A PRELIMINARY, INTERPRETIVE SURVEY OF THE HISTORY OF COMMAND AND CONTROL

Contractor for U. S. Atomic Energy Commission

FOREWORD

The Historical Evaluation & Research Organization of Washington, D.C. was requested to conduct a preliminary examination of command and control in military history to ascertain the extent to which history could be helpful in understanding our present day problems, particularly relating to permissive links.

Study "Pre-Alert" examines the spectrum of command and control exercised through the centuries; it investigates decision-making processes in warfare; and contains a survey of weapons and weapon systems.

The group of military historians who made this exploratory study feels that it demonstrates that military history is relevant to modern problems of military leadership, command and control, and decision-making. Even though this may be true it does not furnish any significant insight into today's design problems. It is believed, however, that the study will prove interesting to those people who are concerned primarily with the "hardware" of command and control.

Much credit is due J. L. Dossey and G. R. Ellison for their assistance during the formative stages of this research project.

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PREFACE

The primary purpose of Study "Pre-Alert" is to undertake a preliminary investigation of the extent to which historical example and experience can provide useful guidance to Sandia Corporation in the development of devices and measures designed for command and control of weapon systems. In particular, the study is intended to be relevant to procedures which will assure "foolproof" automatic controls which will prevent accidental or unauthorized employment of a weapon system without danger that such controls might be so complicated, or involve such inhibitions to individual initiative, as to preclude adequate military response by the weapon system in the event of unforeseen conditions or circumstances.

In undertaking this study, we have examined theoretical concepts of command and control in the context of brief but comprehensive surveys of the history of weapon systems, of command and control systems, and of political involvement in command and control. In addition, we have evaluated the general applicability of historical experience-¬ particularly in the 20th Century--to modern problems of military decision-making in land, naval, and air warfare.

Study "Pre-Alert" was initiated on the assumption that historical experience is relevant to contemporary problems of decision-making in combat or in expectation of combat. Our preliminary research, as presented in this report, clearly attests the validity of this assumption.

Accordingly, we have prepared specific recommendations for further, more intensive investigation of the subject. This proposed examination, which we have titled Study "Alert", will analyze selected historical case studies for the purpose of reaching conclusions peculiarly relevant to modern problems of command and control. Special emphasis will be given to the human factor in the chain of command and to the relative importance of control and individual initiative.

Study "Pre-Alert" reflects the collaborative efforts of the following members of the HERO Associate and Permanent Staffs: Trevor N. Dupuy, Stanley L. Falk, Richard M. Leighton and Charles B. MacDonald. Useful and substantive contributions were made by the following members of a review group of HERO Associates: Martin Blumenson, R. Ernest Dupuy, William R. Emerson, Paul Y. Hammond, Maurice Matloff, Louis Morton,

Theodore Ropp, and Frank N. Trager. Dr. Franklin P. Kilpatrick of the Brookings Institution was a Special Consultant and a member of the review group. The report was edited by R. Ernest Dupuy with the assistance of Robert M. Langdon and Mary M. Hoyt.

T. N. Dupuy
President and Executive Director
Historical Evaluation and Research Organization
Washington, D. C.

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Part One

THE RELEVANCE OF HISTORICAL EXPERIENCE TO MODERN COMMAND AND CONTROL

Historical Trends

During the greater part of recorded history, the development of new weapons and of doctrinal concepts for their use in combat evolved gradually, taxing man's ingenuity, but seldom requiring sudden or drastic changes either in method or in direction. In the past century and a half, however, the range, scope, and destructiveness of war have increased in ever-accelerating curves, to pose unprecedented challenges to military men, to political leaders, and to mankind in general.

Yet despite these tremendous changes in methods and means, the most common denominator of warfare remains man himself, whose basic nature has not changed in significant degree over the course of history. Furthermore, revolutionary and unprecedented as most modern military developments have been, ours is not the first age in history when man has faced sweeping innovations in the implements and techniques of warfare.*

In early primitive military organizations, a commander's control was limited to small forces of men whose actions he could personally direct and whose movements were within range of his voice and hand signals. Discipline, where it existed, stemmed from a personal fear of, or respect for, a leader who normally exercised command through physical strength or bold example. Over the years, the size, sophistication, and operational range of military units increased; and with these increases arose requirements for commanders to transmit orders and to exercise control by means of messengers, flag or smoke signals, trumpet or drum beats, and, eventually, subordinate commanders and rudimentary personal staffs. Group allegiance and social cohesiveness facilitated the training and discipline required for evolving command and control doctrine as tactical units changed from tightly controlled, solid mass formations to more flexible, mobile ones and as gunpowder weapons made their appearance.

*See Appendix B for a survey of the history of weapons and weapons systems; also see Appendix C for a survey of the history of command and control in warfare, and Appendix D for a survey of political involvement in military command.

Similar developments occurred in naval warfare. There was a transition from the actions of individual, oar-propelled vessels, operating close to shore and commanded by voice or by a wave of the arm, to broader, high-seas maneuvers of sailing ships, directed by flag hoists or other signals.

At the turn of the 19th Century, the requirements for effective command and control multiplied at a rate never before experienced. With the increase in the size of field armies (which began during the Napoleonic period), strains were imposed on existing control mechanisms; in addition, increased firepower capabilities forced military units into widely dispersed formations which, in turn, decentralized and dislocated command. Steam propulsion greatly enhanced mobility on land and inland waterways, vastly extending the geographical scope of military operations. The telegraph and more sophisticated methods of military signalling kept the commander in contact with his widespread forces. By the same token, his communications procedures and command relationships became more complicated. Although the introduction of the military staff system assisted him, the staff decentralized and diluted his individual influence. Personal leadership by a commander in chief, the rule in earlier generations, was no longer feasible; operational control in general, and battle control in particular, passed increasingly to subordinates. In the tactical unit alone did personal command endure--but armies now contained hundreds or thousands of tactical units, and as many commanders.

At sea, similarly, technological developments allowed greater flexibility in maneuver, spread the geographical range of practical operations, and shortened the reaction time during which subordinate commanders could safely respond to opportunity or necessity. Control, on the one hand improved by better communications and other linkage mechanisms, was at the same time dissipated.

By the 20th Century, the commander in chief no longer commanded or controlled his forces in person. Rather, he exercised general direction, leaving considerable freedom of action to on-the-spot subordinate commanders or staff representatives. This was desirable, to a large extent, since increasing numbers, size, and dispersal of subordinate units made it important that initiative on the part of their respective leaders be encouraged. But the commander in chief still depended on firmly established doctrine to prevent substantial deviations from the over-all objectives laid down in his directives. Even more significantly, in light of the trend toward the growing scope and destructiveness of war, the commander in chief had to be increasingly concerned with the possibility of faulty execution on part of subordinates.

Similarly, as the possible consequences of acts of war have increased in scope and gravity, there has been growing civilian-political concern about the problems and dangers inherent in the employment of military force for political ends. This has led to closer political supervision over, and to some direct involvement in, military command issues in war, as well as in peacetime crises.

The advent of nuclear weapons, and of long-range rocket missiles which can accurately deliver them between continents in minutes, exemplifies the dilemma which current trends pose to political and military leaders. To what extent can a command and control system, under modern conditions, permit individual initiative in the process of military decision-making? And what are the consequences if individual initiative is inhibited?

Some Theoretical Considerations

Relationship of Doctrine and Control

Historically, the relationship between military doctrine and control systems has been both subtle and unstable. Only in part is that relationship the familiar human one between concept and practice, in which the idea either leads or follows, depending on whether it represents creative innovations or tardy adjustment of thought to action. Doctrine is not concept, per se, but rather idea that has been formalized and institutionalized and embedded in systematized practice. Its normal relationship to a control system is, therefore, one of harmony, almost identity. However, blending doctrine into system does not always produce harmony. History contains examples of persisting outmoded doctrine, enshrined in obsolete texts like, for example, the ancient Roman treatises on war, which the Middle Ages continued to read and revere but, in practice, ignored. Conversely, every great military innovator has faced, and had to compromise with, the problem of translating ideas into systematized practice. The great field service regulations of history, from the Ars militaris of the 6th-Century Byzantine Emperor Maurice to the controversial British Army Field Service Regulations of the early 20th Century, were imposed on existing systems which adjusted sluggishly to new precepts.1

Military doctrine has, moreover, a dual aspect. It has been defined as "principles, policies and concepts which are combined into an integrated training system for the purpose of governing, and assuring consistent, coordinated employment of all components of a military force in combat."^ Doctrine is thus at once integral and external to any military system. Within the system it is a functional element, serving the purposes of the system rather than its own inner logic. At the same time, it provides an objective formal conceptualization and description of the system as a whole, or of any part of it. The pro-

positions advanced in this study, with reference to specific military systems in history, are actual or potential ingredients of military doctrine.

Two kinds of military doctrine can be discerned: first, that concerned with the use of combat power, the ends to which it is applied, and the methods of so applying it; and second, that concerned with the control of combat power. "Utilization doctrine" is related to the external projection of combat power--its functioning in an environment; "control doctrine" is related to the internal organization and regulation of combat power, with a view, of course, to its effective use. This study is concerned with both kinds of doctrine, but in different ways. In analyzing the internal elements of control systems, as will be presently shown, the study notes the role of doctrine--both utilization and control--as an internal functional element of these systems. At the same time, as indicated earlier, this study explores, in a preliminary and tentative way, the hypothesis that an intensive but selective examination of command and control in history may provide a solid basis for developing doctrine conducive to effective control of modern weapon systems. In short, its basic concern is control doctrine.

"Control" has been defined as

> the process whereby a commander effectively directs military forces so that they are fully responsive to his will. Control depends primarily upon adequate means or measures whereby a commander assures the cooperative and coordinated efforts of his subordinates in carrying out his command assignments; it includes the organization of his force for combat, the assignment of tasks to subordinates, the designation of objectives, and the authoritative direction necessary to accomplish the mission.3

It should be noted that the term "control" is used here in three senses which are logically distinct: the capability of controlling military forces and operations; the exercise of that capability; and the instrumentalities whereby the capability is exercised. Convenience justifies this usage but, in accepting it, there must be consistency in matching the scope of "control-as-means" with that of "control-as-capability". That is to say, control should be construed in the former sense, to include not merely administrative systems, processes, tools, techniques, facilities, and the like, but also other less tangible "means" by which control is effected or limited. Unquestionably training and doctrine are extremely important in ensuring compliance with the letter and spirit of directives. Discipline, esprit de corps, established organizational structure, and familiar operating processes all combine to create the internal coherence and stability that facilitate control. The personality and style of the commander are

significant features in any control system. So, too, is the effectiveness of subordinate commanders in executing orders and responding intelligently to new situations. Beyond all these is the vague but powerful force of habit and attitude, rooted not in training and doctrine alone, but also in sources perhaps outside the military environment altogether. In short, consideration should be given to the totality of means, instruments, and influences that combine to make up a control system which gives a commander the capability of translating his will into effective action.

Elements of a Control System

In the light of the foregoing discussion, for purposes of the present analysis, the elements of a military control system might be categorized under six major headings as follows:

1. Structure: the organization of forces available to the commander.

2. Operating systems: for tactics, administration, and training.

3. Linkage: communications, staff relationships, liaison, and intelligence.

4. Command (including the chain of political as well as military authority):

   a. Normal, "chain-of-command" direction by superior commanders and higher political authority.

   b. Extraordinary intervention, by superior political or military echelons of authority, which "short-circuits" the normal chain of command (e.g., deputies on mission in the French Revolutionary armies Soviet political commissars; presidential invocation of commander in chief powers; Congressional intervention; or intervention by a military commander in the operational sphere of a subordinate judged in an emergency to be inadequate).

5. Personality of commander (to include style, character, and idiosyncracies):

   a. The specific commander from whose vantage point a given situation is viewed.

   b. Subordinate commanders.

6. Internal operating atmosphere: troop morale (esprit de corps), discipline, habits, and attitudes.

The underlying concept in the above scheme of analysis is one of a system, or network, in which command decisions are made and transmitted

to the elements which execute them. As a "system", it is to some degree impersonal (elements *1,* 2, 3, and 4), but in any given control system, at all echelons (elements 5 and *6),* human factors exert a strong, sometimes dominant, influence. It will be readily apparent that the elements are not sharply distinct. Most obviously, "linkage" (element 3) can be considered as one of the internal systems or subsystems under "operating systems" (element 2), but it is so vital to command and control that it merits independent consideration. Internal systems might also be considered to include both structure and command, but the distinctions serve a useful purpose nevertheless. By the same token, "operating systems" (element 2) might be divided into several separate components--e.g., administration-operations-training or, under a different schema, policy-doctrine-procedures. There is no clearly defined line dividing the system as a whole from elements outside it. At the top, it blends into elements of higher authority not normally part of the system and, at the bottom, into the "objects" of control (i.e., the forces-weapon systems which execute commands).

The present scheme of analysis also includes, as integral to control systems, the equipment, facilities, and other material means that directly serve the functions of command and control. Weapons themselves may intrude as an element of the system, if used to perform or assist in performing these functions (e.g., military aircraft or armored vehicles used in communications, or even the officer's pistol used to compel the obedience of a soldier). In general, however, technology belongs primarily to the environment in which control systems function, rather than to the systems themselves.

Control and Decision-Making

Decision is implicit in command, and command, as indicated before, is integral to a control system (hence, "command and control"). A useful, though not universally accepted distinction, may be made between "decision" and "decision-making". The latter, in an institutional context, is widely recognized as something far more complex than an individual, intellectual act of deciding what to do (in a "moment of decision")--although to the psychologist this act in itself is complex. Military decision-making is a highly institutionalized, collective process, which includes the gathering of relevant information; the analysis of the situation; determination of available alternative courses of action and the probable consequences of each; submission of formal recommendations by staff and subordinate commanders; and, finally, the decision itself--the commander's choice of action. Sometimes the decision-making process is construed to extend even further, through the issuance of orders or directives and their transmission to subordinates.[4]

"Command and control" thus considers of decision-making, the process just described, plus the control processes by which the decision, the commander's instantaneous act-of-choosing, is implemented. The commander's decision is the key point; the culmination of the decision-making process and the initial impulse in the control process. Decisions by subordinate commanders are the impulse points, booster transformers in the command line.

Military control systems in history may be classified on a scale ranging from highly restrictive systems at one end to highly permissive ones at the other. In the former category, the burden of detailed decision-making is concentrated at high levels of command; in the latter, subordinate commanders exercise wide latitude in interpreting the superior commander's desires; they may implement decisions or ignore or reverse them in response to completely unforeseen developments, or local conditions of the moment, unknown at higher headquarters.

The restrictive or permissive character of a control system inevitably reflects the interaction of the six elements identified earlier. A strong-willed, great leader may, of course, leave for posterity an image of a control system which is little more than a reflection of his personality. But such a commander-dominated system is not necessarily a highly restrictive one. Alexander, Hannibal, Caesar, Genghis Khan, Gustavus, Frederick, and Napoleon were all strong, dominating commanders, but each of them knew how to elicit initiative and resourcefulness in subordinates. And Robert E. Lee, though mild mannered, had a dominant, yet also permissive, relationship to his subordinates. In Lee's case, other elements of his control system must be considered: the brilliance and limitations of his subordinate commanders; sloppy, haphazard organization, administration, and staff work; uncertain communications; virtual absence of formal doctrine or training; baffling combination of high morale (esprit de corps), poor discipline, state and sectional rivalries, intense patriotism—plus the constraints imposed by President Davis, the Confederate Congress, and the state governors. These elements produced a command and control system that was highly permissive and, by objective standards, inefficient. Yet it somehow managed to function adequately and, on occasion, brilliantly.

The Environment of Command and Control

A military control system is more, however, than a product of the interaction of its internal elements. That interaction includes a response to external pressures, influences, and events, to which the system, like all human institutions, must adapt itself. In short, a control system is a creature of an external environment of methodology, conditions, and moving events in response to which it must not merely react, but, in varying measures alter its own shape and character.

Like the control system itself, this environment can be analyzed in a variety of ways. One possible scheme would distinguish four major environmental elements--the military, natural, politico-social environments, and the events occurring in any of these.

a. The military environment.

(1) Forces (including weapon systems) controlled, or likely to be controlled, by the system.

(2) Friendly or neutral forces (including weapon systems), associated, or prospectively associated.

(3) Hostile or prospectively hostile forces (including weapon systems).

Of all the major environmental elements, the military environment exerts perhaps the most direct influence on a control system. As indicated earlier, the forces immediately controlled by the system are in fact intricately enmeshed with it through the character of subordinate commanders, through the state of morale (esprit de corps) and discipline of the troops themselves, and through the internal structure and system that lend cohesiveness and responsiveness to the force as a whole. Forces not directly subject to the control system have parallel systems with which they must work in harmony and close coordination. To a lesser degree, the same is true of associated, friendly, or prospectively friendly forces. Enemy forces and their control systems exert a different, but in some ways more compelling influence, through their power to dictate adaptation as the price of survival.

In considering the military environment, it is important also to recognize the influence on control systems of the technological aspects of that environment — particularly weapon systems. As primary objects of control, weapons and their supporting systems exercise a decisive influence, through their technical capabilities and limitations, on the character of the control system. This is dramatically evident, of course, in the problem of controlling the responses of modern, automated weaponry. But the problem has existed throughout the history of organized warfare. Battlefield control systems in the 18th Century, for example, were designed around the technical problem of achieving controlled, effective volley fire and weapons, which were extremely limited in range and accuracy, and had to be reloaded in a series of manual operations after each shot. This allowed only a very short period of time for the play of firepower before resort to shock action.

b. The natural environment (weather, climate, terrain, geography, natural resources, avenues of movement, distance).

