise of the earlier plan) was that on February 20, 1940, a new operation order was issued, embodying Manstein's concept and assigning a third army to Army Group A, which was to conduct the main effort under the new plan.

Meanwhile at a lower echelon a series of events was taking place which were to prove as important tactically as Manstein's efforts had been strategically. Guderian, now a general commanding XIX Panzer Corps, had been vigorously urging employment of armored forces for exploitation as well as for rupture. His efforts had met with skepticism in the army high command until he took part in two important map maneuvers February 7 and 14, 1940, both attended by Halder. At both of these he played his corps in an exploitation role with unmistakable effect. Halder was won to Guderian's views, and the use of Guderian's armor in exploitation after the May breakthrough enabled him to maintain the momentum which took him to the Channel in 15 days.*

* Guderian maintained after the war that Halder was not convinced and that the armored exploitation in France was carried out on his own initiative. Manstein, who was present at the map exercises, noted that Halder was impressed, and Halder entered in his diary under date of February 14 his conviction that an armor echelon for exploitation must follow the rupture echelon. Even so, Halder two days later privately confessed his "inner doubts on prospect of ultimate success."

While Germany was thus preparing an armored blow with materiel, crews, and doctrine attuned to a pitch never before attained, belated efforts to organize armored forces were begun in France and England. The French concept of armor solely as an infantry support weapon held so firmly that, although in 1938 steps were taken to mass armor for special missions, the first French armored division was not formed until September 1938. This division consisted of four battalions of heavy tanks formed into two demi-brigades and two battalions of motorized infantry, with rudimentary support elements. In January 1940 a second such division was organized, and by May 1940, a third was in existence and a fourth in process. By this time each demi-brigade had been reorganized to consist of one battalion of 34 heavy tanks and one of 45 light tanks, a total in the division of 158. The motorized rifle contingent had been reduced to one battalion and the artillery to two groupes of 12 truck-drawn guns each. These divisions not only were under-equipped and partly trained when committed to battle but, in the main, they were committed piecemeal and with little effect.

Great Britain, although it contained some of the most advanced and articulate advocates of armored warfare,* lagged even behind France in development of the armored division. As has been noted, tank development and doctrine took divergent directions, infantry support on the one hand and all-tank organizations on the other. But, despite much experimentation with mechanized formations of various sorts, the first armored division was not organized in England until 1938, actually as a mechanized cavalry division. The first armored division along modern lines was started in April 1939. It consisted of two tank brigades, one light and one heavy, of three regiments (actually battalions) each, with a total complement of 321 tanks, one motorized rifle battalion, and a "support group." This last included a 16-gun motorized artillery regiment and a company of engineers. The division was not fully equipped at the outbreak of war, did not reach France until after the German victory, and was not engaged.

Thus, when Germany attacked, on May 10, 1940, France and Great Britain had on the ground 56 French and two British tank battalions, a total of 58, plus some British light cavalry tank battalions. German tank battalions totalled 35, organized in 10 panzer divisions, some of which were short their complements

* For instance, Swinton, Fuller, B. H. Liddell Hart, and Lt. General G. le Q. Martel.

of tank units. French and British tanks available totaled about 2,700 while those in German units were 2,574, and another 800, mostly light, in reserve, a total of about 3,500. Further, the French and British tanks were, except in a few instances, qualitatively superior to the German.

The German attack was launched on May 10, 1940, by Army Group B (von Bock) in the north with two armies under his command, Army Group A (von Rundstedt) in the center with five armies, and Army Group C (von Leeb) in the south with two armies. Von Bock's mission was to penetrate Holland and Belgium north of Aachen, while that of von Leeb was to pin down the large French forces in and behind the Maginot Line by threats and demonstrations. Von Rundstedt's was the principal mission, to break through to the Channel and cut Allied forces north of the Somme from the main French armies to the south.

Opposed to the main German thrusts in the north and center were the Dutch and Belgian armies and French Army Group I (Billotte), composed of six armies and the British Expeditionary Force. The problem of command was complicated not only by the refusal of the neutrals to coordinate a defensive plan but also by the insistence of the British commander (Gort) that he was not subject to Billotte's orders but only to those of the French commander in chief. Facing von Bock were the BEF and the French Seventh Army (Giraud), the best trained and most fully equipped France had put in the field. Opposite von Rundstedt in the Ardennes was the French Ninth Army (Corap), with a large proportion of reserve divisions inadequately equipped, without anti-aircraft and antitank weapons, and made up of elderly reservists inferior training, discipline, and morale. This distribution of forces reflected the Allied preoccupation with a Schlieffen maneuver and the conviction of the French high command that the Ardennes was impassable by armor.

Seven of the ten panzer divisions were assigned to Army Group A and three to Army Group B. Von Rundstedt organized an armored army under General Ewald von Kleist for the Ardennes penetration and von Kleist nominated Guderian's XIX Corps for the spearhead.

Von Kleist's attack was preceded by heavy dive-bomber assaults on known Belgian positions and on targets of opportunity, to some of which they were directed by ground commanders. A rifle battalion was air-landed in Storch liaison aircraft at Vitry, some 30 miles ahead and just over the Luxemburg-Belgian border. Guderian's spearhead pressed rapidly through the Ardennes brushing aside weak Belgian and French resistance.

The major obstacle to be surmounted was the Meuse river, whose bridges had been demolished. Engineer parties from the panzer divisions' organic engineer battalions rushed the river line in rubber assault boats closely followed by infantry. When these detachments had sufficiently expanded their bridge-heads, engineer bridge units laid ponton bridges over which the armor crossed.

By the end of six days Guderian's panzer corps had penetrated more than 100 miles and appeared to be gaining momentum west of the Meuse. Hitler was so upset by this audacious thrust with its two long flanks that, in Halder's words, he was "terribly nervous and frightened by his own success." His insistence on protection of the south flank led to commitment to that task of a number of infantry divisions which could more profitably have been used for exploitation and widening the salient.

On the Allied side, the British and French north of the Somme were overwhelmed by the converging attacks of Army Groups A and B. South of the Somme some piecemeal and loosely coordinated efforts were made by elements of France's four armored divisions to break into von Kleist's south flank. In these efforts the 1st Armored Division was destroyed and a fairly well-coordinated attack by the 4th Armored Division (de Gaulle) was easily beaten off. The other two French armored divisions, distributed among the infantry, made no impression on the German advance.

The net result of the German concept of armor organization and tactics and their aggressive and imaginative employment of this arm was an unprecedented victory in western Europe. Reaching the Channel in 15 days, Kleist's armored spearheads turned north, joined with elements of Army Group B and penned the Allied forces between them and the Channel. Eight days after resistance in the north had ceased the regrouped German armies struck southward across the Somme and within less than a week France capitulated.

Conclusions

The German successes in 1940 may be attributed generally to these factors:

1. Early recognition of the probable impact on battle of a weapon which theretofore had received only limited and inconclusive tests.

2. Freedom from the inhibiting effects of large stocks of tanks of limited performance remaining from World War I.

3. The requirement for some substitute for or augmentation of the limited military force allowed by the Versailles Treaty.

4. Exploitation of the potentialities of armor by developing doctrines and organizations around it rather than forcing its adaptation to organizational and doctrinal concepts already existing.

5. Constant experimentation and testing to obtain maximum effectiveness from qualitative improvements in the weapon and the impact of these improvements on organization and doctrine.

6. A readiness to accept and adopt the results of these experiments and tests despite sometimes vigorous opposition from within the Army.

7. Boldness and imagination in employment of armor, especially in exploitation and the maintenance of momentum, that actually multiplied its inherent advantages and those of the organizations and doctrines developed for its use.

Pertinent to all of these factors is the enforced German delay in construction of armored vehicles until most of the early mechanical limitations had been overcome and a system of rapid voice communication had become available.

DEVELOPMENT OF COMBAT AIRCRAFT

TO SUPPORT GROUND COMBAT

World War I

In a span of only 11 years, from the time of the first powered flight in 1903 to the outbreak of the First World War, the airplane was developed into a weapon of combat. The first aircraft were intended to supplement the carrier pigeon for communication and to aid cavalry with reconnaissance. In 1907 the US Army established an Aviation Section of the Signal Corps for

this purpose.* The evolution from the reconnaissance plane, used solely for observation, to the fighter plane was not long in coming with the attachment of a machine gun which could be fired through the propeller of the plane. Thus, although observation still remained an important function, active fighting now lay within the plane's capability. Increasingly, the task of gaining air control over the battlefield became the role of these flying guns.

The idea of placing machine guns in airplanes was conceived early in the war on both sides, but the technical shortcomings of both weapon and aircraft of the day made it difficult to place guns that would load and fire efficiently on the wings, outside the radius of rotation of the propeller blades. A logical solution was to put the machine gun in the cock pit, beside the pilot, so that he could aim plane and weapon simultaneously at a foe, in the air or on the ground. The trouble with this, however, was that machine gun bullets struck the propeller, soon sawing it off.

The French improvised a crude solution by fixing steel plates to the propeller blades, thus deflecting bullets that would otherwise strike them. The Germans soon took the lead in this area of development when they mounted an efficient fixed machine gun in the Fokker monoplane--having already observed the crude French device in a captured plane. The German gun was synchronized with the propeller, so that the bullets went out between the whirling blades. The French, in turn, improved upon the German development with their Nieuport in 1916. The practice of mounting machine guns in the wings, however, continued to a limited extent.

By the end of the war three separate types of planes emerged: the observation plane, the fighter and the more heavily constructed bomber, usually a multi-engined aircraft.

The combined fighter-bomber developed in 1917 by British Lord Trenchard was one of the most important steps forward. This was a fighter plane slightly modified to carry up to four light (25 pound) bombs for ground support purposes. The plane's characteristics remained unchanged; thus, after a fighter had achieved its main objective of superiority in the air, it could then be employed in ground support, either by using its machine gun alone, or by dropping its light bombs as well. In 1918, the

* From the outset American soldiers and aviators were considering ways of using aircraft for combat purposes as well.

use of the fighter-bomber contributed to the initial success of the great German offensives; similarly British fighter-bombers played a role in stopping those German drives. The British Somme counteroffensive (August 1918) and the American St. Mihiel offensive (September 1918) marked the first major utilizations of bombers and fighter-bombers in mass preparation for offensive battle.

The concept of aircraft as a separate arm was first officially recognized by the establishment of an independent Air Force (the RAF) in Britain in 1918. In general this contributed to a more flexible and more aggressive use of airpower.

Between the Wars

The technological advances between the First and Second World Wars, particularly in propulsion and aircraft frames, which gave marked improvement in speed, range, and load-carrying capacity, saw the emergence of prototypes of the modern high-speed fighter planes and both short- and long-range bombers.

In Great Britain and Germany the low-wing, single-engine fighter was typified by such craft as the Hurricane, ME-109, Spitfire, etc. These planes were armed with as many as six or eight wing-mounted machine guns and could be adapted to carry light bombs in the fighter-bomber role. They could fly at speeds between 350 and 400 mph.

The two-engine, low-wing bombers (Dorniers, Heinkels, Blenheims), which also appeared during this period, were the pre-World War II prototypes of the modern light and medium bombers. Their increased range, greater speed, and larger cargo capacity permitted delivering a significantly more lethal load, and they could be mass-produced.

In 1935, the Americans produced the prototype of the strategic bomber. The B-17, or "Flying Fortress," was the first modern four-engine long-range bomber. With the similar B-24, and the more advanced B-29, the B-17 was to play a major role in the defeat of Germany and Japan.

In 1939, the British perfected fighter direction based on the new and revolutionary development of radar. With improved radio communications and control centers, radar was to make possible the most efficient use of the fighter-interceptor. The

increased effectiveness of the RAF fighters, individually and collectively, because of these new systems, perhaps gave the margin for victory in the Battle of Britain, although of course the qualitative superiority of the Spitfire over the ME-109 was of some significance.

One interesting use of air lethality between the World Wars was demonstrated by the British. They found that aircraft could be highly effective in the punitive role in minor border and tribal wars. Not only did this permit quick response, but it frequently obviated the necessity for costly punitive expeditions on the ground.

Genesis of Tactical Air Forces

The increased capabilities of the new fighters and light bombers furnished the means for creation of the first modern tactical air force: the German Luftwaffe. The Spanish Civil War provided a testing ground and gave the Germans (as well as the Soviets and Italians) considerable combat experience in the tactical employment of light and medium bombers, fighter-bombers, and fighters. Later the Luftwaffe, in conjunction with German armored and infantry divisions, made possible the rapid over-running of Poland, France, the Balkans, and western Russia. Their blitzkrieg tactics very nearly resulted in an early German victory in World War II.

Blitzkrieg owed much of its overwhelming effectiveness to the Germans' revolutionary handling of tactical air support. They welded the fighter plane, dive-bomber, and medium bomber into a weapons system of tactical warfare within the blitzkrieg concept. The invasion of Poland was the first example of highly effective close tactical air support, although both the Germans and British had experimented with the idea, using fighter-bombers during the last part of World War I. The Germans accomplished the coordination of aircraft with armored vehicles which had been visualized by far-sighted Englishmen like Swinton and Fuller some 20 years earlier.

The enveloping movements of armored columns were supported by aircraft (dive-bombers and fighter-bombers) performing the three basic functions of tactical air power: (1) gaining air superiority by defeating the enemy in the air and by destroying or neutralizing enemy air bases; (2) interdiction of enemy lines of communication to inhibit movement of reinforcements and

supplies; (3) close support of ground forces by the attack of battlefield targets (flying artillery). The Germans initially placed the most importance on flying artillery since their first opponents could give but weak resistance in the air. After the eight months of "phony" war, the pattern was continued in Holland, Belgium, and France. Here again, ground movement was strongly supported by Stukas and Messerschmitts, which also performed the mission of flank protection.