The influence of natural environment on all aspects of military system is voluminously documented in military history and requires no elaboration here. The most spectacular example of successful adaptation was the superb control system developed by Genghis Khan and his generals in the 13th Century, to achieve rapid movement, coordinated action, and concentration of large cavalry armies in campaigns ranging over immense distances of steppe, desert, and mountains. Unsuccessful adaptation may be illustrated by the failure of the British control system, in the campaigns of 1777, to overcome the handicaps of distance across the Atlantic and in widely separated theaters of operations in North America.

c. The politico-social environment.

(1) Political: organization, policy, controls over military.

(2) Social, economic, cultural institutions, and conditions.

(3) The environment of ideas and attitudes.

(4) The technological environment.

Of these four subelements of environmental influence, that of technology is the most evident, particularly with regard to its impact on communications. The effect of the railroad and telegraph on 19th-century systems of control is one of the many examples. The problem of devising effective controls for weapon systems is directly related to the larger technological environment of the society which produces these systems. Consider, for example, the close relation between gunpowder weapons, at any time during the past five centuries, and the then-existing state of chemical and metallurgical science.

The other three influences are more indirect and subtle, but, nevertheless, profound. Military control systems have seldom been able to insulate themselves from the play of politics; this is as true today in contemporary France, the Soviet Union, and South Vietnam as it was in the days of Imperial Rome. Military control systems must accommodate themselves to, or else dominate, the political institutions of the society they serve. No less profound, if sometimes less visible, is the influence of the social, economic, and cultural environment on military control systems. Take, for example, the role of a society's economic class structure in shaping the composition of its professional military class. And the impact of ideologies — particularly new and revolutionary ones--has created major landmarks in the history of command and control (notably in the emergence of the control systems of the French Revolutionary and Russian armies).

d. The environment of events.

Since events occur in an environment of static conditions and relatively slow-moving developments, and are distinguishable from the

latter only in degree, it is perhaps a semantic refinement to consider events as a separate environmental influence on command and control. Yet the best justification for so categorizing them is the tendency, deeply rooted in human psychology, to regard occurrences which visibly "happen" in a moment, or a definably brief span of time, as something apart from the underlying, largely imperceptible movements in human affairs which are perceived only by dint of intellectual effort. For present purposes, it is sufficient to recall the profound impact upon command and control systems of such events in the military environment as the Battle of Adrianople in A.D. 378 or the Battle of Crecy in 1346, both of which resulted in immediate and relatively sweeping changes in basic military concepts.

Application of Historical Experience to Current Problems

The French military theorist, Ardant du Picq, wrote: "Experience is long and life is short. The experiences of each, therefore, cannot be completed except by those of others."[5] The study of past campaigns is the most obvious method of filling in the gap between personal experience and the breadth of knowledge needed by commanders and by those whose business it is to anticipate the requirements of future warfare. Military historians do not expect the study of history to produce exact or even closely related parallels to situations that may later have to be faced. Indeed, one of the great dangers of reading military history uncritically is the tendency toward slavish adherence to outworn traditions and methods, summed up in the term "military conservatism". What the historian hopes is that the past will be used as a bedrock of vicarious experience, to be built upon by architects and builders with critical and analytical vision. The case for military history rests, as Brigadier W. G. F. Jackson puts it,

> on its value in developing the military judgment of future commanders [and, one might add, other students of war] by stocking, sharpening, and inspiring their minds while, at the same time, giving them a sense of what is practicable in war."

A second major danger in the study of military history lies in its malleability. "History", wrote Carlyle, "is a distillation of rumor."7 This problem is amplified by the fact that no historian can hope to cover all aspects of an event, but must choose and distill and, perhaps, oversimplify. It is also unfortunately true that some historians may be more interested in sensationalism, or in proving a personal theory, than in accurate reconstruction of the past.

The danger is particularly acute for those who would seek evolutionary trends or processes through the study of history, for history is so replete with examples of every type of action that it

is always possible to find an appropriate incident to support a particular theory. The only way to avoid this danger is by objective, critical analysis. No historical theory should be accepted at its face value but should be subjected to extensive analysis based on the widest possible scope and depth of study.

It has been seriously asserted, for instance, that nuclear weapons are only a stage in the evolution of weapons and tactics, comparable to the advent of gunpowder and automated weaponry, and that the difference is merely one of degree. Under scrutiny, this assertion proves to be a moot generalization. While not without elementary validity, it is in fact a straw man which impairs the very thesis it is intended to support: the relevance of historical experience to modern military problems. The pragmatic, nonhistorical critic will be quick to point out that nuclear weapons constitute a quantum leap forward in terms of destructiveness within a given unit of time. He can also point out that wholesale unleashing of these weapons would be tantamount to suicide for large portions of the human race--a phenomenon for which history offers no precedent.

These arguments do demolish the straw man, but not necessarily the thesis. Valid comparisons of modern and early weaponry are difficult to make, because the concepts themselves have changed. The modern, tactical, one-kiloton "nuke" is, in the first place, the "cutting edge" of a system comprising an elaborate delivery and support apparatus, served by a large number of personnel, and reaching well back into an army's administrative establishment. Without this supporting apparatus the projectile or the missile would be inoperable. It is doubtful whether any single weapon in earlier ages is quite comparable in this sense."

The weapon "systems" of history were, in fact, families of related weapons, each of which was, at any given point in time, the end product of a complex evolutionary process. Though closely interrelated, these weapons did not develop as homogenous, integrated systems Gunpowder weapons, which began to dominate warfare in the Western world in the 15th Century, were one such family. They were, however, only a part of the larger complex of weapons and tactics that overthrew the supremacy of mailed cav ascendancy was gradual. The early gunpowder weapons, using chemical explosives as a propellant for inert (in themselves harmless) projectiles, were for a long time so inaccurate, cumbersome, unreliable, expensive, and dangerous to their users that soldiers were reluctant to adopt them. The bow, in its various forms, was superior to the early infantry firearms in range, accuracy, rapidity of fire, and cheapness. Eventually, two factors proved decisive in displacing the older weapons: the greater energy released by gunpowder, making

infantry firearms superior in killing power and, ultimately, in range; and of perhaps less significance, the greater ease and rapidity with which ignorant soldiery could be taught to use firearms as opposed, for instance, to the long training needed to develop a first-rate archer. Gunpowder artillery weapons had also proved their superiority in power — though not until later in accuracy or range — to the traditional, mechanically powered siege and field artillery inherited from classical and medieval times.

Automated weapons made a more dramatic impact on warfare around the turn of the 19th and 20th Centuries. In a modern sense, these, too, comprised a weapons family10 rather than a system; including both single-operator and crew-operated machine guns and quick-firing artillery. In the latter instance, the element of automation was subsidiary in importance to the introduction of high explosives.

The perfection of the high explosive shell, namely in the gradual improvement in the power of chemical explosives, culminated in one of the major developments in the gunpowder era. The explosives were used for two distinct purposes: as propellants (already mentioned) and as destructive energy released directly on the target. The development of chemical propellants reached a plateau in the late 19th Century with the rifled musket and field piece which, in terms of accuracy and range, have improved very little. The effectiveness of explosive-on-target weapons, on the other hand, originating with the earliest crude bombs and shells fired from smoothbore cannon, have steadily continued to develop. Atomic and nuclear weapons, even though representing a quantum leap in the single respect of released energy, belong to this line of development. The combination, in the early 20th Century, of many elements and converging lines of development-accuracy and range through rifling and chemical propellants; automation (at some sacrifice of accuracy); high-explosive destructiveness; and, finally, additional range through aircraft, rockets, and missiles (at heavy cost in accuracy)—had an impact on the battlefield that serves, by comparison, to place the atomic-nuclear revolution in a more readily understood perspective.

In one sense, seldom noted, nuclear weapons have made a clean break with history. In the past, the classic method of amassing firepower was to multiply the number of soldiers, or of weapons, each of which contributed an increment to the total. Now, the explosive energy of nuclear weapons is so great that an increment of one represents an increase in firepower unrelated, in any real sense, to the number of personnel comprised in its supporting system. Firepower has increased to such a degree that the historical concept of a man-weapon ratio has itself become virtually meaningless. Indeed, a modern division can unleash a volume of firepower so immense, by comparison with that of a force of the same size in any earlier period, that the difference can properly be regarded as one of kind rather than degree.

There is a question, however, whether quantity of firepower can be equated to destructiveness. The bloodiest battles of history were fought, in the main, with primitive weapons. And those of the 18th Century, the age par excellence of the inaccurate, slow-firing, short-range, smoothbore firearm, were among the bloodiest. At Malplaquet (1709), the victors lost 33 per cent of their effectives; at Zorndorf (1758), the Russians, who were defeated, lost 50 per cent as opposed to the 38 per cent loss of the victorious Prussians; and in the year following, at Kunersdorf, the defeated Prussians lost 48 per cent of troops committed. Casualties on this scale were rarely equalled in later periods, including the great wars of the 20th Century, when firepower was immensely greater.

Today a force armed with nuclear weapons could presumably obliterate an enemy, almost regardless of number, if the latter was obligingly massed on a level field without cover and within range. Of course such a situation would not occur today. But on the 18th-century battlefields things like this did happen, although slaughter was usually brought to an end by the disinclination of one side or the other to continue.

In general, firepower has been destructive (of human life, at least) in the measure that men have exposed themselves to it. Over the greater span of history, the natural tendency of men under fire to seek cover has been counteracted by tactics of mass or line designed to achieve disciplined, coordinated defense against shock attack and by massed counterfire. Only by mid-19th Century, when improved weapons rendered firepower so lethal that men could no longer stand under it, was the mass or serried line abandoned for the protection which could be obtained by using terrain. The factors that have made warfare so destructive in the 20th Century—duration and intensity of campaigning, mobilization of men and materiel on an unprecedented scale, attacks on civilian populations and structures-are largely unrelated to the growth of battlefield firepower.

Destructiveness is a function of two factors—released energy and accuracy. Accuracy is the measure of the efficient use of explosive energy. Nuclear weapons have enormously enlarged the former, but at heavy cost to the latter. This reflects one of the continuities of history. Daring most of the age of chemical explosives, accuracy rose along with power, both factors jumping upward in the mid-19th Century with the advent of rifled weapons, improved propellants, and the metallic cartridge.

With the advent of nuclear weapons, while the factor of released energy—explosive power--leaped upward, together with range, accuracy declined sharply. Only recently has this decline in the accuracy curve leveled off and begun to rise again, coincident with the growth of low-yield nuclear weapons.

There remains, however, the fact that the use of explosive power directly on target may represent a grossly inefficient use of destructive power, in terms both of dissipation of energy in the atmosphere or on inert, basically indestructible terra firma and in terms of excessive destruction, i.e., vaporizing or liquefying human and material targets which, for military purposes, it would suffice merely to kill or disrupt.H

This quality of "overkill" in nuclear weapons, while inherent in the whole development of explosive-on-target weapons, has reached the point of halting, or at least suspending, another historical continuity--the search for constantly greater explosive energy. There are indications that the major problem in nuclear weapons development today has become one of packaging smaller, not larger, concentrations of power in the individual unit delivered on target, in order to avoid a degree of destruction that, far from serving military purposes, may run counter to them.

Nuclear firepower, despite its waste of explosive energy, has added a theoretical dimension of destructiveness to warfare primarily in the strategic sphere. Almost two decades after Hiroshima, cities appear to be almost wholly defenseless against nuclear attack. But it is important to remember that the increase in destructive power is true in a special and limited sense--the capability for destruction within a given unit of time. Man has always possessed the power to kill and destroy; and this is an absolute power. On the whole, ancient cities were sacked and obliterated more thoroughly than those in the recent past: Nineveh, Babylon, Tyre, and Carthage, for instance. And during the closing months of World War II, the fire storms unleashed by American bombing raids on Tokyo (rather than the damage caused by the bombs themselves) inflicted more devastation than did the atomic bombs dropped on Hiroshima and Nagasaki.

The defenseless city is not a new phenomenon in history. The best analogy to modern weapon systems (nuclear-tipped, long-range missiles or nuclear-armed, strategic bombers with their supporting systems) is not to be found in individual weapons of the past, but in the effective weapon system of the 13th-century Mongol horde, which could wipe out segments of civilization in weeks and months. Walled cities could not repel these forces which employed amazing speed, mobility, engineering skill, and striking power. For longer than we have lived with the nuclear weapon, a large part of the civilized world could find no defense against the Mongols other than distance. Today, even distance no longer avails. But overnight, a new breakthrough (in a technology which has made the very word "breakthrough" commonplace during the past two decades) could reverse this situation.

Precisely what does it mean to say that cities are defenseless against nuclear attack? In essence, it means that two of the historical means of defense--active defense through the repulse and defeat of the attacking weapon or force by one of superior strength (or "shooting down a bullet with a bullet") and passive defense through manned fortifications--are useless. There remains, however, a third means of defense which has equally valid historical credentials--deterrence^. A would-be attacker, strong enough to overcome active and passive defenses may be deterred by the threat of penalties which he is unwilling to accept. History provides a long list of such penalties—execution of hostages held by defenders, loss of territory which would be left unprotected by the movement of forces incident to carrying out an attack, the antagonism of third parties whose vital interests would be endangered, the outrage of public opinion, or simply the prospect of incurring prohibitively heavy casualties in the course of attack. All these historical "sanctions" can still be invoked to deter a nuclear strike on cities, the most effective, perhaps, being the "hostage" status of the would-be attacker's own equally defenseless cities.

It is beyond the scope of this paper to measure the extent to which the deterrent policies of the major nuclear powers have made unlikely the use of both strategic and tactical nuclear weapons. Suffice to say, the voluminous literature on this subject has explored in exhaustive detail both the nature and effectiveness of deterrent retaliatory capabilities and the still-unsolved problems of waging limited war in a nuclear environment. While the subject remains highly controversial, the prospect of a limited nuclear conflict appears, on the whole, remote.12 To this extent, the traditional concepts of the utility of military history will probably continue to have relevance for the foreseeable future.

Even if nuclear weapons are not used, however, the spectre of the atom still will hover over all actions and relationships between nations, so that military and politico-military affairs will constitute a vast poker game in which the stakes are national survival. Thus—as has been frequently noted in recent years—the responsibilities devolving upon those responsible for the employment of military force are heavier than ever before. If the responsibilities and consequences are greater, then it follows that the experiential background needed by those in responsible positions is also infinitely greater. Personal experience, awareness of history, and theoretical exercise are the three basic means by which this background can be gained and, of these three, history is the least limited and, in comparison with theory, infinitely closer to reality. It may, indeed, be found that no historical precedent

can provide guidance for some of the difficult decisions facing commanders in chief in the future—but they cannot be certain of this and cannot wisely cast loose from history unless they fully understand the range, scope, and limitations of possible historical precedents.

Both tactically and strategically, as we have seen, nuclear weapons can be readily placed in historical perspective, without minimizing the absolute or relative destructiveness of such weapons—which is unquestionably cataclysmic. Furthermore, despite the discontinuity which this awful destructiveness creates in terms of actual battlefield example, we must agree with Brigadier Jackson that

> nuclear weapons have not destroyed the positive uses of military history because these weapons are restricted to a small and, we hope, unlikely segment of the spectrum of war. On the contrary, the risks inherent in the nuclear era demand from future commanders a higher standard of military judgment.13

Judicious use of military history can provide a source of input to expand the practicality and scope of judgment.

1. C. W. C. Oman, The Art of War in the Middle Ages (Ithaca, New York, 1953), chap, iii; J. F. C. Fuller, Lectures on FSR-II (London, 1931) and Lectures on FSR-III (London, 1932).

2. See Appendix A; Glossary.

3. Ibid.; Note also that, while combat is the principal function of military forces, they also have other missions.

4. Ibid.; Note definitions of "command and control" and decision-making".

5. Battle Studies, (trans.)(Military Services Publishing Co., 1947), p. 8; the first sentence, of course, is merely a rephrasing of the aphorism first attributed to Hippocrates, but repeated by Horace, Chaucer, and Longfellow, among others.

6. "Forward-Looking Retrospect", Journal of the Royal United Services Institution, (Nov., 1962).

7. Thomas Carlyle, History of the French Revolution, VII, chap. v.

8. It may be pertinent to recall, however, the immense bombard used by the Turks in the siege of Constantinople in 1453--not in terms of its destructive power, which was not remarkable in absolute terms (though remarkable for the times) but of the size and elaborateness of the train of engineers, technicians, transport, and laborers required to serve it.

9. This is the reason why the several types of bows in ancient, medieval, and modern times tended to be products of regional or national specialization: e.g., the longbow in Wales, later adopted by England; the powerful Turkish horn bow; the crossbow (to some degree) in Genoa; the various short bows developed by the horse archers of antiquity in the Near and Middle East.

10. Strictly speaking, a sub-family within the gunpowder-weapons family.

11. A point emphasized by the multiplicity of artillery weapons as developed up to the present time; emphasized by the homely adage that one doesn't use an elephant gun to kill a fly.

12. We cannot ignore the fact, however, that both sides have the means to initiate such a war; what is likely to inhibit them doubt whether limited nuclear war can be fought in any logical coherent sense.

13. Op. cit.

Part Two

CONTROL AND DECISION-MAKING IN WARFARE

Introduction

The general purpose of Part One of this report was to show the usefulness and relevance of historical experience to modern military problems in general and to command and control in particular. Part Two scans the spectrum of command and control as exercised through the centuries: its evolution and its variations, illustrated by human actions and reactions under a diversity of circumstances.