Later World War II Tactical Air Developments

Ironically, it was the British and the Americans who went on to exploit the full potentialities of tactical air support. The most important developments after the beginning of the war took place in the Middle East theater, where the RAF played a major role in stopping Rommel's drive into Egypt. Procedures for flexible cooperation between air forces and ground elements were worked out between the local British commanders who, for the first time, spelled out the three classical missions of tactical air support which had been demonstrated by the Germans. The principal difference between the British and the German methods was in the relationship of air and ground command. In the German system the air commanders were subordinate and were forced to deploy their units in accord with the desires of the ground commanders. This caused no problems so long as there was no substantial air opposition. But the British discovered that they could be assured of air superiority over a dangerous foe only if their first objective--regardless of the course of the ground battle--were to be to obtain such air superiority.

The Americans at first followed the German system, but after suffering serious losses in the air and on the ground in early actions in Tunisia, adopted the British system, which became accepted American air doctrine. There has been much postwar controversy over the validity of this doctrine, and there must be serious question of its validity in the light of dramatic changes which have taken place in aircraft. But with the weapons on hand in 1942-1945, there is little doubt that the doctrine then adopted was the one which best exploited the capabilities of the aircraft then available.

In the Pacific war the problem of priority of fighter task allocation was never so serious as in North Africa and Europe. This was partly due to geography, and partly because, after the early months of the war, the Japanese were not capable of offering

the same kind of opposition in the air as the Germans did in the West. Accordingly, the roles of Army, Navy, and Marine Corps aircraft in tactical support were very similar to that of the Luftwaffe in its early European campaigns. The most significant use of aircraft in the Pacific campaigns was in softening up beachhead defenses, and in supporting landings. In the central Pacific these functions, and subsequent close air support of the ground operations, were performed mainly by carrier aircraft.

In the Southwest Pacific the air support mission was almost always accomplished by Fifth Air Force fighters, operating from fields within 500 miles of the beachhead. Only in the Hollandia and Leyte landings were the assault troops initially dependent upon carrier-plane support. This was highly effective in both instances, although the results of the naval battle for Leyte Gulf very briefly permitted Japanese land-based aircraft to gain air superiority over the beachhead from the depleted American carrier units. The hasty construction of airfields ashore, and the expeditious arrival of land-based fighters, plus the arrival of carrier reinforcements, soon rectified this situation. No further serious air opposition was encountered by American ground forces in the Pacific war.

Air Transport

The logistical potentialities of aircraft were only dimly and incompletely perceived at the outset of World War II and were first fully exploited by the United States.

The employment of transport aircraft for airborne assault had been foreseen by most nations before the war, and this combat concept was developed further by the Germans and Russians. But the concepts of large-scale logistical support of ground forces by transport aircraft, of strategic air deployment of substantial ground units, and of regular and massive air evacuation of wounded were all pioneered by Americans, with substantial cooperation from the British. It was Americans and British, also, who brought airborne warfare to its greatest developments to date.

It was in the China-Burma-India theater of World War II that the most extensive use was made of the logistic potentialities of air transport. The operations of General Stilwell's force in north Burma (eventually reaching a combat strength of

more than six divisions) were completely supported by air supply for almost two years. The long-range penetrations of Wingate's Chindits (the accomplishments of which were substantially less significant than suggested at the time) were made possible only by airpower, including air assault, combat air support, and air logistics. Finally, the climactic successful offensive of General Slim's Fourteenth Army in central Burma was almost completely supported by air supply--at the same time that the Chinese-Americans were still operating on air supply further north--in a truly amazing display of the capabilities of air logistics.

The Impact of Jet Aircraft on Land Warfare

Jet propulsion for aircraft was developed almost simultaneously by the British and the Germans during World War II. The latter, however, under the pressure of Allied land and air assaults, pushed this development more quickly, and had jet fighters in operation early in 1945. This was too late, however, to affect the outcome of the air war.

Unquestionably the jet is more lethal than the propeller aircraft in air-to-air combat, simply by virtue of its greater speed and higher ceiling. The adaptability of the jet to tactical air support, however, is another question. Both jets and propeller fighter-bombers were used in support of ground forces in the Korean War and--once air superiority was achieved--the propeller craft provided the better support, from the standpoint of the ground soldier. The main reason appears to be that the speed of the jet has seriously reduced the aircraft's time over the target and has greatly impaired the pilot's ability to acquire and to attack targets of opportunity, or assigned targets, on the ground.

Weapons Relating to Tactical Air Support

There are two major varieties of weapons relating to the tactical air support of ground forces, aside from the weapons of air-to-air combat which permit, or restrict, the air superiority necessary for such operations. The first of these comprises antiaircraft weapons whereby ground forces fight back against the attacking aircraft. The second includes the weapons which the aircraft use against ground elements.

The first antiaircraft weapons were the rifles and machine guns of ground forces, used in World War I against the strafing fighters. These were generally ineffective and merely helped to sustain the morale of troops subjected to the somewhat terrifying experience. Later, specially mounted .30 caliber and .50 caliber machine guns were employed, with rudimentary sighting devices to permit them to "lead" the attacking planes. And some light cannon, with similar inefficient devices, were employed, to use high-explosive shell, with both percussion and time fuzes. Again, none of these was very effective.

Antiaircraft artillery was greatly improved in all countries between the wars, and the requirement to develop an effective antiair capability gave great impetus to the adaptation of electronic developments to military uses. By the outbreak of the war rather sophisticated computing devices were available which, in combination with modern optical equipment, permitted accurate tracking of aircraft, predicting flight-paths, and calculating range, altitude, and time of flight for a high-explosive shell to reach a predicted point of interception. This machinery could then electrically traverse and elevate the pieces (or make it easy for soldiers to do this manually by matching pointers) and set a proper time setting on time fuzes. The results would have been deadly--against World War I planes. But by the outset of World War II aircraft performance was such that even these marvelous weapons were relatively inaccurate, and did not account for a very high percentage of planes lost in the war.

As is pointed out elsewhere in this study, however, the development of the VT, or proximity, fuze, greatly increased the lethality of antiaircraft artillery. This capability has been still further enhanced, for relatively low-flying aircraft, by the development of radar tracking devices and by improvements in electronic equipment. The only trouble is that the increasing capabilities of high-speed, high-altitude aircraft have been largely offsetting.

More recent developments in antiaircraft weapons, involving large rocket missiles such as the Nike family, as well as such devices as target-seeking missiles, electronically guided missiles, and the like, are beyond the scope of this study.

In the field of air-to-ground weapons, primary reliance up to the end of the period covered by this study (1953) has been on the two first employed in World War I: machine-gun fire and small, antipersonnel, high-explosive bombs. There have been two important additions to these: the napalm fire-bomb and the

rocket, both of which came into use in World War II. Both of these have added to the actual effectiveness of air support, as well as contributing to the moral effect of air attack, which is perhaps its most important effect. In terms of actual lethality, air-to-ground weapons are considerably less effective than similar quantities of metal or high-explosives brought to bear against an enemy by artillery or small-arms. This is due mostly to a lower level of accuracy, as well as to the difficulty of effective action against entrenched troops. Nevertheless, moral effect is significant. Furthermore, there can be many instances when artillery can not be employed against targets that can be reached from the air--either because of terrain considerations, range, or inability of artillery to keep up with ground or airborne advance.

For various reasons, but primarily because of the rapidity and extent of changes since 1953, it is believed inappropriate in this study to discuss electronic and counterelectronic warfare as it relates to tactical air operations and defense against air attack.

THE AIR ASSAULT TEAM

The air assault team is, like the armored division, a type of 20th-Century combat team. Its troops, training, weapons, and tactics are tailored to a specific mission. The doctrine under which they are employed must be consonant with them and with the mission. Coordination is necessary not only within the team but with all other operating elements involved in the common military effort. In the case of airborne attacks, for example, one cardinal point of doctrine that has emerged is the necessity of a prompt linkup with conventional troops armed with heavy weapons.

Origins of the Airborne Concept

That airborne attack, sometimes called "vertical envelopment," has been a wistful goal of man since he invented organized warfare is well attested by mythology and folk legend. There are numerous tales of warriors on flying horses and troops carried by trained eagles, as well as Munchausen's story of riding a cannonball over the enemy lines.

Since the first flight of a hot air balloon in 1782 the prospect of delivering troops over the enemy's head to his sensitive rear has caught the imagination of many practitioners and dilettantes of warfare. And during the four-month siege of Paris in 1870-1871 a total of 65 balloons filled at the gas works carried on an airborne operation in reverse, lifting 23,485 pounds of dispatches, 164 passengers, and 381 carrier pigeons out of the city.

This operation demonstrated why no balloon-borne attack had been attempted in war and why it would have failed had it been attempted. Many of the Paris balloons landed in the German lines, some drifted out to sea, and at least one was carried to Norway before it returned to earth. Man's dream of flying to the enemy's rear clearly had to await some more tractable form of lift.

In 1903 the Wright brothers' invention led the way to that better form of lift. In World War I aircrafts' mechanical unreliability, limited payload capacity, and uncertain airworthiness precluded their use for the tactical delivery of troops in combat. Further, not until near the end of World War I was a compact portable parachute with quick release and a pilot chute perfected.

Interwar Development of Airborne Attack Forces

No one individual can be credited with the ultimate application of the airplane to tactical lift. By the end of World War I its essential requisites had begun to coincide in manageable form. Yet many factors, most of them unrelated to the technological questions involved, prevailed against its early realization. Prominent among these were:

1. Severely restricted postwar military appropriations which led to emphasis on procurement on combat rather than transport aircraft.
2. A philosophical trend toward "defense" in the Western world which directed attention away from aggressive tactics and the technological means for their implementation.
3. The extremely slow growth of civil aviation, with the result that there was no reserve of transport aircraft.

4. Slowness to grasp the existing potentialities for high combat mobility on land and its promise of prompt linkup with and exploitation of airborne assaults.

5. Divergent interpretations of the "lessons" of World War I by the Western powers, which militated against coordination of international military thought toward imaginative applications of its great technological advances.

6. The worldwide depression of 1929-1939, which diverted attention to immediate domestic problems and further curtailed support of military innovation.

Nevertheless, within the first decade after the war's end, several faltering steps were taken toward realization of man's ancient dream of lifting himself over an enemy's head.

It is perhaps pertinent that the most serious and persistent experiments in airborne operations were undertaken in the two countries whose political philosophies were overtly aggressive. The Soviet Union began tests in 1930 and Nazi Germany after the advent to power of Adolf Hitler in 1933. In both of these countries airborne development was carried to the point that both had parachute and air-transported units of division size ready at the onset of war in 1939.

Progress in the Western nations was more pedestrian. In the United States a small delivery of men and equipment by parachute was made in 1928 by the Army and occasionally thereafter. But it was not until 1938 that airborne operations were incorporated into doctrine and 1940 that organization and training of airborne units was begun. England organized no airborne units until 1940, although experiments there had been undertaken as early as 1927. France and Italy had no airborne formations prior to World War II.

Soviet Developments

The Russian development of airborne forces exceeded that of any other European nation, although in subsequent combat operations they were of relatively little worth. The failure of airborne troops to meet expectations in Finland in 1940, plus conclusions deduced from experience in the Spanish Civil War (1936-1939), led to de-emphasis on airborne operations until after the German successes in Holland in 1940 and Crete in 1941.

These brought about a revival of interest, but by the time of the German invasion of Russia (June 1941) only one parachute brigade in each of three projected corps had been fully equipped. Subsequent repeated failures in major operations, together with shortages of aircraft and the immediacy of combat requirements, led to employment of the troops principally as conventional land forces.

German Work

German development of airborne forces and doctrine was little publicized before 1940, but it was highly productive. Behind the early German success lay not only a realistic appreciation of the limitations of airborne forces but an equal regard for mission and objective in assessing their capabilities. Thus, with one or two exceptions, airborne units were not assigned tasks for which their necessarily light armament was not adapted, and prompt linkup with more heavily armed conventional forces was written into their doctrine.

The objectives chosen for airborne attack were reasonably within its capabilities, were not attainable in other ways, and were essential to subsequent operations. Finally, the principle of surprise was exploited to the utmost.

In the spring of 1940 Germany had available 4,500 trained parachute troops, concentrated in the 7th Parachute Division under command of the Luftwaffe rather than the Army. The parachute elements were organized in three rifle regiments supported by a signal battalion, an artillery regiment, an engineer battalion, and antitank and antiaircraft battalions. The auxiliary troops and one of the rifle regiments were transported in gliders.

In extension of the capabilities of this one Luftwaffe parachute division, the Army's 22nd Infantry Division (12,000 strong) was trained in airlanded operations. The transport aircraft employed for all airborne operations, parachute delivery, glider towing, and troop lift, was generally the Junkers Ju-52, a three-engine monoplane with a capacity of 22 equipped troops. The 1940 glider was the DSF 230, with a troop capacity of nine.

These two divisions, only one of which was an airborne division in the current sense, plus one rifle battalion that could be airlanded, constituted the entire German airborne capability on May 10, 1940, when the Western assault was launched. That

its accomplishments were out of all proportion to its size was the result of the imaginative doctrine already discussed, as well as of certain other tactical devices. One of these was the use of dummy parachutists to divert attention from actual drop zones and to increase the impression of strength in those zones. Another was intensive preliminary bombardment of the drop zones by aircraft and, where possible, by artillery.