After briefly noting the relationship of military control systems to the societies which they serve, we will discuss the way in which this relationship has been demonstrated over the course of history. The principal portion of this discussion concerns itself with control systems in general, but concentrates on the exercise of political and military control in land warfare. The last two sections deal with specialized aspects of control systems in naval and air warfare.

The Enclosure to this part of the report contains a list of some historical examples (most of which have been discussed directly or indirectly in the text) which might be suitable subjects for more intensive investigation in depth as historical case studies relevant to modern problems of command and control. These examples are roughly grouped into four categories: (1) those in which the command and control issues were primarily political; (2) those primarily involved in land warfare; (3) those primarily involved in naval warfare; and (4) those primarily involved in air warfare.

Control Systems and the Evolution of Societies

Of all military institutions, command and control systems (which have long existed, even if only recently classified as such) are perhaps most resistant to rapid and radical change. They tend to evolve gradually, adapting themselves reluctantly to the challenge of new weapons and tactics and to changes in the political and social environment. Even cataclysmic events, which may destroy armies and overturn thrones, do not alter overnight the settled ways of thinking and doing which constitute the tough inner fabric of systems in general, including those of military command and control.

Control systems must compete violently with opposing systems in order to survive;for each victor there must be a loser. History records occasions when control systems were destroyed, along with other social institutions, as a result of military defeat and conquest. Presumably this was one of the unnoticed consequences of the fall of Sumer, Assyria, and other great empires of ancient times. A more vivid example, in our own day, was the virtual destruction of the German Army General Staff system during World War II, with Hitler himself delivering the coup de grace in the blood bath which followed the abortive conspiracy of July 1944.

Command and control systems, by their nature, however, have roots in the societies they serve. War and conquest may obliterate all that shows above ground but, if the society itself survives, the roots are likely to sprout new foliage that strongly resembles the old. It is far too soon to conclude, for example, that the new military institutions now emerging in Germany and Japan, following the apparent extinction of the old, will assume forms wholly different from those that flourished before the war.

The processes of institutional diffusion are more pervasive here than in other areas of cultural interaction. The very pressure of competition between hostile military systems creates a common environment in which mutual imitation becomes a law of survival. The transfer of characteristics is, of course, primarily from stronger, more successful systems to weaker ones; but the reverse process also operates. Eventually major differences among systems tend to disappear. The whole process of mutual imitation counteracts--and in turn is modified by--the opposing tendency of national or cultural peculiarities to perpetuate themselves. Like other social institutions, military control systems often take form, in their early stages of development, in relatively isolated national environments, sheltered from powerful external pressures. But once fully formed they must, through the sheer necessity of performing their natural functions (i.e., in war or preparation for war), plunge forthwith into competitive struggle with systems of adjoining societies. In the course of the struggle strong systems become dominant, imposing their essential features on the weak, but absorbing in the process some of the useful features of the latter.

The Exercise of Political and Military Control in Land Warfare

The Origins of System: Macedon and the Ancient World

The pattern of development is illustrated by the Macedonian command and control system, the instrument of Alexander's conquests

and the first of the fully documented great military systems—the foundation on which all later systems in the Western world were built. Carefully forged by Alexander's father, Philip, in the mid-4th Century B.C., it grew to maturity on the fringes of Greek society, shielded from major tests of strength against either the dominant Greek military systems—Sparta and Thebes—or those of the moribund Persian empire to the east. Naturally it built upon already existing foundations: the traditional Greek phalangial system, with supporting arms, which had triumphed against the Persians in the preceding century; and the brilliant innovations of the Thebans, which had been dramatically successful against the dominant Spartan system in the Battle of Leuctra in 371 B.C. But it was a fully mature system, tempered in a long series of "safe" border wars against weaker opponents and refined by methodical organization and training, which at Chaeronea (338 B.C.)—a battle of which we know little except that it occurred—decisively crushed the phalangial armies of Greece and inaugurated its career of conquest.

This Macedonian command and control system contained, in essence, the basic principles on which all succeeding systems have been based. These were: a general plan of battle, with concrete objectives specified for subordinate elements; some degree of coordination among the combat arms; and the retention of a mobile reserve, to be committed only at the critical point and time to influence the result. The purely phalangial system which it superseded, basically rigid and suited primarily to defense in a fixed position, had no such flexibility.

For two centuries or more the Macedonian system was widely imitated and dominated land warfare in the ancient Near East; it gradually lost vitality in the process. At P/dna (168 B.C.), it succumbed to the Roman legionary system which too evolved slowly and was protected in its formative years from dangerous external threats. Long before Pydna the Romans had overcome, by a narrow margin, a formidable challenge in the wars against Carthage whose military power was derived primarily from its wealth and the genius of its great commander, Hannibal, rather than from its military or social institutions, inferior, on the whole, to those of Rome. Hannibal's techniques of control, at the peak of his success, differed little from the model created by Alexander. The legionary system, on the other hand, was supreme for the ensuing five centuries and contributed significant new features of strength in the instituional areas of command and co ntrol--formal doctrine and training, tactical organization, linkage, chain of command, and underlying social and political cohesiveness--which made it astonishingly immune to the shortcomings of mediocre commanders.

Primitive and Sophisticated Control Systems

The interacting processes of competitive imitation and national or cultural differentiation described above can be seen in operation throughout the centuries of subsequent development. They can be seen, in our own times, in the history of the German Army General Staff system which, with national variations, was imitated by all the military powers of the early 20th Century and, despite its formal extinction at the end of World War II, remains a powerful influence today.[1] Each of the great military systems of history has produced its own variants of the systemic elements of control.2 But over the whole immense span of time from the 4th Century B.C. to the 19th Century A.D., the underlying characteristics of military control in land warfare have remained remarkably constant.

The most obvious distinction is between relatively primitive and relatively sophisticated systems. In the former (normally a feature of societies still in an early stage of development--the Goths, the Franks, the Vandals, the Northmen, the Arabs of the initial Islamic conquests, and the Seljuk Turks), command and control--characteristically permissive and largely ineffective--merits in general only passing mention. But a few, startling exceptions to the usual association of primitive control systems with young societies should be noted. The Ottoman Turks, for instance, developed a highly refined, effective, centralized command and control system which, in its day, was one of the best in the world. In the 13th Century the Mongol system was even more formidable--perhaps the most formidable in history. Conversely, the feudal society of medieval Europe, paradoxically founded on war as its raison d 'etre, which dedicated its dominant elite to the pursuit of war and which attained high levels of sophistication in most spheres of human development, never achieved an effective system of military control, even in the great religious military orders.3 Under firm leadership, on rare occasions, medieval armies operated with discipline and tight control (as Richard I showed at Arsuf and Jaffa, 1191). But the more typical performance brought disaster to the massed chivalry of central and eastern Europe, including large contingents from France at the hands of Mongol cavalry armies (at Liegnitz and the Sajo River, 1241). This was the triumph of a truly sophisticated, finely wrought control system over one that remained crude and unfinished, even after many centuries of development.

Until the 19th Century, the more sophisticated military control systems of history were more restrictive than permissive in character; the single commander was customary. On occasion, however, command was exercised by two or more coordinate commanders simultaneously or alternately (e.g., in different sectors of the battlefield), or through a "council of war", which imposed its direction on one or more operational commanders. These occasions were comparatively rare for, even when the principle of divided battlefield command has been institutionalized, it has often been evaded in practice. Under single

commanders, control systems tended to be restrictive rather than permissive, by virtue of the confined arena in which battles were fought and owing, in turn, to the limitations of weapons and communications. Napoleon's control of the course of battle at Borodino or Waterloo (1815) was scarcely greater, or less, than that of Marlborough at Blenheim, a century before, or that of Alexander at Arbela, twenty-one centuries earlier. Each commander, on each occasion, could see most of the battlefield. Probably the major advance in command and control, over the entire span of time, had been the personal withdrawal of the commander from combat in order to direct maneuver.This increased the flexibility with which commanders could manipulate reserves, shift committed elements from one sector to another, and otherwise employ maneuver after the battle was joined. Well into the 19th Century, the Napoleonic concept of the commander's coup d 'oeil (as the essence of military genius and the controlling factor on the field of battle) provided the traditional image of command and control. Yet the coup d 'oeil was an illusion. Both it and the commander's battle plan remained (and still remain) largely at the mercy of the accidents of battle--sudden panic, unexpected resistance by troops who "should" have yielded, but did not, the intercepted message, the misunderstood order, or the unnoticed terrain obstacle.6

In viewing the long development of these systems, no "law of progress" is discernible. Control systems emerge and evolve as part of the institutional fabric of a society. As a society decays, so does its military control system. There is, of course, a recurrent progression from simple to more complex, sophisticated forms of military control, but this kind of development cannot be equated necessarily with successful adaptation to the competitive environment. History is strewn with the ruins of sophisticated control systems which collapsed before rudimentary ones: the Roman legionary system, with seven centuries of growth and glory behind it, fell at Adrianople (A.D. 378) before the onslaught of ill-organized Gothic horsemen; seven centuries later, the professional turmas of Byzantium were crushed at Manzikert (A.D. 1071) by the Seljuk Turks, semibarbaric horse-archers originating in the steppes. In neither case can it be assumed that the system was more at fault than the accidents of circumstances and (at least at Adrianople) poor generalship. Whatever the direct causes, these catastrophies were reinforced by the indirect effects of underlying political and social deterioration which inhibited subsequent recovery.

The Modern Revolution in Warfare

In the 19th Century all modes of warfare were profoundly transformed by the French and Industrial Revolutions. From the forces

released in Europe by these two interacting revolutions the citizen soldier emerged: fervidly patriotic, relatively literate (and thus susceptible to nationalistic propaganda), suspicious of his superiors, averse to military discipline, often mutinous, capable of vast endurance and prodigies of valor, but also fickle and easily panicked. He was armed with weapons of growing precision, accuracy, and destructiveness. Command and control systems had to be adapted to the fundamental changes in the soldier and his weapons and to the increasingly complex supporting linkage mechanisms. Revolution and war intensified nationalistic feeling everywhere, giving governments enormous powers over war-making resources, including the power to call forth young and middle-aged men by the hundreds of thousands. This levee en masse, soon institutionalized in national systems of conscription, became an accepted instrument of the new way of war.

In the realm of technology, the 19th Century brought about spectacular, revolutionary new weapons which, from the middle of the century on, immensely increased the volume and effectiveness of firepower. These innovations scattered and drove to cover the dense masses of troops that for centuries had crowded into relatively small battlefields. The army commander was left far out of sight or sound of most of his troops, and the individual unit or sector commander had in increasing degree to make his own decisions.

Yet this trend toward permissive control systems and decentralized decision-making that resulted from the massive increase in firepower did not in itself imply a weakening of command and control. Conditions of warfare placed new demands on doctrine as well as on the initiative and resourcefulness of subordinate commanders and on the efficiency of military administration. The situation in which the battalion commander in the battles of 1863, 1866, or 1870 found himself when dealing with the enemy immediately confronting him, was essentially the same as that faced by Alexander, Caesar, Gustavus Adolphus, and others who had massed whole armies on single battlefields and maneuvered them by voice, trumpet, standard, and courier. With few exceptions, only the messenger remained to link the lonely battalion commander with other commanders to his right, or left, or with the remote general whose strategic design might succeed or fail through his actions. This was a school that bred commanders, or broke them, in short order. And it was supplemented by a growing emphasis on more formal schooling in the classroom and in field maneuvers and on the formalization of routine administration. The Prussian Army General Staff, imitated by all major powers in the late 19th and early 20th Centuries, became the symbol of a new kind of military professionalism, built upon systematic education and technical training, planned career development, carefully formulated doctrine, highly developed staff and administrative procedures, and, perhaps most important, a strict code of professional conduct and service. All this provided the ingredients for a system of command and control designed to operate efficiently and execute the purposes of the high command even after communications had been blotted out in the roar of battle.

Moreover, even while the growth of firepower was imperiling higher commanders' control of maneuver on the battlefield, the new technologies of linkage—the telegraph, the railroad, the steamboat--were enhancing the capability for effective and continuous control over strategic maneuver and the conduct of far-flung campaigns. The telegraph, alone, gave governments an unprecedented degree of control over distant commanders, curtailing their power of independent decision. In the process also, through the new medium of the popular press and field correspondents, the telegraph not only brought military operations under the scrutiny of an insatiably curious, emotional, and ill-informed public, but opened wide gaps in security curtains.

On the eve of the First World War, linkage technology verged on a breakthrough, even in the realm of battlefield communications. By means of the telephone, high commanders could hope to maintain contact with front-line units, at least in fairly static situations. Motor vehicle transport, while not yet fully adapted to large-scale troop and supply movement, offered commanders and staff officers a means of rapidly moving about the fringes of the battlefield in speedy staff cars. Radio communication, still in its infancy, was introduced. By and large, on the eve of the great war, military command and control systems had attained a degree of sophistication, and an apparent capacity to use effectively the new instruments of warfare, which competent observers found entirely reassuring. The holocaust of 1914-1918 proved them to be wrong.*1*

The breakdown in command and control in World War I was due not alone to spectacular advances in weaponry; it was caused by the larger economic revolution which swept both Europe and the United States during the 19th Century. A vast accumulated potential for mass production and movement of war materiel, implemented by a new form of levee en masse (with women replacing men in factory and on farm) not only freed a larger porportion of manpower for combat but also produced materiel in unprecedented quantity. The "nation in arms" was replaced by the "nation at war". This flood of weaponry, other materiel, and manpower literally choked existing command and control systems on the Western Front.

Roads, wire, and such innovations as small-gauge railroads for hand haulage on the battlefield itself, were obliterated by massed artillery. Unit commanders had little scope for imaginative action in the prison of interlocking trench systems and the heavily manned, continuous, sealed frontwhich the Western theater became by 1915. Until the Germans introduced their Hutier tactics there (1918), there seemed no alternative to frontal attack by massed infantry behind a rolling barrage of artillery; and even this invariably bogged down, through exhaustion of men or supplies, after an advance of a few miles or yards. The new tactics provided no answer to the

problem of continuously moving up—and behind the advancing attack—the immense quantities of materiel needed to sustain momentum. Finally, and extremely significant, the sheer erosion of initiative and hope among men at all levels of authority was the result of sustained exposure to front-line conditions.

In other theaters of the war, however, where geography and terrain permitted tactical and strategic mobility, the sophisticated command and control systems developed by 1914 worked adequately. Indeed, the consistently superior performance of the Germans, who were almost always in inferior numbers on the Eastern and Italian fronts, is difficult to explain in terms of materiel superiority alone, and strongly suggests a high degree of qualitative superiority in the sphere of command and control.

From the end of the First World War to the end of the Second, the evolution of command and control was shaped primarily by two parallel developments. On one hand, new weaponry and improved transport permitted a revival of tactical mobility and sustained forward movement for considerable distances (most dramatically displayed in the North African desert campaigns of 1940-1942). On the other hand, despite the new mobility, developments in communications technology restored to higher commanders the capability of closely controlling the actions of subordinates. Since, however, the subordinate commander almost invariably had intimate knowledge of the situation in his own sector which was denied to his superior, the capability of frequent and even continuous communication between the two often permitted a dialogue at each stage of an operation or at each point at which a new decision was required. From this dialogue, ideally, emerged a synthesis of the two viewpoints: permitting a decision by the higher commander which blended the information and recommendations of the subordinate with his own knowledge of the larger situation and the broad objectives of the operation. The fairly frequent occurrence of this kind of situation in World War II pointed to the need for resourcefulness and self-reliance on the part of subordinate commanders. Combat operations were too fast moving, and communications breakdowns too common, to permit a reversal of the general trend toward permissive and flexible control systems that had begun a century or more earlier. But the merging of the commander's broad view with his subordinate's local view of the battlefield situation made possible a kind of technological balance among the means of fire, movement, and communication, presenting an entirely new environment for decision-making.

Political Authority and Military Control

The warrior king—combining in his person supreme political and military authority--who personally led his troops in battle, was one

of the oldest and most continuous players on the stage of military history. But in 1815, with the passing of Napoleon, the last of the "great captains" and warrior kings, the institution became extinct for all practical purposes. The tradition lives on, symbolically, in heads of state who, in virtually all countries, whether their authority is real or nominal, are vested with formal command of the armed forces. This is true in the United States, which has no royal tradition; in France, a presidential republic with an ancient tradition of monarchy; and in present-day Great Britain, a constitutional monarchy where real sovereignty resides in the legislature. It was true in prewar Japan, a constitutional monarchy where the military advisers of the Emperor held the reins of power; in the Second German Reich of the Hohenzollerns, a traditional constitutional monarchy with power centered in the crown; and in Hitler's Third Reich, a naked dictatorship.

Under warrior kings, such as Alexander of Macedon, Charles XII of Sweden, and Napoleon Bonaparte, acute problems of defining the role of political authority in the military command structure did not arise. But in the 18th Century, especially in France and part of Germany, royal favor frequently placed titled incompetents in posts of high command, where their amateurish meddling jeopardized the conduct of military operations by the professionals. In effect, the political authority of the state was projected downward into the regular command structure, where its actual role tended to be capricious and irregular. The ensuing difficulties stimulated the growth of rudimentary military staff systems in this period, particularly the emergence of the institution of the "chief of staff"--called also maitre des logis or general quartier meister--who carried on the real work of planning campaigns and co-ordinating military administration behind the facade of the nominal royal high command. It is significant that the example of Napoleon, who was a genuine warrior king, actually set back the institutional development of European command and control systems until the emergence of the Prussian General Staff in the mid-19th Century.