German Success

The main airborne effort of May 10 was directed against Holland, with only 500 troops reserved for use in Belgium. The principal targets in Holland were the bridges at Rotterdam, Dordrecht, and Moerdijk, with The Hague a secondary target. Four parachute battalions and one airborne regiment were used against the three principal targets with complete success and negligible losses. The attack on The Hague, carried out by one parachute battalion and two airborne regiments, failed with severe casualties.

In Belgium, success was precariously achieved but was spectacular beyond expectation. The objectives of this operation were the two bridges over the Albert Canal west of the Dutch "Maastricht Appendix" and Fort Eben Emael which guarded the flank of this zone. The canal bridges were seized without difficulty but the Dutch succeeded in blowing the Meuse bridges in Maastricht, delaying the linkup forces from the east. This delay did not affect the outcome.

German Failure

German airborne operations were undertaken only four more times during the war. Only one of these was large-scale--the invasion of Crete. It constituted the only major operation in history carried out solely by airborne forces. But it so crippled Germany's airborne capability, in both troops and aircraft, that no subsequent major effort was attempted.

The assault on Crete was made by the 7th Parachute Division supported by the 5th Mountain Division from Greece. It was planned that immediate support would be provided by seaborne forces, but seaborne support was prevented by the British Navy. Although landing of the 7th Division was thoroughly protected by the

Luftwaffe against extremely meager British fighter defenses, the airborne forces, once landed, were unable to make progress and suffered prohibitive casualties. It was then decided to land the 5th Mountain Division. Even this reinforcement might have failed had not a landing been made under British artillery fire on Maleme airfield, upon which the core of the ultimately successful attack was built.

Observations

Although limited and generally experimental, German airborne operations yield some suggestive observations, some of which were substantiated by subsequent Allied experience.

1. In the German operations, particularly those of 1940, surprise was a highly important factor. Except at The Hague this factor was augmented by rapid and vigorous exploitation, presenting the enemy with no opportunity to recover and react.
2. Division of command between the Army and the Air Force led to difficulties which, had the operations been on a larger scale and the stakes more momentous, could have culminated in major disaster.
3. Unsupported parachute and glider-landed troops were inadequately armed, especially in artillery, armor, and antitank weapons, to match, as in Crete, a determined ground defense. By 1942 Germany had developed 75mm and 105mm recoilless rifles of limited range for airborne use and a tapered bore 28/20mm anti-tank gun; but none of these was used in a major operation.
4. Linkup with conventional forces within a brief interval after landing was essential to success in major operations.
5. Emergency use of the 5th Mountain Division in place of the trained 22d Air Landing Division in Crete demonstrated the adaptability of airlift to movement of all ground troops. The German commanders themselves promptly noted this fact.
6. The German experience clearly indicated two requisites for successful prosecution of airborne operations as a concomitant of the general application of military power, requisites which the Reich was unable to provide:

a. A massive airborne capability backed by an adequate replacement training system, depending, in turn, on an equally adequate supply of training aircraft and aircraft fuel.

b. An industrial base, competent and sufficiently flexible to meet a continuing requirement for materiel replacement, especially in transport aircraft, while conforming to equally urgent demands for materiel in other categories.

THE ANGLO-US LANDING TEAM

The battalion landing team (BLT), in its movement ashore, has an important similarity to the airborne assault team. In both cases, and in contrast to infantry during other attacks, while the appearance of the troops demoralizes the enemy to some extent, at the outset their weapons are relatively ineffective. Little or no fire is put forth by the infantry's organic weapons during the approach, the conditions being prohibitive. For protection, the landing force is wholly dependent on the fixed weapons (usually machine guns) on the transporting craft, supporting ship fire, including heavy guns offshore and closer-in rocket batteries, and air bombardment of the defending positions.

This is infantry in its hour of greatest moral and physical weakness. Indeed, the drain on the resources of men in the boat waves is invariably greater than on emplaced forces ashore, even though surprise may have been achieved and the over-water approach been relatively unscathed, and despite the direct assault's having been preceded by what is often described as an "overpowering" preliminary bombardment. In cold fact, nothing was proved more abundantly by World War II operations than the unique power of defending forces to survive "saturation" fire by air bombs and naval artillery when protected by conventional earthworks and to remain capable of quickly organizing effective resistance.

The men in the embarked assault force, meanwhile, are usually wretchedly ill from crowding on the transports, from sea sickness, and from the long strain of fearful anticipation during the haul shoreward, when they are doing nothing and although fired on are unable to fire back. It is proverbial that the moment of greatest weakness for troops in the amphibious assault is at the waterline. In World War II American combined forces thrice engaged in major assault against shores which the enemy chose to defend at the waterline, Tarawa (or Betio) in the Central Pacific, Salerno in Italy, and Omaha Beach during the invasion

of Normandy. Each battle came near being a great repulse and shocking defeat for the United States, with the issue remaining in balance for many hours. In all three cases the tide gradually turned because the attackers could bring up reinforcement more abundantly or rapidly than the defenders.

It must be noted that the BLT or embarked regiment moving in the attack against a defended shore cannot be evaluated separately as a lethal or shock element. Once it crosses the waterline, its object is to cross the beach and get to the shingle, and on from there to the high ground, just as rapidly as it can make the passage, with weapons and essential supply. Should it stay on the beach, it is doomed. Hence while boat teams are making their only advance as such, all advantage of "lethality" and weapons shock is voluntarily forfeited to the defending forces. Once the zone of fire is crossed and defilade, or other accident of ground, facilitates assembly of platoon, company, or battalion, the formation proceeds as it would in other field operations, using fire and movement to fragment and dislodge enemy forces. So the BLT is not a shock force but a terminological and administrative convenience. In this it resembles airborne maneuvering elements, but differs sharply from armor and infantry. The antique manual of landing operations published by the Joint Board in 1933 defines an amphibious landing as "in effect the assault of an organized defense position modified by substituting naval gunfire support for divisional, corps and army artillery, and generally navy aircraft support for army aircraft support." Experience requires the amendment that in the crisis of action, these offshore fires, inflexible as they are, are also perforce the only available substitute for normal battle response by the assaulting infantry's own organic weapons.

The Wrong Way--Suvla Bay

World War I experience had led many authorities to believe that successful amphibious operations were now impossible. The advantages defenders reaped from modern airpower, high-lethality weapons, and rapid reinforcement through modern transportation seemed overpowering. The landing at Suvla Bay in 1915 illustrates the Allied lack of sound amphibious doctrine and training that proved far more crippling handicaps than the enemy advantages.

By midsummer of 1915, the British-French expedition which had been landed on the Gallipoli peninsula to sweep toward Constantinople had wholly bogged down, in large part due to tragic ineptitude in planning and preparation for the initial assault. The troops ashore were confined to several shallow and tormented beachheads near the peninsular tip.

With the object of regaining freedom of movement for the whole enterprise and lifting the pressure from the embattled perimeters, a British infantry corps of 25,000 men was put ashore at Suvla Bay on the night of August 6. The landing was scheduled for 2230, just in time to beat the rise of a waning moon. The expedition was commanded by Lt. General Sir Frederick Stopford, age 61, chosen only for his seniority. Both he and his troops were without battle experience, and their junior leaders were wholly ignorant of the very special tactical problems of the venture.

The landing in darkness placed insupportable burdens on command and organization. Officers and men were dependent on voice recognition to establish authority, and while a good junior officer can learn the faces and names of 200 men within 40 days, he cannot learn to identify more than a dozen by voice. In the darkness, units became intermingled, officers could not command, and troops hesitated to obey, since no one knew to whom he was speaking. When enemy fire was added to this chaos, uncontrolled panic naturally resulted.

There was very little enemy fire against the landing mêlée, but that little bit proved decisive enough. So great was the inertia which settled on these troops through their night of shock that when morning came it was impossible to stir the determining number and boot them along from the beach and the adjoining salt flat to the distant high ground. A few brave parties struck out to the eastward; the mass stayed inert not far from blue water.

Given two days as a gift, the Turkish enemy closed first in strength on the nearby ridges above Anafarta Sagar which all along unmanned had beckoned to the stranded corps. When the mighty allied effort fell apart among the subridges just beyond Suvla Bay, the Gallipoli hope turned to ashes and the inevitable sequel was the liquidation of the one great amphibious effort in World War I.

World War II Amphibious Success

Between Gallipoli and World War II, amphibious operations changed dramatically. History makes it perfectly clear that there is no other way to account for Allied victory in World War II except to follow the curve of development in amphibious operations during that period. At the high crisis of the conflict, the European Axis Powers dominated the whole coastline of the continent and the Japanese were emplaced along a perimeter covering the whole western half of the Pacific, leaving open only the sea lane between the Americas and Australia-New Zealand. There was no other way to victory except to invade continental Europe from the sea and to wrest back chain by chain the island groups and atolls which the Japanese had fortified to keep hostile forces distant from the homeland.

That it was done and that no Allied amphibious attack was defeated in the course of recovery seems almost incredible. The inherent vulnerability of the men in the assault forces was unchanged; the advantages of the defenders were still powerful. The phenomenon can be explained only by the development of a sound body of amphibious doctrine during the interwar period and by improvements in fire support and the creation of new, specially designed vehicles and vessels during World War II.

Developments in Doctrine

The basic amphibious doctrine of World War II was developed between the wars, and largely between 1922 and 1935, by the US Marine Corps. Although numerous adjustments had to be made when the tremendously larger forces of World War II engaged in amphibious assault, the doctrine proved fundamentally sound. The doctrine was, in fact, an adaptation of the precepts set forth a century earlier by the European military thinker Jomini-- "to deceive the enemy as to the point of debarkation, to select a beach with hydrographic and terrain conditions favorable to the attacker, to employ naval guns in preparing the way for the troops, to land artillery at the earliest practicable moment, and strenuously to push the invasion by seizing the high ground commanding the landing area."*

* Jeter A. Isely and Philip A. Crowl, The US Marines and Amphibious War, Princeton, 1951, p. 4.

The Marine Tentative Manual for Landing Operations (1934) stressed the role of naval gunfire in replacing the fire support an infantry attack would ordinarily have. It paid considerable attention to combat-loading of men and supplies--both were arranged so that the first landed and unloaded would be the first used ashore. Troop units were to be kept together offshore and landed together, so that unity and command were maintained. Beach regulation parties were to be landed first to mark beaches, maintain communication with the ships, direct units off the beach, and thus reduce congestion and confusion on the beach. Air superiority of three-to-one was considered necessary for a successful assault, and air-ship and air-ground communication techniques were worked out.

World War II Innovation

The new developments that appeared during World War II were crucially important. They were (1) a new accent on preliminary air bombardment of the target (and in Europe of the communications zone behind it); (2) great improvement in support fire control and a new order of magnitude in the volume of ship fires; (3) creation of a whole new family of small landing craft with lower silhouettes, more speed, better protection, and over-all dependability assuring uniformity of delivery, the more advanced types having true amphibious characteristics in that they were mobile both afloat and ashore; (4) development of a whole new family of ocean-going transports, the LST being most representative, which being open-ended could discharge cargo (men, heavy weapons, supply) directly upon the beach, thereby affording a quick buildup ashore and energizing the attack; (5) strategic bombardment of the target by Army Air which phased into tactical bombardment by Navy Air just prior to and during the infantry assault. Ship-to-shore logistics became greatly simplified, support fires were enormously expanded, and movement of the assault element was more accurately synchronized with the offshore bombardment, all of which compounded the shock to the defenders. The development of voice-radio communication was essential to these advances.

The need for true amphibious carriers, so structured that they would make troop landings independent of harbors, had not been anticipated. The landing barges of the Japanese, revealed in the invasions of Malaya and Java, initiated the chain reaction of imitation by the military of Britain and the United States. With historical accuracy, President Roosevelt spoke on August 13, 1944, of "the landing craft, a wholly new type of ship, one we

didn't dream of two years and a half ago." Not Britain's loss of her last port on the continent, Dunkirk, but the disasters which followed Pearl Harbor spurred the epochal change. Even then, the necessity for a vast stockpile to feed offshore bombardment went unrecognized. Indeed, following Operation Galvanic (invasion of the Gilberts) Admiral Kelley Turner had to cable the Navy Department to get the munitions plants going again because in one action his fleet had exhausted 60% of the ammunition which had been expected to last it through the war.

The supply of small amphibious craft never came abreast of requirements. In consequence, there was no standardization of lift for the ship-to-shore movement, as to what type of craft should form in the boat waves, and in what numbers, and how much firepower and armor, not organic to the BLT, should cover it when it closed on the shore.

The rule followed was to do the best possible with the available materiel. In Europe, until the last invasion, the BLTs were largely carried in Higgins boats and DUKWs, highly conspicuous and soft-skinned craft, because nothing else was in sufficient supply. In Pacific operations, the real amphibia of World War II continued to appear in ever-increasing numbers. These were the Alligator (tracked, unarmored), the Buffalo (tracked, armored, carrying a 37mm gun and two machine guns in its turret), and the DUKW, the Army's amphibious truck. The extent to which the boat waves could be mounted in these craft, which offered less target area and save for the DUKW gave better protection, varied from operation to operation, not according to the lessons of experience, but according to the flow of materiel from the factories in the zone of interior to the theater of operations.