The Prussian General Staff emerged primarily in response to the growing complexity of war and military administration and resulted in increasingly strict delimitation of the political and military spheres of authority. The whole thrust of new military professionalism, as expounded by its apostle Clausewitz, emphasized the subordination of the military to the political authority as a pure instrument of state policy rather than a power determining its own ends. The Prussian philosopher of war wrote:

> The subordination of the political point of view to the military would be unreasonable, for policy has created the war; policy is the intelligent faculty,war only the instrument, and not the reverse. The sub-ordination of the military point of view to the political is, therefore, the only thing which is possible.

This meant, in theory, that the political authorities of a state would define policy, including the decision for or against war and if the former, the broad objectives to be sought in conflict. It was the responsibility of the professional military leaders to advise their political superiors as to the feasibility of the objectives prescribed and then, whether or not their advice was accepted to try to achieve them. The political authorities, for their part, had the obligation to provide the means required by the military to carry out approved policies, including authority commensurate with responsibility.

By the end of the 19th Century, this theory corresponded with the actual division of labor between the two spheres of political and military authority in most nations. The difficulty lay in delimiting exactly, in concrete situations, where the line should be drawn between the two. In other words, assuming that supreme political authority was exercised by a civilian executive (whether absolute or responsible in turn to an elected legislature), who was ultimately responsible for the conduct of war, the question arose whether the conduct of the war, at the next lower level of authority, should rest with the professional military leaders or should remain under the supervision of the chief executive, either directly or through intermediate civilian, political officials. The American President, Polk during the Mexican War, took a direct part in planning and coordinating strategy, and both Presidents, Lincoln and Davis, in the American Civil War, participated actively in the strategic direction of military operations. Legislative intervention at this level of military control occurred more rarely, but the role of the Civil War Congressional Committee on the Conduct of the War vividly illustrates the problem.

Nevertheless, by World War I, governments generally accepted the proposition that the immediate "military" direction of war should be left to the professionals. In the American system this acceptance was institutionalized in the sharp organizational division of responsibility. The military establishment divided authority between politically appointed civilian secretaries, who controlled the expenditure of money for military purposes and supervised the technical and administrative bureaus (headed by military officers), and the professional military chiefs of the armed services who, in "military" matters (i.e., strategy, operations, training), reported directly to the President, although they remained subordinate to the civilian secretaries in "administrative" and "technical" matters This arrangement theoretically ensured that no civilian judgments or attitudes would be interposed between the top military leaders and the civilian commander in chief, to whom they were directly responsible

In prewar Germany, an authoritarian government with a strong militarist tradition, the sphere of professional military authority was somewhat broader and, within the military establishment, civilian influence was weak. To an even greater extent than in the United States, the basic Clausewitzian principle prevailed--that the actual conduct of war, below the level of policy-making, was a professional military matter. The implications of this view, and the evidence of its acceptance, were exemplified in a dramatic incident on August 1, 1914. At that time Emperor Wilhelm II was informed by the younger Moltke, his Chief of Staff, that it would not be possible to redeploy against Russia the German armies which were already massing in the opposite direction for an invasion of France. The shift seemed desirable on the political grounds that this would influence England not to intervene on the side of France. The significance of this incident was not the Emperor's acceptance of this verdict but the fact that, under the established division of authority, military leaders had been given free rein in military plans and arrangements which, by circumscribing the political options, actually dictated policy at the highest level. (That this was totally inconsistent with the military philosophies of Clausewitz seems never to have occurred to the Germans, his most ardent disciples.)

Most other governments also embarked upon the First World War with the military in full control of the "military" aspects of the war effort, as variously defined. In the United States, President Wilson, rejecting the traditions of Polk, Lincoln, and Davis, carried the principle to an extreme. In Germany, under the pressure of defeat and growing hopelessness, the already dominant military eventually took over de facto control of the government.10 In other countries, however, the general paralysis of strategic control in the high commands, and the pressure of defeats and casualties, influenced a movement in the opposite direction to a reassertion of civilian leadership. The two revolutions in Russia in 1917, the subsequent overthrow of the Hohenzollern dynasty in Germany, and the disintegration of the old regime in Austria-Hungary reflected the general reaction against professional military leadership.

In Germany and Russia this reaction was related to war-weariness and disillusionment with the performance of the armies in the field. But disillusionment was relatively short-lived in both countries. The German public soon regained faith in the nation's inherent military prowess and readily accepted the "stab-in-the-back" legend as an explanation for the army's defeat. In Russia, the Red Army had the good fortune to start with a clean slate, blaming defeat on the old imperial officer corps and generals who were no longer on the scene. In the early postwar years, victories over counterrevolutionary and foreign armies provided a basis on which to build a new Russian

military tradition. Nevertheless, both the Soviet and (after 1933) the German military leaders were victims of the classic suspicion which revolutionary regimes seem to harbor against the professional military class. Hitler used and rewarded the Wehrmacht leaders who were loyal to him, but kept them under tight control; Mussolini, while his power lasted, also dominated the generals; and in Russia, the purges of 1936 and 1937 were attempts to insure the communist leadership against political ambition on the part of generals. Even in Spain, under Dictator Franco, the military were unable (despite the prestige accruing from their victory in the civil war) to equal the dominating role of the Falangist party. Among the major powers, only in Japan did the military gain a steadily increasing ascendancy over the political leadership during the interwar years.

In the West, the status of professional military leaders suffered in varying measure from the widespread pacifism and antimilitarism of the years following the war. The French army, with its tradition of monarchist, Bonapartism, clericalism, and antirepublicanism, was especially suspect in the turbulent, usually left-of-center politics of the Third Republic. The British public and politicians did not readily forget the military blunders and huge casualties of the war. And so, on the even of World War II, the United States seemed most confident of the competence of its professional military leaders, perhaps because of the very limitations which tradition and the Constitution placed upon them.

During that conflict the tight rein of political control was most conspicuous in Germany and Russia. Stalin held the ranks of Marshal of the Soviet Union and Generalissimo, in addition to de .facto supreme political authority, and closely guided both strategy and day-to-day military operations. Hitler coordinated the operations of all the armed forces through OKW (Oberkommando der Wehrmacht) and, from December 1941 on, personally commanded the army as well. Of all' the dictators, Hitler's exercise of supreme military command was the most personal, confident, and meticulous. In addition to controlling the machinery of high command, the dictators also used another instrument of totalitarian political control over the military: direct surveillance by special agents, both clandestine and overt, at all levels of command. In Germany and Italy, substantial segments of the armed forces consisted of special elite corps (such as the SS in Germany), directly controlled by the party; and in all the totalitarian countries, dedicated party members held many key positions of command. Japan's military rulers, by contrast, held power until the last moments of the war, and in Italy, the shaky dictatorship of Mussolini, unequal to the strains of military defeat, yielded power, progressively, to the military.

Civilian control in the democracies depended more on constitutional and traditional sanctions, reinforced by special wartime arrangements. But personal leadership played a significant role. Franklin D. Roosevelt's control of the military, particularly in the direction of strategy, was both permissive and capricious—but firm. The military, for their part, showed not the slightest inclination to overstep the constitutional limits of their responsibilities. They grumbled over the President's occasional intrusions into strategic planning and demanded a degree of regulation of the national economy which neither he nor the Congress was willing to grant. But they accepted, without question, the principle of "civilian control" and, within that framework, exercised greater power over the nation's war effort than had ever before been accorded American military men.

Congress, it has been said, was willing "to trust in God and General Marshall", and the military ended the war with some $50 billions in unused appropriations. Purely from an organizational point of view, the machinery of command and control, from the President and Joint Chiefs of Staff down to the major theater commanders (bypassing in practice the civilian service secretaries in matters of strategy), was an impressive managerial achievement in a nation that had never taken much interest in military management. The self-restraint exercised by the American military leaders in exercising the freedom of action permitted them is illustrated by an incident which occurred less than a year after Pearl Harbor. When the Joint Chiefs of Staff were informed by the President's civilian advisers that their proposed budget strained the economic capacity of the country, they lopped $10 billions off the budget without Presidential intervention.

In Great Britain, civilian supremacy was also unchallenged during World War II. The energetic Prime Minister, who also held the post of Minister of Defense, entered far more deeply into the processes of strategy-making and the conduct of campaigns than in the United States. At the high command level, as his own memo ires and those of Lord Alanbrooke testify, Churchill's tireless and insistent attention to military problems of all kinds, from decisions on major strategic objectives to technicalities of military administration or equipment design, was the despair of his chiefs of staff. Where Roosevelt refrained from reaching below the Joint Chiefs of Staff to the level of theater or field command, Churchill had no such scruples. Unlike the American system, the British formalized civilian control at the cabinet level in a small War Cabinet operating through its own Defence Committee, over which the Prime Minister, as Minister of Defence, also presided. The chiefs of staff (including a personal chief of staff to the Minister of Defence, analogous to Roosevelt's personal chief of staff) were an integral part of the Defence Committee and collectively responsible to the War Cabinet through the Minister of Defence.

Experience in Naval Warfare

The problem of command and control in naval warfare is both simpler and more complex than that involved in land warfare. It is simpler, primarily, because naval combat is conducted on a barren plane surface.[11] It is simpler, also, in the fact that, while variants in the formation and maneuvers of land forces are almost infinite and are limited only by numbers of men and amounts of equipment available to the fertility of imagination of the commander, water-borne organizations are self-contained. Each individual vessel is a weapon system complete in itself and incapable of alteration to conform to some changing condition of the moment.[12]

Finally, while methodology of accomplishment has changed in tempo with technological developments the basic objectives of naval operations have not altered; they resolve themselves into a comparatively few clear-cut missions. These are:

1. Command of the sea (destruction or neutralization of enemy major naval combat forces),

2. Commerce destruction,

3. Commerce protection,

4. Projection of naval power ashore: (a) naval weapons attack on enemy land targets; and (b) ship-to-shore amphibious operations,

5. Blockade, and

6. Blockade evasion.

The complexity of naval command and control lies in the fact that the naval commander has neither opportunity nor capability physically to interject his personality upon some specific segment of his command in combat. It is not uncommon for a ground-force commander to visit one of his subordinate units during a moment of crisis. The naval commander, until a few years ago, carried his flag in one of the combat units of his battle line—usually, by long custom, one of the most powerful vessels. Once combat was joined, therefore, the naval commander was confined to that particular unit and shared its fortunes; his ability to control the action limited to the use of signal communication.[13]

Until the turn of the 20th Century, when radio began to span oceanic gaps, long delay and hazard in communications made the strategic control of naval flotillas, once they were at sea, a matter of additional complexity. As a result, the general pattern of naval command and control became a melange of restrictive

initial directives and of the loosest sort of ultimate combat control. Both the fleet commander and subordinate unit commanders were thrown upon their own initiative, victims of a system in which the later approval of higher authority might be measured only in terms of adherence to doctrinal regulations, regardless of conditions of the moment. A Byng, off Minorca (1756), could be court-martialed and shot for not observing the letter of his instructions; a Porter at Puerto Rico (1823), could be castigated for upholding the dignity of the United States by armed force. In both these cases the naval commander on the spot—out of communication with his superiors-¬ used his own snap judgment.

Against these cases, one can cite a Tattnall—under similar conditions—bringing his American squadron into action to support the British attack on the Taku forts off Tientsin in the Second Opium War (1859) because, as he said: "Blood is thicker than water." Tattnall's action received the hearty approbation of his superiors. Nor can we overlook the Trent case of 1861, when the kidnapping of Confederate commissioners from a British liner brought the United States and England to the brink of war. Wilkes' snap judgment — arrantly illegal--brought him first a gold medal from Congress, later a slap on the wrist from his embarrassed superiors.

The advent of radio, it might be assumed, would correct this impasse between conditions of the moment and routine instructions, without undue curb on initiative. However, such was not the case on August 4, 1914, when the German warships Goeben and Breslau passed safely under the guns of HMS Indomitable and Indefatiguable because the British Mediterranean commander decided against their molestation. Technically, Britain was not yet at war with Germany, though all concerned were aware of its imminence within hours. So the German ships arrived safely at Constantinople, bringing Turkey into the war and changing the entire course of the struggle. Initiative which might otherwise have saved countless thousands of lives had been throttled by restrictive command and control— though a court-martial later cleared the admiral.

The introduction of the submarine into warfare not only had impact on surface battle doctrine for command of the sea, but also on the missions of commerce protection, commerce destruction, and blockade evasion. In our own time is the extremely significant impact of the Polaris submarine missile on the missL on of projecting naval power ashore. The advent of the submarine exacerbated the linkage problem of command and control at sea not only because of the difficulties of communicating with a submerged vessel, but also because the vulnerable underwater craft could rarely transmit messages without attracting unwelcome attention from hostile aircraft and surface ships.

The general communications problem was to some extent alleviated in World War II when the U.S. Navy initiated use of a "command ship"—equipped with multiplicity of electronic paraphernalia which would enable immediate and adequate communication throughout the command as well as under superior authority. In this new type of flag-ship, not a part of the battle line, the commander retained both control and liberty of movement in combat. However, this development was far from solving the problem of the detached unit commander, isolated from communication by enforced radio silence and confronted by an unexpected situation.

Finally, and particularly pertinent to the new problems of warfare, was the emergence of the aircraft carrier task force as the dominant weapon at sea. It is interesting to note that, despite the increasing complexity of naval warfare, and the growing pervasiveness and effectiveness of automated, naval command control systems, the course of the greatest sea battle in history (Leyte Gulf) was dictated primarily by independent actions of different Japanese and American admirals, acting on their independent initiative. This might indicate that the naval commander of today, despite the wealth of a sophisticated electronic linkage lying at his finger-tips, still must be ready to exercise his own initiative for decision in emergency; his situation is possibly no whit different from that of his predecessor on the quarterdeck of a wi.id-ship of the 16th Century.

Experience in Air Warfare

Air warfare has grown, within a fifty-year span, from the "knight errant" individual warrior clashes reminiscent of the age of chivalry to a primary element in the integrated application of combat power in modern war. Insofar as command and control are concerned, linkage has leaped from the finger-pointing, wing-wagging, and display panels of World War I air combat to highly complex and almost foolproof electronic apparatus. The strategical leap, closely following the successive unfolding of heretofore unsuspected powers has been to a great extent free of traditional preconceived, and possibly obsolescent, command and control systems inherited by both ground and naval forces.

Despite its short historical span, useful lessons or ideas may be provided by case studies of air warfare's kaleidoscopic progress. Many of them are relevant to the over-all problems of command and control today and in the future.

Like naval warfare, air warfare embraces a limited category of missions:

1. Reconnaissance.

2. Command of the air.

3. Support of ground and sea forces (this, in turn, can be broken down into missions of interdiction and close support).

4. Long-range (or strategic) bombardment.

5. Transport (which can be broken into sub-missions of combat transport support and logistical transport support).

6. Air defense.

It would appear that except for the actual melee of air-to-air combat, the execution of air missions has been more successful under a highly restrictive command and control system. For example, in air defense we have the rigid ground control and supervision of elements of RAF Fighter Command in the Battle of Britain, 1940. Squadrons were literally "led" by ground control to their designated targets and unleashed only when contact had been made. Except during the air combat itself, pilots and subordinate commanders exercised no initiative.

It would appear that the degree of success of support missions, also, has been dependent upon the rigidity of command and control exercised not only by the air component but by the supported force. However, the truth of this generalization must be verified by further intensive study of close support operations in both World War II and in the Korean War. This would entail comparison of the relative success of Marine and naval aviation and of USAF tactical support units on similar missions.

Use of land-based air power in support of naval operations also deserves detailed scrutiny. It was successfully employed by both Germany and the Anglo-American Allies in World War II. The Luftwaffe played an important part in keeping British sea power well offshore along the Scandinavian, Atlantic, and Mediterranean coast-lines. The U.S. Army Air Force and the RAF both contributed much to anti-submarine defense in the Battle of the Atlantic. In all these cases, air operations were directed by quickly extemporized and not always efficient command and control systems. This was particularly true of U.S. Army Air Force bombers operating with the Navy along the Eastern Sea Frontier of the Continental United States, and of the bomber squadron based on Ascension Island (both in 1942).

These random examples emphasize the necessity for a complete survey in depth of air warfare as practiced in the last score of years. The examples are many. One could question, for instance, the efficiency of U.S. Army Air Force command and control as exercised on Luzon airfields in the Philippines on that fateful December 8, 1941.

One could examine the causes of the costly "short bombing" in Normandy on July 25, 1944, in the breakout (Operation COBRA). Was command and control at fault in these instances? One could, on the other hand, derive valuable positive information from study of the excellent tactical air support furnished by the XIX Tactical Air Command in support of the U.S. Third Army in Patton's "race through France" of August 1944. Most valuable of all, for the future, would seem to be an analysis of the command and control exercised by the Joint Chiefs of Staff and by General H. H„ Arnold in Washington over the world-wide operations of the Strategic Air Force during the period 1943-1945.

Notes

1. The main historical trends in the development of command and control are surveyed in Appendix C.

2. Analyzed in Part Two.

3. The art of the individual warrior was, of course, carried to a high state of perfection, and feudal military organization was admirably adapted to its original function--the preservation of local security in a highly decentralized society. It was, however, ill-suited to sustained, systematic warfare.

4. One of its few apparently successful manifestations--the partnership of Marlborough and Eugene--was an example of alternate voluntary subordination by one commander to the other, within the framework of ostensibly coordinate command.

5. This, however, did not preclude the assumption of personal command in time of extreme crisis. Vide, for example, Napoleon at Areola (1796) and Lutzen (1813).

6. Clausewitz' great treatise on the uncertainty and dynamism of war is still the most perceptive critique of command and control.