The pattern and volume of naval gunfire support, and of strategic air bombardment, also varied greatly. Support fire depended on how much emphasis was placed upon surprise, how many warships could be present, the distances between home base and the target, and command estimates of the point of diminishing return in softening-up fires.

There is no such thing as the "typical" preparation. There are only illuminating examples. In the largest of all amphibian enterprises, there was no preparatory air bombardment of the beaches, the Supreme Commander's Staff being divided as to whether such action was advantageous. Two examples of fire support in amphibious operations will be discussed; they indicate that, although fire support is essential, even the most abundant fire support does not, alone, insure combat effectiveness.

Operation Galvanic--Tarawa and Makin

To begin Operation Galvanic, November 1943, the 7th Air Force bombed the two targets of Tarawa and Makin for only one week prior to the direct assault, by which time the seaborne convoy was already approaching its target. There was only superficial damage to enemy works and no loss of military personnel. Navy carrier-based bombers struck directly ahead of the boat waves, dropping one-ton and half-ton bombs for one-half hour (this was at Makin) against coast artillery positions, heavy antiaircraft guns, pillboxes, stores, and personnel. The works remained relatively undamaged when this phase was completed and only four craters were found either in or immediately adjacent to them. There were two naval bombardments in support of two separately staged landings on the one island, one soon after dawn and the other in the pre-noon hours. Over-all, the naval fires went slightly less than three hours. The firing plan called for the expenditure of 1,990 rounds of 14-inch, 1,645 rounds of 8-inch, and 7,490 rounds of 5-inch shells from four battleships, four cruisers, and six destroyers which provided a preliminary fire support practically in ratio, just under 3,000 tons of naval projectiles being thrown against the enemy during the four hours before the first assault troops hit the beaches.

Eye-witnesses to these massive bombardments, especially those aboard the capital ships and APAs who had a better chance for observation than troops idling in the small boats, truly believed that they would shatter all resistance. Rear Admiral Howard F. Kingman, who commanded the fire support group in the attack on the main island said: "It seemed almost impossible for any human being to be alive on Betio." But these impressions proved almost wholly illusory. The main effect wrought on the defense was disorganization from the blasting of communications, the obliterating of roads, the shattering of radar installations, and the destruction of wire. While resistance was no longer unified, its parts remained deadly, saved for the most part by ground cover. Although most surface structures had been destroyed or knocked about, entrenched works and strong points remained almost intact. The difficulty was that there were too many targets to be destroyed for the time allowed and too much of the fire had been wasted on open space.

The taking of Tarawa yielded an estimated 4,690 Japanese killed; Marine Corps casualties in the attack were 3,301. At the end of the fighting on Makin, 550 of the enemy were either dead or taken prisoner (all but one POW were Korean labor troops); total battle casualties among the Americans were 218. Thus,

over-all, for every three Japanese fighters killed, two Americans were either killed or wounded. The figures say eloquently that the lethality of the preparatory bombardment was phenomenally low, to be estimated in a few percentage points. When the sides at last closed, there remained on both islands a garrison in numbers and state of morale still capable of engaging and standing off a force of its own size. The attack prevailed due to the abundance of reserves, whereas the defense could not reinforce.

Kwajalein

There could not be a more fully exposed target than Kwajalein. The island is almost perfectly flat, except for a few coral outcroppings and the numerous bobai pits. Its average elevation above sea level, giving a few inches more or less, is the height of a man. In shape, it is not unlike a boomerang. But it does not taper off to a fine point and its width is enough that, seen from above, it presents a fairly solid object and can be methodically platted.

On Kwajalein, there is literally no place to hide from air bombing and no natural feature which affords any protections against fire from the sea. The earth crust is extremely shallow. The vegetation, after the Japanese cleared ground for their base and road network, was not lush. Except for the covering of the coastal battery at the end of the island, there were no conspicuous concrete works. It is approximately $2\frac{1}{2}$ miles long and averages 800 yards in width over most of its length. It is thus an area about $1\frac{1}{2}$ square miles with no natural features to limit the radius of blast.

As already noted, preceding the invasion of the Gilberts, strategic air had worked over the target islands for only one week, and such was the distance that these strikes were not intense. But preceding Operation Flintlock, there was plenty of time for systematic land-based bombing of the targets out of the new airstrips in the Gilberts, and by carrier-based naval aviation. The first 7th Air Force strike against Kwajalein proper was run December 21 when four B-24s dropped six tons of bombs. There were nine subsequent missions running through January, and about 200 tons of bombs were dropped on the atoll.

The island was hit by Navy bomber planes of Task Force 58 for two days immediately in advance of the invasion. There were

four separate groups of carriers, battleships, cruisers, and destroyers in this attack, with 700 carrier-based planes.

Early on D-Day morning the off-shore bombardment resumed, the battleships having moved up to within 1,500 yards of the big island. The official Army history describes the resulting fire as "unprecedented in volume and effectiveness." Two shells per second were exploding into Kwajalein. On that day almost 7,000 Navy rounds (14-, 8-, and 5-inch) raked it from end to end. From nearby Carlson Island five battalions of field artillery added another 29,000 rounds to the barraging of Kwajalein, in the most intense one-day shoot of World War II. Six Liberator bombers, flying well above the artillery trajectories, dropped 15 1,000-pound and 2,000-pound bombs on the same target, striking at the island's heavy gun installations. They were followed by 18 dive-bombers and 15 torpedo bombers which struck the near end of the island while as many fighter planes strafed the far end of the island with machine guns and rockets. All told, 96 sorties were flown off the six carriers in this round.

At day's end the island was a rubble heap. Even to the eye of a sophisticated witness who had viewed other battlefields, it looked as if all life on Kwajalein had been extinguished. Here was devastation unimaginable, the most chaotic scene ever wrought by American guns and bombs until that hour. That night many fires blazed amid the wreckage.

On D-plus-one, two US regiments landed from small boats on the southern end of Kwajalein, crossed the beach with little opposition, and thereafter fought their way to the extreme end yard by yard, at which point the battle ended. The direct and general support fires from the five battalions nearby Carlson Island kept moving in front of this line and rarely slackened.

On the third day of the battle, enemy bodies strewn over an area of approximately six acres were examined to determine, if possible, the cause of death. Nature of wounds, the near presence of craters, etc., were taken into account. Allowing some margin for error, it was still calculated, on the basis of this sampling, that in excess of 70% of the enemy who died above ground had been killed by Army-delivered shellfire, either field artillery or mortars. All of the surface dead examined had apparently been killed after the island was directly invaded.

From this and other evidence it is almost conclusively clear that the initial hurt to the Japanese was not more than four percent killed by the massive preparatory bombardment from air and

sea. Yet this small loss, and the accompanying shock to survivors, were sufficient to so disarrange the defenders that they offered no group resistance to the defenders until they were well ashore.

The field artillery shoot against Kwajalein island was the most intense, and the most methodical, of any delivered in World War II landing, and the target was ideal for a steady march of fires the length of the battlefield in shielding the infantry advance. This relatively small target measured approximately 4,500,000 square yards. When about 65,000 105mm and 155mm rounds are laid on it, that means but one shellburst for every 70 or so square yards. The lethal radius of even the largest naval artillery shell when fired against inshore targets cannot be counted great enough to make this truly "saturation" fire. Men will survive, little hurt or shocked, just a few yards beyond the lip of the crater.

Briefly to summarize, then, the killing impact of all power loosed with the object of enabling the BLT to get ashore and help establish a beachhead during World War II, under the most optimum circumstances, was never more than three to five percent. This means that in excess of 95% of defending personnel survived the preparation bodily sound. Yet that was margin enough in each case to insure the landing. The irreparable hurt to the defense from the preparatory fires came from the disarrangement of communications.

JOINT OPERATIONS TASK FORCE SYSTEMS

Until the development of airborne operations in countries with an air service separate from the army, amphibious operations alone offered any possibility for the development of interservice joint task force systems. Since ancient times rivers had been crossed in warfare and landings made, but the operations were not carried out with a carefully worked out joint command. When cooperation between two services was necessary it was ad hoc; there was no development of joint doctrine for amphibious operations or joint task force systems until the United States developed it during the second quarter of the 20th Century. In this development political and interservice considerations were much more important than changes in weapon lethality. But the system which has evolved and the experience with joint operations during this period has led, and is still leading, to significant developments and improvements in weapons, equipment, and techniques.

The amphibious operation is truly joint by any definition. In the simple operational sense the amphibious assault is joint since it joins or brings together in a single military endeavor the efforts of forces which are organized, trained, and equipped for operations in different elements. In the legalistic "service" sense it is likewise invariably joint since it will always involve coordinate participation by substantial elements of two or more of the services in the Department of Defense. With the development of airpower and the tactical use of it, joint operations which employed air elements as well as land and/or sea became important.

Development of Unified Command Doctrine

By the start of World War II doctrine for organizing and controlling amphibious operations had been developed by the US Navy and Marine Corps, whose function it was to conduct them. The experience of World War II gave ample opportunity for the Navy and Marine Corps to perfect an adequate, effective method for the integration of the varying forces and weapons involved in amphibious operations. When, after the fall of France, the Army saw that it would eventually be called upon to participate in amphibious operations, it adopted the Navy-Marine Corps doctrine and published it as an Army field manual.

In the Pacific campaigns the willing use by the Army of the Navy-Marine methods, and the training provided the Army, first by the Amphibious Corps, Pacific Fleet, and later by the Troop Training Unit, facilitated the formation of joint task force combat teams. The fact that carrier aircraft were generally available for air support minimized the difficulties which did occur in Europe from the attitude of independence taken there by the Air Corps. In the Southwest Pacific, a system of planned air cover and air support was set up, which functioned well under MacArthur's command.

In Europe the arrangements for the most part followed the pattern of the Sicilian landings, where the landing force-naval force relationship was joint, but the air planning and control remained at the theater level.

In 1947, Congress passed the Unification Act, which made the Air Force a separate service and assigned to each of the services general responsibility for its peculiar kind of warfare. To the Marine Corps was assigned responsibility for development

"of those phases of amphibious operations which pertain to the tactics, techniques, and equipment employed by landing forces." This set the stage for much discussion of joint forces and the development of joint doctrine. Since it was above all in amphibious operations that more than one service would be involved, it was in the evolution of amphibious doctrine that the principles of joint command were developed.

Preparation of joint doctrine was complicated by the fact that, whereas in the Navy view there was only one type of amphibious operation, the Army and the Air Force concept was that there were two essentially different kinds of amphibious operations. One was a joint amphibious operation, large in scale, the kind that the Army and the Air Force participated in. The other was an ordinary amphibious operation, participated in by the Navy and the Marine Corps alone. The Army held that whenever the operation extended beyond the seizure of a beachhead it was of a size that required Army and Air Force participation, which meant that generally the Army had "dominant interests." This in turn meant that the Army would have command of the operation. The Navy disagreed, taking the view that amphibious operations should be under over-all naval command. As a further complication, the Air Force insisted that no Air Force units would ever participate as units within a task force, that their forces would only act in conjunction with an amphibious task force (the amount, duration, and timing of action being dependent upon their absorption in their own theater air operations), and that unity of command so far as the Air Force went was only at the Theater Command level. While these divergent views were still being discussed, the Army and Air Force recommended that under the direction of the JCS and the Joint Staff there should be a series of "Joint Centers" for the development of doctrine, technique, and equipment for joint operations. This was considered by the Navy and Marine Corps to be contrary to the provisions of the Unification Act, and it made no progress.

In 1950, the Marine Corps decided that in order to carry out its landing force development function "in coordination with the Army and Air Force" it had to provide a specific organization. From this came the Landing Force Development Center at Quantico, under the supervision of the Commandant, Marine Corps Schools, who was assigned duty as Coordinator Landing Force Development Activities, to coordinate the Center's activities with the field activities of the Marine Corps and with the development authorities of the other services. Each service was asked to assign officers of certain qualifications to represent it in the Center.

This action served as a catalyst and led to a solution in early 1952 of the Joint Center discussion. The service which had primary responsibility for a particular form of operation took responsibility for achieving coordination of the joint aspects. It was agreed that each service would establish a Joint Board for its "joint" operation, under the authority and responsibility of its service chief, with representation on the Board from each of the other services. These Boards were:

- Joint Amphibious Board--Navy
- Joint Landing Force Board--Marine Corps
- Joint Airborne Troop Board--Army
- Joint Tactical Air Support Board--Air Force
- Joint Air Defense Board--Air Force
- Joint Air Transportation Board--Air Force

The Marine Corps Landing Force Development Center then became the Joint Landing Force Board.

Thus it can be seen that the development of doctrine for unified command of joint operations task force systems was caught up in the currents of interservice rivalries that made each service jealous of relinquishing any of its command authority over its own forces. Attempts to minimize these rivalries and obtain the maximum of cooperation in joint action during the war through the establishment of joint staffs or even through the maintaining of personnel of one service on the staff of command of another, had been fairly successful; but the problem of who was going to command a given joint task force, to what extent he controlled elements of other services assigned him, and how much assistance the other services would give had always been sticky problems. Yet the weapons at hand and the tactical and strategic uses to which they were adapted had resulted in the vital necessity for cooperation, and, more than that, unified command of elements drawn from different services, to carry out a given operation. Increasingly after the war the need was realized for a firm doctrine for the organization and command of joint operations task force systems. The concept of joint operations task forces, uniquely in the United States, was firmly accepted; it was the command organization that in 1953 was still not resolved. But the impulse which had led to the establishment first of the Joint Chiefs of Staff Organization and then to the Department of Defense was working toward clarification of the doctrine for unified command of joint task forces.