7. See Appendix C.

8. There was, of course, Napoleon III, a rather pathetic shadow of his great uncle; and the bizarre, terrifying Lope of Paraguay.

9. On War, Bk VIII, Ch VI, Part B. (Trans. 0. J. Matthijs Jolles, New York, Modern Library, 1943), p. 598.

10. During the closing weeks of the Civil War the Confederate Congress had thrust a similar role on the unwilling shoulders of Lee.

11. Although land masses constrict naval operations close to shore, and while the increasing range of land-based air power presents further restrictions, neither these specialized conditions nor the existing submarine terrain obstacles affect the validity of the basic statement.

12. Vide Appendix B.

13. On rare occasion a commander whose flag-ship was disabled or mortally injured in combat has successfully shifted his flag to another vessel. Vide Perry at the Battle of Lake Erie (1813).

Enclosure to Part Two

SOME HISTORICAL EXAMPLES RELATING TO THE FUNCTIONING OF MILITARY CONTROL SYSTEMS

Primarily Related to Political Control

Pre-World War I

1. Lord Germain and British strategic control in the Revolutionary War.

2. The French Revolutionary control system.

3. Exercise of command by five civilian President Commanders in Chief: Polk, Lincoln, Davis, Wilson, Roosevelt.

4. Political control of Union and Confederate forces in the Civil War.

5. The Trent Affair.

6. The relationship of Lincoln and Grant, 1864-1865.

7. Control of armed forces in modern crises preliminary to war, 1853-1956 (Crimean War, Civil War, Franco-Prussian War, World War I, World War II, Korean War, Suez-Sinai invasion).

World War I

8. Civil-military relations in Germany in World War I.

9. Civil-military relations in France, England and the United States in World War I.

World War II

10. A comparative examination of civilian control in the British and American military systems in World War II (including a preliminary analysis of prewar origins).

11. Political controls in the command and control system of Germany in World War II.

12. Political controls in the command and control system of Russia in World War II.

13. Eisenhower's decision to stop on the Elbe, April 1945.

14. Truman, Stimson, Spaatz, and the decision to drop the first atomic bomb.

Post-World War II

15. Political control of UN forces in Korea, 1950-1953.

16. Control of Allied forces during the Berlin Blockade, 1948-1949.

17. Landing of American forces in Lebanon, 1958.

18. Control of Allied reaction to the construction of the Berlin Wall.

19. Control of U.S. forces during the 1962 Cuban Crisis.

Primarily Related to Land Combat

Pre-World War I

1. The Mongol control system of the 13th Century.

2. Frederick the Great's control system.

3. The influence of revolutionary ideology in the exercise of command at subordinate levels in the French Revolutionary and Napoleonic armies.

4. Napoleon's control system (including Davout and Bernadotte at the Jena-Auerstadt, etc.).

5. Lineoln-McCleilan and Halleck-Grant in 1862; a comparative study.

6. Lee, Jackson, and Longstreet, 1862-1863.

7. Lincoln and Grant in 1864-1865.

8. Grant's control system, 1864-1865.

9. Thomas in the Nashville Campaign, 1864.

10. VonMoltke's control system, 1866,1370.

11. The Little Big Horn Campaign, 1876.

World War I

12. The German, French, British, and American staff systems at the outset of World War I; a comparative analysis.

13. Operation of the German, British, and French command and control systems in the Marne Campaign, 1914 (including the Battles of the Frontiers).

14. Operation of the German and Russian command and control systems in the Tennenberg Campaign, 1914.

15. The Battle of Lodz (Von Schaffer and the Grand Duke Nicholas).

16. British experience in controlling front line and reserve units, 1915-1918.

17. Falkenhayn and the Battle of Verdun.

18. Adaptation of the German control system to the Italian Front, 1917.

19. The Ludendorff-Hutier tactical system.

20. Phasing and management of the Allied counteroffensives of 1918.

21. Development of artillery fire-control techniques, 1914-1918.

World War II

22. German, French, and English command and control systems in the Battle of Flanders, 1940.

23. Hitler's control system on the Eastern Front, 1941-1945.

a. The change of direction at Kiev, 1941.

b. The Hedgehog defense in front of Moscow, 1941-1942.

c. The German summer offensive of 1942.

d. Stalingrad.

e. Hitler vs. Manstein and Model with regard to flexible defense.

f. The decision to defend Budapest.

24. Malaya-Singapore, 1941-1942.

25. The Philippines Campaigns, 1941-1942, 1944-1945.

26. The Burma Campaigns, 1942, 1944-1945.

27. Initiative vs. control at Anzio, 1944.

28. Clark's decision to capture Rome, 1944.

29. Controls exercised over Eisenhower by Marshall and over Montgomery by Brooke in operations at Normandy, 1944.

30. Truscott in the invasion of southern France.

31. The Ardennes Campaign, 1944-1945.

32. The Remagen Bridge.

33. Patton's Rhine crossing at Oppenheim.

34. Development of American artillery fire-control techniques, 1930-1945.

Post:-World War II

35. The decision to land at Inchon, 1950.

36. The advance to the Yalu, 1950.

37. MacArthur's command relationships with Walker and Almond,

38. JCS controls over Ridgway and Van Fleet, 1951-1953.

Primarily Related to Naval Combat

Pre-World War I

1. The Royal Navy's control system from Drake to Nelson (including consideration of the Fighting Instructions).

2. Problems of control in America's Barbary wars.

World War I

3. Admirals Troubridge and Milne in the Goeben-Breslau incident, 1914.

4. British control of surface operations in World War I (including Jutland, etc.).

5. German control over submarine commanders, 1914-1918.

6. The German navy's decision to initiate unrestricted submarine warfare.

7. Trie Royal Navy's response to unrestricted submarine warfare.

8. Allied convoy control in the North Atlantic, 1917-1918.

World War II

9. German control over submarine cocnmanders, 1939-1945.

10. Allied convoy control in the North Atlantic, 1939-1945.

11. French and British naval commanders at Mers el Kebir and at Alexandria, July 1940; a study in contrasts.

12. Disengagement of the Royal Navy during the Battle of Crete.

13. Operation of high-level Japanese and American control systems at the time of Pearl Harbor.

14. Operation of the American and Japanese naval control systems in the Pacific War, 1941-1945 (includes Midway, operations in the Solonons, Philippine Seas, Leyte Gulf).

Primarily Related to Air Combat

World War I

1. Evolution of control systems for air warfare, 1914-1913.

World War II

2. German direction of air forces in blitzkrieg, 1939-1941.

3. The employment of RAF Fighter Command in the Battle of France, 1940.

4. The control of RAF Fighter Command in the Battle of Britain, 1940.

5. The American air control system in the Philippines, December 1941.

6. Development of an Allied system of tactical air warfare in World War II.

7. The Allied control system in the bombardment of Germany.

8. German control of V-Weapons, 1944-1945.

9. Japanese efforts to retain air superiority in the Solomons, 1942-1943.

10. The employment of air transports in the Arnhem-Nijmegen operation.

11. Control of German air defense forces, 1943-1945.

12. American control system in the bombardment of Japan, 1944-1945.

Post-World War II

13. Development of an American control system for air support of ground forces.

14. Employment and control of air forces during the Berlin Blockade, 1948-1949.

15. Restrictions on UN air operations over North Korea, 1950-1953.

Part Three

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. This brief, exploratory study demonstrates that, despite the technological developments of our times, military history is relevant to modern problems of military leadership, command and control, and decision-making. This comparability is promising. The extent and limitations of relevance can be determined only by more detailed study, applying in depth the analytical potentialities inherent in historical research, which have been demonstrated in breadth in this preliminary exploratory study. Intensive research can be specifically directed to provide guidance to Sandia Corporation in the designing of devices and procedures for an effective command and control system.

2. The task of designing devices and procedures for an effective command and control system may be compared to Aristotle's "mean" of courage--somewhere between foolhardiness and cowardice. The problem of perfecting a system which avoids both rigidity of central command and control and adventitiousness at the line of action is complicated by the need to wed decisiveness at the center with timeliness in the field. Yet no system so far devised, nor to be developed, can completely compensate for the nonquantifiable human element.

3. A sequential relationship exists between (a) the potential consequences of a kind of military action, (b) the degree of control exercised by responsible authority over such kinds of military actions, and (c) the effects of such control on initiative at subordinate levels. It is impossible to quantify the relationship, for the relative importance of each factor varies with differences in weapon systems, as well as with other tangible and intangible influences. A rigorous and detailed analysis of historical experience relevant to the modern environment of war can, however, greatly illuminate this relationship. The analysis would need to include the following points:

a. Consequences and decision-making

(1) Relationship of weapon destructiveness to deployments

(2) Effects of isolation on responsiveness to command

(3) Effects of awareness of consequences on a decision-maker

(4) Effects of awareness of consequences on a subordinate's responsiveness to command

(5) Extent to which possible consequences inhibit initiative and the levels at which this is significant.

(6) Other psychological influences of consequences on decision-making

The element of initiative in a command and control system

(1) The importance and value of initiative at different levels of command

(2) The dangers of initiative; variations dependent upon command levels

(3) Factors inhibiting initiative

(4) Encouragement of initiative within a control system framework

(5) Minimizing the dangers of initiative

(6) The importance of the personal history factor in the selection of responsible subordinate commanders

Control aspects of a command and control system

(1) Relationship of weapon destructiveness to the degree of control exercised

(2) Assurance of responsiveness to command

(3) Extent to which there can, or should be, limitations on political involvement in military command

(4) Control in a disaster situation

(5) The problem of adaptation to unforeseen circumstances

(6) Differences between control in combat, and in noncombat, crisis situations

(7) Degree to which various requirements of control may be mutually conflicting

(8) Dealing with potential threats to effective control

4. The basis for such analysis will be provided by a number of carefully selected historical case studies. To assure a broad and representative basis, the examples will include instances relating to political controls, as well as an equitable selection from land, sea, and air warfare.

Primary emphasis will be laid on examples from the 20th Century, but pertinent experience from the pretechnological era will provide a comparison of human reactions in widely varying environments and circumstances. The command and control factors in crises leading to war will be compared with those in crises in which war was avoided. Examples will also include both permissive and restrictive control systems, functioning under a wide variety of circumstances.

5. Relevant situations or experiences that should be studied in considerable depth are classified as follows:

(1) Examples relative to political controls and to the military control systems for land, naval, and air combat.

(2) Highly developed control systems in the pretechnological era.

(3) A control system operating in a noncombat crisis leading to war.

(4) A control system operating in a noncombat crisis in which war was avoided.

(5) Successful operation of a permissive control system.

(6) Failure of a permissive control system.

(7) Successful operation of a restrictive control system.

(8) Failure of a restrictive control system.

(9) Example of a restrictive control system established primarily for political purposes.

(10) Success of an allied control system.

(11) Failure of an allied control system.

(12) Successful instance of direct political intervention in military operations.

(13) Failure of a direct political intervention in military operations.

(14) Successful high-level military intervention in subordinate conduct of operations.

(15) Failure of high-level military intervention in subordinate conduct of operations.

(16) Breakdown of a control system due to faulty doctrine.

(17) Breakdown of a control system due to command failure.

(18) Breakdown of a control system due to human "friction".

(19) Breakdown of a control system due to communications failure.

(20) Breakdown of a control system due to intelligence failure.

(21) Breakdown of a control system due to fortuitous or unexpected circumstances.

(22) Breakdown of a control system due to enemy action.

(23) Breakdown of a control system due to "overloading" or insufficient reaction time.

(24) Example of decision-making in disaster circumstances.

(25) Example of subordinate decision-making in a relatively isolated environment.

(26) Example of successful subordinate initiative in a permissive control system or after a control system breakdown.

(27) Failure of subordinate initiative in a permissive control system or following a control system breakdown.

(28) Successful circumvention, or deliberate violation, of restrictions on part of subordinate commander.

(29) Failure resulting from circumvention, or deliberate violation, of restrictions on part of subordinate commander.

(30) Failure of a subordinate to comply with commands, due to his awareness of exceptional consequences of the required act.

6. We have selected twenty-one case studies (all containing aspect relevant to modern problems of command and control) from the list contained in Part Two to meet the criteria of paragraphs 3 and 4, above.

A list of the selected case studies, with a brief statement indicating their relevance to the problems of decision-making and initiative in command and control systems may be found in Enclosure 1. Enclosure 2 contains a matrix relating the twenty-one selected case studies to the criteria listed in paragraph 5, above. This matrix will also help to suggest which aspects of these case studies warrant the most detailed attention.

7. The exploratory analysis undertaken in Study "Pre-Alert" indicates that historical experience provides useful insights into other aspects of the always variable problem of command and control. Some of the data which have already emerged in this study, though not directly relevant to the development of techniques and devices for modern command and control systems, are of such significance to coalescing concepts and doctrines of civilian and military leadership and of command and control systems in the modern world as to merit prompt attention. The specific additional areas which we believe deserve such immediate and serious study by Sandia Corporation or appropriate governmental agencies are the following:

a. The problem of recognizing and developing qualities of initiative and creative leadership in the environment of modern, largely automated, command and control systems.

b. Tine relevance of military command and control systems to the American concept of "civilian control".

c. Pertinent Presidential experience in military command and control since the Mexican War.

d. The concepts and underlying issues involved in the development, before World War I, of the General Staff system, the organizational origin of modern command and control systems.

e. The problems of command and control of multinational, multilingual allied forces, including the effects of different cultural backgrounds, values, military traditions and concepts, and levels of economic development on communications, responsiveness to command, initiative, and related subjects.

f. Specified historical turning points in warfare prompted by the integration of new weapons, or concepts, into then-traditional methods of waging war, to ascertain the relative importance of the factors producing the change, in order to gain insights into the comparable problems faced by today's planners who seek to guide the transition from "conventional" warfare into the nuclear era.

Recommendations

HERO recommends:

1. That an intensive, critical study be undertaken of historical experience relevant to the introduction of devices and procedures affecting military decision-making into a modern command and control system. An outline and a detailed working plan for this study, entitled Study "Alert" are being submitted.

2. That additional areas for related study in the subject of command and control, as suggested in paragraph 7 of the Conclusions, be considered for further research.

Enclosure 1

SELECTED CASE STUDIES FOR INTENSIVE INVESTIGATION OF COMMAND AND CONTROL ASPECTS

1. The Mongol System of command and control, 13th Century. An example of a strategic and tactical command and control system, operating in the pretechnological era, but involving conditions that may well prove applicable to modern battlefields. As with nuclear weapons, the Mongol system could wipe out populations and civilizations, even though at lesser speed. On the battlefield, the Mongols operated over vast distances with minimum resources, maneuvering from both fixed and mobile bases with powerful hit-and-run tactics in a manner that may well be applicable to the nuclear battlefield.

2. The Royal Navy's control system from Drake to Nelson. An example of the development and effects of a highly restrictive command and control system, strictly enforced over a number of years, and the influences which led to its later disappearance in favor of a less centralized, permissive tactical system.

3. Political control of armed forces in modern crises preliminary to war, 1853-1956. This period provides the opportunity for studying international crisis leading to war under an instructive variety of political, military, and technological conditions. Wars studied will include the Crimean War, U.S. Civil War, Seven Weeks' War, Franco-Prussian War of 1870, Russo-Japanese War, Boer War, World Wars I and II, the Korean War, and, possibly, lesser conflicts.

4. Operation of the British naval control system during the Goeben-Breslau incident, 1914. A brief, but illuminating example of the problems of effective command and control in a non-combat crisis situation in which war is imminent, including the consequent frustrations to local commanders confronted by a dangerous, unforeseen situation fraught with political and military implications.

5. Operation of the German, British, and French command and control systems in the Marne Campaign, 1914. An example in military history in which there was an almost complete breakdown of communications and linkage within the German armies and, to a lesser extent, within the French and British armies. There was also a similar breakdown in linkage between the French and the British Allies. This involved several instances of exercise of subordinate initiative following a control system breakdown or degradation. That these events occurred in the opening stages of an era of vast, unforeseen changes in warfare provides added instructiveness.

6. Operation of the German and Russian command and control system in the Tannenberg Campaign, 1914. Similar in some respects to the Marne Campaign, this example is particularly useful because of the way in which a command and control system recovered from near collapse due to the independent but coordinated efforts of several highly trained professionals, at least one of whom also exhibited an exceptional degree of initiative to exploit the opposing system's breakdown.

7. Control of German submarine operations in World Wars I and *TL.* An example of the political problems of employing exceptional weapons in modern war, including useful examples of problems of control of dispersed units with difficult linkage arrangements, as well as the actions and reactions of isolated subordinates.

8. Control of Allied convoys in World Wars I and II. Examples of highly restrictive, yet highly successful command and control systems. The linkage and control techniques are particularly relevant.

9. Development of American artillery fire control systems, 1917-1945. Concerned with the evolvement of perhaps the most highly specialized and effective technological control system to be developed for an instrument of land warfare prior to the nuclear age, this study should have direct relevance in terms of hardware to the problems faced by the Sandia Corporation today.

10. German, French, and English command and control systems in the Battle of Flanders. .1140^" An example" "of a highly successful German tactical control"system in a new era of warfare, as opposed to a collapse of the French system intensified by political intervention. The British system, on the other hand, continued to function under adverse circumstances, also in the face of political intervention. Even more significant was the political involvement on the German side.

11. Control of RAF Fighter Command in the Battle of Jrita in. The successful operation of a highly centralized "and "restrictive command and control system (which was also extremely permissive within narrow limits) under adverse conditions in one of the decisive battles of world history.

12. Hitler's control system on the Eastern Front, 1941-1945. This is probably the most clear-cut example in modern times of the imposition by a head of state of centralized control over field operations. As such, it is extremely pertinent to Study "Alert".

13. Operation of the American and Japanese command and control systems in the Philippines Campaigns of 1941-1942 and 1944-1945. Several kinds of pertinent experience are encompassed in these campaigns, e.g., the complete breakdown of American Air Force command and control at the outset; and the interesting comparison of the operations of American and Japanese commanders confronted by a dangerous, unforeseen situation fraught with political and military implications.

14. Operation of the Japanese and Allied command and control systems in the Burma Campaigns of 1942 and 1944-1945. Provides a useful comparison to the preceding example through parallels and differences, but also with greater political complications on both Allied and Japanese sides.

15. Operation of the American and Japanese naval control systems in the Pacific War, 1941-1945. Individual examples of success and failure of control systems will be elaborated as well as instances of the exercise of initiative by subordinate commanders on both sides, actions in disaster situations, action in isolated circumstances, etc.

16. Initiative versus control in the Anzio and Rome Campaigns in Italy, 1944. These two operations involved much the sane cast of characters in two widely differing kinds of operations, in both of which there were issues of Allied differences. The first shows a relaxation--virtual abnegation--of command responsibility by a higher commander, resulting in a highly controversial decision by the subordinate. The second shows the circumvention of command by a subordinate.

17. The Ardennes Campaign of 1944-1945. A highly instructive comparison of German, American, and British command and control systems under circumstances far different than those in 1940. The political influences on both sides are significant, as are also the manners in which intermediate field commanders reacted to opportunities for initiative.

18. Allied air control systems in the bombardment of Germany in World War II. Examples of ooth restrictive and permissive control systems, including numerous instances of exercise, of subordinate initiative, failure to use initiative where it might have been expected, and the frustrations of commanders under extreme provocation by uncooperative or unfriendly allies (Russian).

19. Development of an American control system for air supjaort of ground forces. Demonstrates the problems of evolving "a satisfactory control system to meet a wide variety of requirements, including examples of system breakdown, or degradation, in World War II and the Korean War. This is an illustration of a wide variety of technical and psychological problems in a still-current and controversial issue of command and control.

20. Political control of American forces during the Berlin crises of June 1948 (beginning of the Blockade)" and" July 1961 (construction of the Wall). A highly pertinent nuclear-age"~ example, in which the crises did not lead to war but were fraught with incendiary possibilities which could have precipitated conflict. Coordination among allies at the highest political level, as well as at military operational echelons, figured prominently in the crises.

21. Political control of United Nations forces in Korea, 1950-1953. One of the few modern examples of political control over a truly multinational army. It al**.SD** provides an opportunity to study an example of limited war where various possibilities for escalation (including nuclear weapons) were present but were avoided despite, in some cases, considerable pressure from military leaders.

ENCLOSURE 2

Matrix Comparing Selected Case Studies to Kinds of Examples to be Investigated

	1. Moncrol Svstem		3. Pre-War Crises. 1853-1956	4. Goeben-Breslau	5. Marne CamDaicm	6. Tannenberg Campaign	7. German Subs, WW I & II	8. Allied Convoys, WW I & II	9. Am. Artillery Fire Control	10. Battle of Flanders. 1940	11. Battle of Britain, 1940	12. Hitler. East Front. 1941-45		14. Burma, 1942, 1944-45			17. Ardennes. 1944-45	18. Allied Bombardment of Germanv. WWTI	19. American Air Support to Ground Forces)		
1. a. Political Situation			x	x															x	x
b. Land Situation	x.		x		x	x			x	x		x	x	x		x	x				x
c. Naval Situation		x	x	x			x	x							x						x
d. Air Situation			x					x		x	x		x	x	x			x	x	x	x
2. Pre-technological example	x	x																			
3. Non-combat to war			x	x									x							x	
4. Avoidance of war			?																	x	
5. Successful permissive	x	x	x		9	x	x		x	x	9		x	x	x	9	x	9	9		9
6. Failure, permissive			x	x	9	x	9			x			9	x	x	x	x		9		9
7. Successful restrictive			x				x	x			x	x						x	9	x	9
8. Failure, restrictive		x	x				?					x							⊁		9
9. Restrictive, primary pol.			x									x								x	x
10. Successful Allied			9					x						x		?	9	x		x	x
11. Failure, Allied			?		9					x				x		9	9				9
12. Successful pol. intervention			x				9	x		?		x					?			x	9
13. Failure, pol. intervention			x				9					x		x			9				9
14. Successful mil. intervention	x				x	x	x	x	x		x			x	x		x	9	9		9
15. Failure, mil. intervention		x			9					x				x	x	x	9	?	9		9
16. Breakdown, faulty doctrine		x		9		x				x					x				9		
17. Breakdown, command failure				9	x	x				x		x	x		x	9	?				
18. Breakdown, human friction					x	x							x	x	x	9	9		9		9
19. Breakdown, comm. failure		x	9		x	x	9						x								
20. Breakdown, intell. failure			9			x								x	x		x				
21. Breakdown, unexpected sit.		x	9	9			9					x			9						
22. Breakdown, enemy action						x	x			x			x	x	x		9				?
23. Breakdown, overloading			x							9	9		9	9	9				9		
24. Disaster situation						x				x		x	x	x	x		9				?
25. Isolated situation							x	9	x		x	9		x	9		9	x	9	?	9
26. Successful initiative		x	9		9	9	?	x		x	x	9	x	9	x	9	x	x	x		?
27. Failure, initiative		x	9		9		9						9	?	x	x	9	x	x		?
28. Successful circumvention		x	?									x			9	9		9	9		?
29. Failure, circumvention		x	9												9	9		9	9		9
30. Failure due to consequences			x	x			9											?		x	x

Appendix A

GLOSSARY

Administration: In its broadest sense, this comprises all military activity which is not operational. Thus it covers matters pertaining to materiel, facilities, services, and the provision of personnel. The most important part of administration is logistics, which has to do with the physical support, maintenance, and, above all, supply of armed forces. The words "logistics" and "administration" are sometimes used interchangeably.

Authority: The clearly understood status of an individual which permits him to issue commands to, and to exercise control over, subordinates.

Chain of Command: The successive commanders through which command actions are channeled. The chain of command extends downward from superior to subordinate and upward from subordinate to superior.

Command: The authority which a military officer exercises over his subordinates because of his rank and/or his assignment to a position of responsibility by recognized, properly constituted authority.

Command and Control: A general, and somewhat imprecise, term of relatively recent origin which refers to the process by which a commander exercises control, particularly employed with respect to long-range nuclear striking forces or to defensive forces created primarily for the eventuality of a general nuclear war. The term is usually considered to include the entire process of military decision-making, beginning with the collection of intelligence, its transmission to a commander's headquarters, the evaluation of the intelligence, the estimate of the situation, the decision, the issuance of orders or directives, and the assured receipt, and proper interpretation, of directives by subordinates. An important aspect of this concept is the communications linkage which carries the intelligence and other information to the commander and which transmits the directives to subordinates.

Communications: As used in this study, this refers to all physical means of transmitting messages, information, or orders from one element of a military force to another (see Linkage).

Control: This is the process whereby a commander effectively directs military forces so that they are fully responsive to his will. Control requires adequate means or measures to ensure the cooperative and coordinated efforts of subordinates in carrying out his command assignment; it includes the organization of forces for combat, the assignment of tasks to subordinates, the designation of objectives, and the authoritative direction necessary to accomplish the mission. Control depends on mutual recognition of authority by superiors and subordinates.

Decision-Making: This is the entire process by which a commander reaches a conclusion on several alternative courses of action open to him. The process includes consideration of all factors relating to the issue. It includes correlating and evaluating intelligence, estimating the known military situation at the time, and usually formulating the specific conclusion into the form of an order to be issued to subordinate commanders.

Doctrine: Principles, policies, and concepts which are combined into an integrated training system for the purpose of governing, and assuring consistent, coordinated employment of, all components of a military force in combat. The origin of doctrine can be experience, or theory, or both. Doctrine represents the best available thought on the employment of forces that can be defended by reason. Doctrine is methodology and, for it to work, all military elements must know, understand, and respect it.

Escalation: An increase in the scope or intensity of an armed conflict. In its most common use, the term is used to refer to a possible change of a limited war (nuclear or conventional) to an unlimited nuclear war. It is also used to refer to any kind of stepping up in combat intensity, such as from undeclared guerrilla war to a declared formal war or from a war involving a small number of participants to one involving a larger number of participants.

Linkage: As used in this study, the term means the physical means and measures whereby a commander exercises his control and assures the coordination of all elements of his command. The principal form of linkage is a sigial communications system, which can include all manner of electronic devices which transmit information and directives from one element of a command to another. It can also include liaison, staff visits, or any other means whereby an exchange of information, or the transmission of orders, can be effected.

Logistics: See Administration.

Operations: All those aspects of military activity directly pertaining to combat engagements. This includes matters that are both strategic and tactical. Matters connected with operations are also called operational.

Responsibility: The obligation to carry an assigned task to a successful conclusion. It is axiomatic in military doctrine that responsibility should include the authority necessary to direct and to take proper actions essential for carrying out the task. Responsibility also includes accountability for failure to accomplish the task successfully.

Staff: A group of assistants upon whom a commander relies for study and recommendations relating to all factors affecting the accomplishment of his mission and for the transmission of his desires to subordinate commanders. Staff action consists of co-ordinated translation of the commander's decision into the minute details of operations and supply. The members of a staff do not assume the commander's responsibilities, though with his permission they may invoke his authority; their role is merely to assist the commander in reaching sound decisions and otherwise exercising his command obligations.

Weapon System (or weapons system): A general and imprecise term of relatively recent origin, possibly more useful to military budget management than to operational concepts. The standard military definition is: "The system which encompasses the weapon or weapons and associated materiel employed to bring the destructive power of the weapon against the enemy." This, however, is considered inadequate for purposes of this study, and the following definition is substituted:

> A weapon system is an aggregation of men, weapons, and associated materiel, organized to operate together in response to the directives of higher authority, and in accordance with a coherent, explicit, and clearly understood operational doctrine, in such a way as to exploit the destructive or casualty-inflicting capability of a particular type of weapon, or complementary group of weapons. A weapon system can be designed to operate independently, or as a discrete element of a larger combat force; the larger combat force may, in turn, be considered as a weapon system if its mission is primarily concerned with the employment of a particular type of weapon or complementary group of weapons. Thus, a warship, a basic unit of combat aircraft, a basic unit of combat ground troops, or a long-range missile unit—along with their respective noncombat supporting elements—could each be considered as basic weapon systems. At the same time, larger groupings of identical, similar, or complementary basic weapon systems can, in turn, be considered as weapon systems; for instance: carrier task force, a submarine hunter-killer group, an infantry division, an armored division, a tactical air wing, a long-range bombardment wing, a complex of long-range ballistic missiles.

Appendix B

SURVEY OF WEAPONS AND WEAPON SYSTEMS IN HISTORY

Introduction

Throughout the course of history, weapons have been the principal determinant of military operational doctrine. The elaboration of this doctrine has resulted in the grouping of weapons, fighting men, and supporting equipment into a kind of structure or organization best calculated to ensure optimum tactical employment of the basic weapon or weapons in combat. In relatively recent times, the groupings of weapons, men, and ancillary equipment have been somewhat loosely described as "weapon systems".* Since a major consideration of military decision-making must be the proper tactical employment of weapons and weapon systems, this historical survey is intended as a backdrop for surveys of the history of command and control.**

In addition to the general discussion of weapons and weapon systems in history, in this text, the time-span of weapons in history and the relationship of the time-span to weapon systems is graphically shown in four enclosures.

The Age of Muscle

From prehistoric times, through antiquity and the bulk of the Middle Ages, to the first decisive application of gunpowder (about A.D. 1450, in the Hundred Years' War, and A.D. 1453 at the siege of Constantinople), man himself was the propelling force behind the weapons he employed in warfare. Though there were two basic weapon groups—missile (the hand-hurled rock, the sling, the bow, the javelin, the catapult) and shock (the club, the spear, the pike, the lance, the sword)—both depended mainly for thrust or propulsion on the muscle of man.

Human muscle power was augmented by a number of mechanical devices such as the lever and the pulley as well as gravity, tension, and, especially, torsion. The bow and arrow enabled man to hurl his missile faster, further, and more accurately. Augmentation of human strength was provided, of course, by the horse, the chariot, and the elephant, but these, too, were merely another form of animal muscle power and were wielded or controlled primarily by the hand of man. Thus, the age of warfare prior to the application of the propelling force of gunpowder may be classified as the Age of Muscle.

*See definition, Appendix A

**See Appendices C and D

Many of the weapons developed in primitive times were carried over into the early historic periods of warfare in one form or another. Their basic improvements were due to the introduction of metals—first bronze and later iron. The arrow, for example, changed little for two millennia except that rather than being tipped with stone, it later bore a head of metal. The club and, later, the axe underwent similar change. Perhaps the first new weapon of the metallic era was the sword, though even this weapon had its prototype in the stone dagger and the stone-tipped javelin and spear of prehistoric times. On the other hand, the thin blade of the sword could not have been created until metallurgy had advanced sufficiently to permit the working of hard malleable metal, in the Bronze Age sometime before 2000 B.C. Thus, the sword was probably introduced by the Egyptians, or possibly the Assyrians. During this same period, protective armor, both body armor and the shield, also was improved, though leather remained the basic material for armor for many centuries.

Rudimentary weapon systems—in the sense that tactical groupings for delivery of weapons are weapon systems--began to develop sometime before 1500 B.C., when warriors were first grouped according to their weapons, missions, and relative mobility. The basic component of armies was a large unwieldy mass of foot soldiers, or infantry, as they would eventually be known. These men could carry various forms of thrusting spears or pikes and were protected by little or no armor. There were also foot skirmishers with missile weapons: archers, slingers, and javelin throwers.

Infantry was not, however, necessarily the decisive arm. This role usually fell to a contingent of small, horse-drawn, armored carts or chariots, sometimes equipped with sharp blades projecting from the wheels. Or often men on horseback, later known as cavalry, usually operating from the flanks of the great mass of infantry, were decisive. Yet, horses were expensive, and men on foot were numerically predominant; the cavalry was an elite force.

Little organization, training, discipline, or tactics existed in these early armies. While a skirmishing screen of archers and slingers maintained harassing fire in the front, the infantry spearmen were more or less herded together in great masses, a hundred or more in depth, while nobles, on horseback or in chariots, took position on the flanks to await a propitious moment for decision.

Not until approximately 700 B.C., in Assyria, did armies begin to take on those characteristics of organization and tactics that were to persist in one form or another through the ages; weapons remained much the same. But about 600 B.C., mounted archers originating in the heart of Asia—the Scythians of antiquity—became the principal element of a new military power appearing on the Persian plateaus; and Persian cavalry became the mainstay of Cyrus[1] and Darius' armies.

Soon after this, amid the rocky hills of the Greek mainland and the Aegean Islands, there developed what may be called the first true weapon system: the Greek phalanx, a disciplined body of heavy infantry. Called a hoplite, the individual infantryman was armed with an eight- to ten-foot pike and was protected by metal helmet, breastplate, greaves, and shield. While archers delivered harassing fire, the hoplitai were arrayed in long, solid lines varying in depth from eight to sixteen men, protected on the flanks by lightly armed troops and, sometimes, by small contingents of cavalry. Everything was designed to contribute to the shock effect of the solid mass of the phalanx. In 490 B.C., the defeat of the Persians in the Battle of Marathon proved dramatic evidence of its power.

Beginning with the 5th Century B.C., the catapult and ballista, weapons which could be called artillery, began to assume a noteworthy place in warfare. Both were wooden, crew-served weapons. The catapult used the force of tension to propel large arrows up to 500 yards, while the larger ballista employed the force of torsion to hurl large rocks for comparable distances. Though Philip of Macedon and his son, Alexander, introduced catapults and ballistae to field operations, the weight and unwieldiness of the weapons dictated that they be employed principally in siege operations.

Siege warfare was not new. Walled cities, and efforts to breach them, had puzzled warriors from prehistoric times. Many ways to deal with fortifications had been developed: blockade; destroying food sources; the battering ram; the movable tower; large shields (leather, wicker or wood) to protect besiegers; flaming arrows; and digging or mining to undermine walls. Extensive field fortifications ware apparently used first by the Romans, who formed camps which were protected by trenches and by palisades composed of stakes carried by the soldier as part of his individual equipment.

The phalanx remained the basic ground weapon system for a long time. Even Alexander's use of "field artillery" and, in particular, his effective employment of heavy and light cavalry were designed to contribute to the effectiveness of the heavy phalanx and his disciplined light infantry. Whereas Philip had made each large unit a separate phalanx, leaving intervals between units, Alexander subdivided the phalanx into four chiliarchiae which, for maneuver, were further subdivided into four 250-man syntagmae that could wheel about when faced with threat on a flank. The aggressive, fast-moving Macedonian phalanx, with its 21-foot pikes (sarissas), was the epitome of the phalangial system and, for more than a century, remained the dominant tactical system in the world.

As the phalanx was superseded by the Roman legion (in the 3rd and 2nd Centuries B.C.), no major new developments appeared in small arms; there were, however, some significant refinements, such as the Roman gladius (short sword) and pilum (javelin). Moreover, a unique departure in weapons had been forcibly brought to Western attention in 326 B.C., when elephants were encountered during Alexander's campaign in India. Both Pyrrhus and Hannibal subsequently used elephants against the Romans but, in general, disciplined foot-troops accustomed to the beasts were able to stand against them and to induce them to stampede.

During the course of its long existence, the legion underwent various changes. In its earliest and best days, it consisted of approximately ten cohorts, totalling some 4,000 men. Each cohort was further subdivided into four maniples, plus a small contingent of cavalry. In battle, the legion was usually arranged in three lines: the maniples (each a small, loose phalanx with intervals sufficient to permit each legionnaire to wield his sword) were deployed with intervals between maniples so that they were in a quincunx or checkerboard formation; the maniples of the second line covered gaps in the first; and those in the third line covered gaps in the second. The true genius of the legion organization lay in the combination of flexible maneuverability and solid defensive capability of the maniples, which numbered 120 men. And military professionalism and fervent patriotism were integral components of the legion as a weapon system.

During the wars of the Roman Empire, cavalry played no more than a supporting role, though in Asia, at the same time (in the Han Empire of China and in the Parthian Empire of a new Persia), cavalry remained the major arm. In both China and Persia this development was forced by incursions of fierce tribes of Mongoloid and Indo-European peoples from Mongolia and Turkestan, whose only type of warrior was the Scythian-type horse archer. Among the Asian peoples, the Indians alone failed to make widespread use of the horse (paradoxically, the stirrup may first have appeared in India, possibly in the First' Century B.C.) .

In the early centuries of the Christian era, the Roman legion gradually declined in combat quality for many complex reasons; at the same time, barbarian pressure against the Empire's frontiers steadily increased. To give greater offensive and defensive strength to the weakening legion, the Romans increasingly utilized small mobile catapults and ballistae which became the organic infantry support weapons within cohort and legion. But the pressures of mounted Germanic and Asiatic barbarians culminated in the Roman disaster at Adriannople in A.D. 378 which caused a shift to armored cavalry from reliance upon a decaying legion. Thus, Adrianople was one of the great turning points in military history.

The Middle Ages

In the years after Adrianople, as the Romans adapted themselves to cavalry, and as raids and incursions by barbaric tribes increased, there were few new weapons introduced. A possible exception was the vicious francisca, a heavy battle-axe employed by Frankish infantry either as a projectile or as a bludgeon. A major refinement was the heavy lance, which came to be employed by a warrior wearing chain mail and sitting on a similarly protected horse. The saddle with stirrups, provided this armored horseman, a prototype of the feudal knights, with the firm base that was essential for his shock role. Additional shock effect was gained by new breeds of heavy horses from Persia and Central Asia. Heavily armored horse archers shared the primary fighting tasks for the declining Empire, while heavy infantry was relegated to a secondary role. The legion became essentially a phalanx, but in a passive, defensive, often stationary role, and as such was a base of maneuver for the cavalry. This development was to some extent a reversion to the military system of Cyrus the Great.

While the Western Roman Empire declined and fell (A.D. 476), the Eastern Empire (surviving as Byzantium) was perfecting armored cavalry and developing a highly sophisticated military system built around the turma (or division) of heavy horse archers. The Byzantines also introduced a new decisive weapon—Greek fire, initially employed during the first Moslem siege of Constantinople in A.D. 673. Apparently a mixture of sulphur, pitch, niter, petroleum, and, probably, quicklime, which burst explosively into flame when wet, the material was packed into tubes and squirted onto hostile vessels. It clung to whatever it hit and burned fiercely. The Mohammedans later adopted the weapon, and used it against the Crusaders several centuries afterward (notably, at the siege of Acre, 1190, when they threw jars of Greek fire from the walls to destroy the Crusaders' siege machines). Yet, for all the effectiveness and terror of the weapon, the secret of making Greek fire has not survived.

Though military art and science degenerated in Western Europe after the fall of Rome, there was no dearth of military action during the darkest period of the Middle Ages. Worthy of mention are: the spread of Islam by military power, the military system of Charlemagne, the raids by the Vikings, the Crusades, the terrifying conquests of Genghis Khan and his Mongol successors, and the Hundred Years' War. Yet, improvements in weapons were relatively few. The most significant development in tactical organizations—and thus in weapon systems—was the amazingly efficient and scientific tactical system created by Genghis Khan from the Asiatic horse archer of antiquity. In this system, the principal element was the touman of 10,000 men, composed of 10 regiments of 1,000 men each, and subdivided, in turn, into 10 squadrons, each comprising 10 troops. Three toumans made up the horde—roughly equivalent to an army or army corps. Voice, trumpet, and drum, plus a semaphore-type system of black and white battle flags provided signals for a we11-developed system of battlefield tactics.

The Mongol battle formation was composed of five lines, each of single rank, with large intervals between the lines. The first two lines comprised the heavy cavalry, with mixed lancers and archers; the other three were made up of light horse archers only. Reconnaissance and screening were carried out in front of these lines by light cavalry units. As the opposing forces drew near, the three rear Mongol ranks of light cavalry advanced through intervals in the two heavy front lines to shower the enemy with javelins and arrows. If this preliminary long-range missile assault did not scatter the enemy, the light horsemen retired and synchronized signals started the heavy cavalry on its climactic charge.

In Europe, the armored, mounted, shock-action knight (or man-at-arms) was supreme in field operations. Despite lack of discipline and a tendency toward fractiousness and insubordination, the combination of chivalry, mobility, and the combat power of these highly skilled, heavily armed and armored horsemen produced an elan and striking power that could overwhelm larger numbers of most opposing combinations. The knight, however, was frustrated by the improvement of fortifications, which reached a zenith with the feudal castle of the 14th Century. Nevertheless—employing the castle as a base—small, mobile, mounted armies could strike swiftly and deeply into enemy territory, even though the limitations on feudal obligations prevented sustained operations. This relative mobility remained the principal characteristic of the knight, even though his body armor became heavier and heavier (culminating in plate armor in the 13th and 14th Centuries).

The gradual increase in the weight of armor resulted largely from the introduction of the 11th Century crossbow, a radically different hand weapon, incorporating the principle of the ballista. This was so terrible in its effect that the Vatican attempted to outlaw it for use by Christian against Christian. The first recorded use of the crossbow was by William the Conqueror at the Battle of Hastings in 1066. The Crusaders later seized upon this weapon to counteract the horse archers of Islam. Though cavalry sometimes used the crossbow, it evolved primarily as an infantry weapon, since it was more accurate in the hands of the foot soldier. It was an early harbinger of the infantryman's return to preeminence on the field of battle.

More significant to the resurgence of the infantryman was the introduction of a radically modified old weapon, the longbow, as dramatically demonstrated by Edward III at the Battle of Crecy in 1346. The secret of Edward's success, however, did not stem from the use of the longbow alone, but from employing a judicious combination of dismounted knights, archers, and mounted cavalrymen which produced a flexible combination of missile firepower, defensive staying power, and mobile shock action. Crecy reversed the verdict of Adrianople, and infantry once again became master of the battlefield.

The English tactics for employment of the longbow were essentially defensive. It remained for the Swiss, introducing an organization and method of combat amazingly similar to the Macedonian phalanx, to assert the superiority of disciplined infantry over cavalry in shock action. The Swiss demonstrated that massed pikes in unwavering, close-packed formation could be more terrifying to horse and rider than the cavalryman was to the pikeman. Their system required excellent organization, rigorous training, and iron discipline of a sort unseen since Roman times. For the most part, the Swiss marched and fought in heavy columns, with a frontage rarely exceeding 30 men, but often 50 to 100 men deep. They marched in cadence, often to music. In addition to basic pikemen, the formations included a few crossbowmen as skirmishers and a number of men in the interior ranks armed with the halberd, a modified pike. This was, in effect, an axe head added near the point of the pike on one side, with a hook on the other; it was more effective than the pike in close combat against enemy horsemen. For over a century, until gunpowder revolutionized weapon systems, Swiss pikemen were dominant in European warfare.

Early Naval Weapon Systems

Prior to the 7th Century B.C., employment of ships for warlike purposes was limited largely to transporting soldiers and supplies in merchant ships, essentially adjunct to land power. About 700 B.C., the Phoenicians introduced the first vessels designed essentially for fighting. These were speedy, oar-propelled galleys, longer and narrower than the typical merchant ship. But it was the Greeks, particuarly the Athenians, who improved the galley and introduced navies as a true new dimension in warfare. The Athenian trireme, as it developed about 500 B.C., was a long, narrow vessel, propelled by 100 to 150 oarsmen and equipped with a metal beak for ramming the sides of enemy vessels. Yet, ramming was difficult to accomplish, and reliance more often was placed on coming alongside and boarding. The Athenians achieved this by swerving unexpectedly, shipping oars at the last moment, and breaking those of the surprised foe. Though the trireme carried sails for auxiliary power, oars were the means of propulsion in actual battle. Since the trireme was not seaworthy in bad weather, it remained close to land and most naval action took place not far offshore.

During the 3rd Century, B. C, the larger quinquireme was introduced. Its complement consisted of 200 to 250 rowers and seamen, supplemented by a small force of sea-going soldiers or marines. Except for these increases in size, the only innovation in sea warfare followed the introduction by the Romans of a combined grappling device and boarding bridge called the coryus. The corvus, developed to neutralize Carthaginian superiority in seamanship, accomplished its purpose. Later, Octavian's admiral, Agrippa, introduced the harpax or harpage, a pole with a hook on the end. It was shot from a catapult, to be imbedded into the side of an opposing ship for grappling purposes. This was particularly effective at the Battle of Actium (31 B.C.), when Octavian routed the naval forces of Antony and Cleopatra.

Few additional innovations occurred in naval warfare until the latter half of the 7th Century A.D. when the Byzantines, reacting to growing Moslem seapower, built up a navy composed of relatively small, light, fast galleys, most with two banks of oars, two masts, and lateen sails. A small force of marines continued to supplement the oarsmen. Though the larger warships had revolving turrets mounting war engines, the most deadly weapons were the bow tubes from which the dreaded and deadly Greek fire was hurled with explosive force.

In the Middle Ages, naval warfare remained much the same, or else degenerated. The last thing, for example, that raiders like the Vikings desired was battle at sea. Yet, by the 12th Century, the rise of Italy and Sicily as thriving maritime nations, which transported Crusaders to their Holy Wars, presaged a return to importance of armed strength at sea. The oar-driven galley was still the basic warship, though some improvements in sails appeared, particularly in northern Europe. Even the advent of gunpowder had, at first, no revolutionary effect on naval weapons and tactics; but later, in the English Channel in 1588, when Spain's "Great Armada" was repulsed by broadside sailing ships, naval warfare entered a new phase.

The Age of Gunpowder

Early Gunpowder Weapons

Though gunpowder weapons were possibly first employed at Crecy, they had little or no effect on the outcome of the battle. Not until the end of the 15th Century were these weapons developed to the point that they could be ascribed as indubitable arbiters of the battlefield.* At first, size was the only distinction between small arms and artillery. Both were simple iron tubes, ignited by means of a slow-burning "match" (a cord soaked in saltpeter and then dried) which was touched to powder sprinkled in a "priming pan"; this being a slight depression on top of the tube, connected to the powder inside by a touchhole. Small arms were extremely inaccurate; artillery was no better.

Sometime before mid-15th Century, development of the matchlock--an S-shaped mechanism often called a serpentine, which held a burning cord-match and was attached to the side of the weapon--increased handgun efficiency. By means of a trigger, the serpentine could be applied to the priming pan and touchhole, now moved to the side of the gun. The match-lock led in turn to development of a butt piece, improved after mid-century into a curved or bent stock that prompted the name arquebus (or

*Early in the 15th Century, crude siege artillery made the feudal castle, or so-called vertical fortifications obsolete. Gradual development of a new type of so-called horizontal fortification provided for the 16th Century fortress a degree of impregnability comparable to that of the 13th Century. The Frenchman, Vauban, brought the art of horizontal fortification to new heights in the 17th Century.

hook-butt). The effective range of the arquebus was only about 100 yards, explaining in part why the English were slow to give up the longer ranged longbow.

Almost all early artillery pieces were too heavy for field operations and were employed almost exclusively as siege weapons. Known at first as bombards, and later as culverins, cannon, etc., these pieces, like the small arms, were mostly muzzle-loaders. Early efforts at breech-loading proved nearly as dangerous to users as to the foe. The first real successes with gunpowder artillery were achieved by the French during the period 1444-1453 when, in siege operations and defensive battles, they drove the English from France and won the Hundred Years' War. In 1453, also, the Turkish conquest of Constantinople was due almost entirely to their siege artillery train of 70 weapons, including one capsule of firing 1,500-pound stone balls.

The first crude but effective employment of gunpowder weapons as field artillery occurred in the Hussite Wars in the first half of the 15th Century. Borrowing from a technique used by the Russians against Tartar cavalry, John Ziska drew up wagon trains in a circle or a square and gave battle from this impromptu fortification. Ziska added armor to the wagons and put small bombards in the intervals between. The fire of these cannon, combined with the infantrymen's handguns, repulsed the attackers, setting the stage for the counterattack which always won Ziska's battles. But the bombards had to be emplaced on preselected ground in the laager or wagenberg prior to battle and, thus, were not actually mobile field pieces in the modern sense.

True field artillery made a sudden, dramatic appearance in the last decade of the 15th Century when the French, under Charles VIII, rode into Italy with relatively light, cast-bronze cannon mounted on two-wheeled carriages pulled by horses. About this time the French also developed the trunnion, which facilitated mounting the cannon and raising and lowering the weapon's bore for aiming.

The Spanish were the first to succeed in grouping men and gunpowder weapons into a coherent operational formation. Gonsalvo de Cordoba (El Gran Capitan), between 1495 and 1503, instigated this new kind of weapon system. Infantry armed with the arquebus provided a base of fire for maneuver and for offensive action by cavalry and infantry pike columns (organized after the Swiss pattern). The arquebusiers, in turn, were protected either by entrenchments or by pike units or both. This re-confirmed the superiority of disciplined infantry over cavalry and was the genesis of modern concepts of fire and movement with gunpowder weapons. Throughout the following century these concepts were developed further by Cordoba's Spanish successors and other European imitators.

Despite increased range and accuracy, artillery in the 16th Century was considerably less important than small arms, simply because of the weight and clumsiness of the cannon. In addition, there was a lack of standardization, due largely to experimentation. The Spanish, however, led in the employment of artillery, in close coordination with their arquebus and pike infantry unit, which became known as a tercio--a weapon system which was the forerunner of the modern infantry regiment or division. The new tactics which the Spanish pioneered brought about an increasing complexity in the coordination of the defensive-offensive employment of arquebusiers, pikemen, cavalry, artillery and engineers (responsible for field fortifications), all of them dependent upon an efficient and reliable supply of ammunition for the gunpowder weapons.

An important modification in weapons, which enhanced the predominance of infantry firepower, occurred in the second half of the 16th Century when the Spanish introduced the musket. This weapon, which had a long barrel of heavier gauge than the arquebus, was at first too heavy for a man to fire without resting it on a prop (usually a specially-made fork-rest). Later, the musket was improved and reduced in weight, but the matchlock method of firing prevailed until the development of the flint-lock in the 17th Century. Then, for more than two centuries, the smooth-bore flintlock musket, exemplified by the British "Brown Bess", was the dominant hand-weapon.

Even before the flintlock, a wheel lock firing mechanism was developed for cavalry pistols. A metal wheel at the side of the priming pan was rotated by a trigger-activated spring, which produced sparks from a piece of iron pyrites. Because the method was complicated and expensive, it found little application in infantry weapons. Wheel lock pistols, however, were extensively employed in a new system of cavalry tactics which combined firepower with mobility and traditional cavalry shock action.

The demise of the long-lived pike started in the early 17th Century (c. 1640) when the French began to plug short daggers with rounded handles into the muzzles of their muskets. Known as "Bayonnettes", from the city where the first of the daggers were made, these weapons had the obvious disadvantage of precluding fire until they were removed. Near the end of the century, a ring-bayonet, clipped into the outside of the musket barrel by a large metal ring, was devised. This was later (1805) re-fined by the addition of a spring clip that locked the bayonet in place. By the end of the 17th Century, the seemingly irreplaceable pike had almost disappeared.

The hand grenade was also introduced in the 17th Century. Because muskets were inaccurate, attacking trcops had to approach within a few yards of the foe before firing; they then charged with the bayonet. This

provided an opportunity for others to run forward and throw shells with burning fuses into enemy ranks. Since this was a risky and difficult task,the tallest and strongest men were chosen to be grenade throwers, or grenadiers. The use of special units for throwing grenades dates back to 1660; eventually, the word "grenadier" became a title of honor for elite forces. Yet because of improvements and changes in hand firearms and tactics, the grenade fell into disuse near the end of the 18th Century, not to return again until the trench warfare of the early 20th Century.

Rise of Professionalism

Coincidentally with the marked increase in importance af gunpowder weapons in the 15th Century, a trend toward military professionalism began to develop in a way not evident since the time of the Roman legions.* By mid-15th Century, following the victories brought about by Joan of Arc, the anarchy created by the disbanded companies of mercenaries in France prompted Charles VII to create 15 (later 20) compagnies d'ordonnance, consisting of 600 men each, as a permanent military establishment to maintain order in France. Charles' advisers, Jean and Gaspard Bureau, established a permanent artillery organization. This creation of a standing army enabled the French to expel the English from the country and to end the Hundred Years' War. Charles' son, Louis XI, continued the military reforms, as did his successor, Charles VIII.

In the 16th Century, the Spanish colunela (column) and later the tercio were further manifestations of the trend toward permanent units, organized usually on a regional basis. Following the Spanish, the French organized permanent units at first called legions, later regiments. Yet throughout most of the 16th Century, the expense of maintaining large, balanced standing armies was so prohibitive that, in wartime, rulers augmented their relatively small permanent forces with mercenary units, usually Swiss pikemen, German landesknechts and reiters, or Italian condottiere companies. Later in the century adequate, permanent units emerged in Europe, notably in Sweden and the Netherlands. In the latter, Maurice of Nassau, under the ever-present Spanish threat, insisted on long-term enlistments and strict discipline. The expansion of Dutch maritime commerce enabled him to pay his soldiers well and punctually. The result was a highly disciplined, homogenous, responsive, professional army, precursor of the professional armies that were to figure prominently in the Thirty Years' War (1618-1648) and in the era of Louis XIV.

*Actually, it had begun in England in the preceding century, when the Plantagenet kings introduced a system of "indenture", whereby their vassals provided standing contingents of troops in return for set payments and allowances. Even though raised and commanded by the nobles, these soldiers owed their allegiance to the king.

Though Maurice led the way, two captains who emerged during the Thirty Years' War can more properly be credited with bringing professionalism to fruition: Albrecht von Wallenstein of Bohemia and, even more notably, Gustavus Adolphus of Sweden. Wallenstein's reputation (and the plunder that fell to his soldiers) drew willing recruits to his colors; Gustavus capitalized on the rise in nationalism that was born in Sweden toward the end of the 16th Century. And both exploited the religious fervor that gripped Europe at this period.

The roots of the tremendous human suffering and political upheaval that characterized the Thirty Years' War lay not in the lack of professionalism in the armies, but in the haphazard relations of the armies with the states. Poorly organized for war, the states were unable to provide the armies' logistical requirements. War had to support war and, when coupled with religious fervor, plunder, pillage, and devastation ensued. This is a clear demonstration of the fact that weapon systems in any age reflect not only technology but also human and political organization.

In the field of weapons, the main contributions of Gustavus Adolphus were: a shortened pike (the bayonet had not yet appeared); a lighter, more reliable musket, and a paper cartridge containing both powder and the shot to go with it; and standardized, light artillery pieces, capable of being employed rapidly and flexibly not only against fortifications but directly against opposing troops. Gustavus also altered the tactical employment of the old Spanish-type weapon system. Instead of massing his infantry in solid squares, he returned to the concept of the Roman legion, using small squares interspersed with cavalry, thereby gaining flexibility and maneuverability. Gustavus also made his basic formation--the brigade of one to four regiments--a permanent organization under a permanent commander, so that shuffling of units was unnecessary when it came time for battle.

Artillery underwent few changes other than those introduced by Gustavus, primarily because the art of gunmaking already had progressed to the point where the range and power of guns was to change little for more than two centuries. The expensiveness of artillery pieces relative to military budgets had something to do with this, as did the fact that ammunition was too scarce to waste in experimental firing. In following centuries, artillery improvements were mainly limited to mobility, organization, tactics, and field gunnery techniques.

The infantryman with his musket remained the dominant force on the battlefield through the 17th and 18th Centuries. Frederick the Great and other leaders drilled their armies incessantly to speed musket fire (one of Frederick's important innovations was the replacement of the wooden ramrod with one of iron). Although cavalry shock action was often decisive, this was usually only in coordination with infantry

action. The firepower of unbroken infantry simply was too great for horsemen, whose pistol firepower was relatively insignificant and whose most effective weapon was the saber. Nevertheless, the threat of cavalry action contributed to the tendency (partly fathered by custom) to maintain tight-packed infantry formations.

Following the trend established by Gustavus, infantry combat gradually evolved into "linear tactics". In the 17th Century, the slow, cumbersome matchlock musket dictated a relatively deep formation--six men deep, more or less--in order to assure continuous fire. The usual method of fire was by countermarch of files, each man discharging his piece in turn and then dropping back to reload. To permit this, ranks and files had to be fairly open, and the men comprising them were in constant motion, individually. Thus the formation was not rigid but fluid, markedly susceptible to disorder.

With the coming of the bayonet, the need for separate contingents of pikemen and musketmen disappeared; and with the advent of the handier, more dependable flintlock, volley fire replaced individual fire. Hence the old, deep, loose formation by files gradually merged into a dense line, only three or four deep. (The generally accepted formation was two long lines of battalions, formed three or four deep.) Tactical perfection consisted in forming and maintaining perfect lines. Training of troops emphasized precise marching, accurate wheels of elements, and high perfection in the manual of arms and the delivery of volleys. This line of battle was almost as sensitive and easily disordered as the old one, but for a contrary reason--the earlier had been fluid; the new line was brittle.

Frederick the Great's incessant drill, iron discipline, and imaginative inventiveness made his infantry predominant, but Frederick had a profound effect on artillery as well. Using standardized, improved, light pieces, he eliminated the civilian contractors who had normally wheeled artillery into position. Instead, he used soldier-gunners, who were mounted on horses and were able to move rapidly. When close to the enemy infantry, Frederick's gunners exchanged solid shot for grape--50 or 60 iron balls, each about an inch in diameter. Grape shot was not new, but Frederick's artillerymen employed it with particularly devastating effect.

In the latter part of the 18th Century, the Inspector General of French Artillery, Jean de Gribeauval, having profited from fighting against Frederick, undertook a complete re-organization of the French family of artillery weapons. Restricting field pieces to four calibers, he made parts as interchangeable as possible, improved gunsights, and introduced "fixed" ammunition--the ball and charge packed into cartridges. For nearly a century, Gribeauval's 12-pounder gun dominated battlefields all over the world.

Also during the latter part of the 18th Century, two independent but related innovations presaged important tactical and organizational changes. In the first place, bitter experience in the French and Indian War taught the British (and French as well) that the tightly packed drill field formations of European combat could not be used in the forested wilderness of America. The British, therefore, developed a new type of highly disciplined light infantry, capable of fighting effectively in open order formations. The new light infantry was effective in European combat as well, though mainly as skirmishers. Other European nations followed the British example. The Germans, for instance, armed these light infantrymen (whom they called jagers) with rifles, rather than the ordinary military musket, which was the principal infantry weapon then used in the English and other armies.

The rifle had been invented in the Alpine regions of Germany and Switzerland several centuries earlier. Because of its great range and accuracy it was regularly used by mountaineer huntsmen (hence the name jager). But it had never found favor as a military weapon. Its two great advantages were outweighed by several drawbacks: it was a much more expensive, more complicated weapon; it was considerably heavier; it could not readily be adapted to a bayonet; it could not be as readily standardized as the musket; and it took even longer to load. The advantages of range and accuracy seemed relatively unimportant to 18th-century European military men, who relied upon muskets only to provide concentrated, unaimed volley fire as a preliminary to a climactic and decisive bayonet charge. But for light infantrymen, firing individually instead of en masse, the importance of accuracy and range seemed greater to the Germans.

Almost simultaneously, a similar conclusion was being reached by American colonists in conflicts with the Indians, and then in the American Revolution. The rifle had been introduced to America early by Swiss and German immigrants and, by the middle of the 18th Century, had become modified into a longer, lighter weapon, firing a smaller lead pellet than its European prototype. Called the Kentucky Rifle, it was used by mountaineers and woodsmen along the entire western frontier-the Pennsylvania mountains, Virginia's Blue Ridge and beyond, Tennessee, and the Carolinas. These American rifles, individual products of advanced gunsmithing art, were weapons of amazing accuracy, deadly at ranges of 200 yards and more as the British discovered early in the American Revolution.

Though only a relatively small proportion of Americans--and Tories-were armed with the rifle in the Revolution, it was a highly regarded weapon, ideal for light infantry tactics. As adapted and modified in the following century, this weapon was the genesis of a new family of ground force weapon systems and had the greatest effect on tactics since the introduction of gunpowder. But the transition was not made until other influences were brought to bear in a new technological era.

War at Sea

The trend toward sail rather than oar propulsion had been evident in North European waters long before the advent of gunpowder weapons, but it remained for the Battle of the English Channel (1588) to bring to a climax the long years of stagnation in war at sea. At first, the heavy weight of early cannon was inimical to the principle of light, oar-driven galleys and dangerously overloaded the upper decks of sailing vessels, making them susceptible to capsizing. Once the principle of the gun port (first developed in 1501) was widely adopted, and cannon could be placed safely inside sailing war vessels below the center of gravity, the broadside battery became practicable, and a true revolution in naval warfare developed. Long-range guns (culverin--effective range over a mile, and demi-culverin--effective range, 500 yards) completed the revolution, so that gradually war at sea developed different tactics and strategy than war on land.

The English, as early as the time of Henry VIII, recognized the tactical change made possible by broadside guns. Although for a long time boarding was still considered the main aim of battle, the English tended to put more and more emphasis on designing their ships for long-range gunnery. As a result, the fore and aft castles became lower and lower, and the beaks soon disappeared from English galleons. The proportion of big cannon to small guns steadily increased. Rather than waste space with a garrison of marines, or sea soldiers, the English sailor was trained to fight, to man a cannon, and to hoist a sail. The new tactics of long-range gunfire were first used decisively by the English against the Spanish Armada (1588). Though the actual engagements in this running fight were inconclusive, the English ability to avoid hand-to-hand combat while inflicting severe damage with long-range gunfire ushered in a new naval era.

The principal shortcoming of the galleon was that it was largely at the mercy of the vagaries of the wind. This was only partly offset by the fact that these newer, longer ships were more maneuverable than the earlier adaptations of merchant "round" ships and by improved sails and rigging, which enabled vessels to "beat" against the wind.

In the 17th Century, the newest development at sea was the Tartaglia quadrant, which enabled gunners to set the weapon's angle of elevation with reference to the horizon rather than the ship's deck. About the same time, the English introduced the blunderbuss, a short modification of the musket, which fired a big load of buckshot, particularly effective in repelling boarders. Naval tactics became stereotyped: a single line ahead, with ships smashing each other with great guns until so weakened by cannonade that one could be taken by boarding. Until well past mid-18th Century, admirals who permitted deviation from the rigid, line-ahead formation were likely to be court-martialed and the punishment in the British Navy was sometimes death.*

*See Appendix C.

Ship's cannon still were smoothbore muzzle-loaders made of cast bronze or iron; the 32-pounder, a 3-ton gun of about 6-inch caliber, was the biggest a line-of-battle ship could handle in its broadside. Late in the 18th Century, the British introduced a new piece, the "cannonade", a short, squatty gun with smashing power at close range far superior to normal armament. It was relatively light and easy to manufacture, but had shortcomings in range. Gun carriages were heavy timber frames riding on four small wheels. After firing, the gun rolled back on its own recoil until stopped by heavy breeching ropes. Late in the century, the addition of block and tackle purchases permitted improved but limited traverse of the guns, thus enabling them to be aimed without "aiming the ship". Naval gunnery was of two schools: the British directed their fire so as to hull the enemy, smash in her oaken sides and sink her; the French aimed for the enemy's tophamper to immobilize her by shooting away masts and rigging.

By the end of the 18th Century the ship of the line had become an immense wooden machine, weighing about 3,000 tons, and measuring nearly 200 feet in length, about the limit for wooden construction. She might carry up to a hundred guns.

By the 18th Century, also, there had been a few navigational innovations, such as the marine chronometer and the sextant. And improved flag signal codes were gradually developed, whereby commanders could maintain control and issue orders until the moment the battle was joined.

The Transition to Technology

The first stirrings of the Industrial Revolution were evident about the time of the French Revolution; in fact, each of these Revolutions influenced the other. New machinery, the first crude uses of steam for operating machines, dawning concepts of mass production and interchangeable parts; all were important in permitting the levee en masse, which was largely responsible for the early critical successes of the raw, undisciplined French militiamen against the professional soldiery of Europe. In subsequent decades, the amazing technological changes of the Industrial Revolution--based primarily on steam and steel--were also applied with revolutionary effects to military weapons and operational procedures. And affecting this new warfare, too, was the impact of one of the greatest of all military geniuses: Napoleon Bonaparte.

Napoleon, an artilleryman himself, put new emphasis on use of the artillery piece. "Le feu est tout", he said. Massed artillery was concentrated on a predetermined weak point in the enemy line, whereupon dense columns of infantry forced a penetration. Napoleon also made wide and effective use of the recently developed "Light companies" as skirmishers, who preceded the main formations, firing from cover to harass the enemy and ferret out his weak points. But Napoleon's innovations were more strategical than tactical; he merely made amazingly better use of the new weapons and tactics developed by his immediate

predecessors. Tactically, his victories were a result of the highest refinement of 18th-century methods; strategically, his concept and employment of the nation in arms, and of the coordinated employment of the largest armies ever seen in Europe, ushered in a new era of warfare.

The echoes of Waterloo had scarcely stilled when new inventions and innovations transformed the face of war in a spectacular new century. One of the first innovations was the percussion cap, which came into general use about 1820, followed before mid-century by the cylindro-conoidal or expanding bullet. The latter was a French innovation named the "Minie ball" after its inventor. By expanding to seal the propelling gases (which resulted in increased velocity and range), permitting standardization, and facilitating loading, it, for the first time, made rifling--and thus accuracy—truly practicable in a common military weapon. Mass production of small arms, introduced by Eli Whitney in America as the 18th Century closed, also provided practicality. The turn of the century saw the introduction of the rocket into Western warfare. But its vogue was brief; its notorious inaccuracy served to eliminate it from arsenals.

The Crimean War—despite the abysmal military leadership on both sides—was in many respects a watershed between the pretechnological and technological ages in warfare. Here, for the first time, were emphasized the tremendous new factors other than technological that were to influence warfare throughout the 19th Century and until the present. The absolute monarchial governments or the 18th Century, for example, had given way to popular and, relatively, responsible governments. (Reports from war correspondents by cable and telegraph, describing the suffering of British troops in the Crimea, brought the downfall of a British government.) Other factors, too, were having their inevitable impact: industrialism and urbanism, improved agriculture, higher standards of public education at secondary and higher levels, and increasing specialization and professionalism of the officer class, as contrasted with the aristocratic ignoramuses of the 18th-century officer caste.

A combination of all these factors, along with weapons innovations, dictated a need for new forms of military organization; the British still used their "thin red line"; the French, the skirmishers and the column, not too different from those of Napoleon; the Russians, deep, heavy masses inhibiting firepower. Although the Crimean War failed to provide new forms, it did point up the directions in which warfare now had to move.

In some respects, Europeans took longer to discern these directions than Americans. The Civil War became the real proving ground for a host of new and modified weapons, whose increased lethality, combined with the tremendous masses of men wielding them, made clear the necessity

for changes. Divisions, corps, and separate armies--all presaged in the Napoleonic era— became the norm. Divisions comprised both infantry and artillery, although additional artillery was concentrated at corps level. Fire and movement became the method by which the divisions advanced. Dispersion was essential, putting a premium on leadership at lower levels and on the courage and ingenuity of the individual soldier himself. The greater firepower made cavalry charges suicidal, so that cavalry was employed almost entirely on raiding, screening, and reconnaissance missions.

The two major technological developments in the 19th Century which were absolutely essential to many significant mechanical innovations were steam and steel. Although steam had been harnessed in the previous century, its real use for motive power on land and sea came during the first three decades of the 19th Century. Steel is definitely a mid-19th Century development. These twin giants of the Industrial Revolution played a significant role in warfare for the first time in the Civil War. Among other technological developments in the military field during that war were an effective breechloading rifle; repeating rifles and pistols; metallic cartridges and improved powder; and breechloading and rifled artillery, which fired deadly explosive shells and improved shrapnel (the latter a sophisticated form of grape shot invented early in the century by an English artilleryman). Railroads greatly expanded the size of the theater of war and gave new meaning to maneuverability and logistics. The telegraph transformed communications down to division level. Military observation balloons (first used at the end of the 18th Century in France) were employed for aerial reconnaissance. The spade developed into a weapon in its own right, as both armies were forced to entrench for protection.

While the Europeans were slower to adapt to the changes in warfare, they were nonetheless introducing new departures. The Prussians employed the breechloading "needle gun" infantry rifle (prototype of modern bolt-action small arms) in the Seven Weeks' War of 1866, although that weapon had been developed a score of years earlier. The French employed an even better, longer range, bolt-action infantry rifle--the celebrated chassep_ot - - in the Franco-Prussian War. The bayonet persisted in theory, but was little used in practice; the range and accuracy of new weapons made it difficult for infantrymen to get close enough for hand-to-hand combat.

The Prussians, in 1870, demonstrated again the military utility of the railroad, especially in a strategic sense (rapid mobilization and concentration). Artillery recoil was at last conquered, first by an ingenious trough and spring mechanism, later through hydropneumatic absorption. Solid shot for artillery pieces disappeared with the introduction of armor-piercing rounds and lighter walled, antipersonnel explosive projectiles. Shells came equipped with either time or impact fuses. And by 1870 the Prussians adopted the steel artillery piece. Concrete and steel began to revolutionize the art of fortifications.

At the end of the century smokeless powder came into use, notably in the Boer War. (Here it was at last made brutally clear to the British that compact lines, no matter how well disciplined, had no place on a battlefield peopled on the opposing side by sharp-shooting, dispersed riflemen.) The Americans, surprisingly in light of their pioneering efforts in the Civil War, were slow to adopt smokeless powder.

The most portentous land weapon of all was the machine gun. Since the appearance of gunpowder, more than one inventor had tried his hand at developing an automatic, repeating gun. In the process, some strange instruments of warfare were produced such as the orgues or organs of the 17th Century and the ill-used and short-lived French mitrailleuse of the War of 1870. The more practical Gatling gun saw some use in the American Civil War, in the Spanish-American War, and in British colonial wars. But the first true machine gun, as the weapon was finally developed, was produced by an American who became a naturalized Britisher, Hiram Maxim. In 1885 he devised a gun that used its own recoil energy to load itself, fire, and eject its own empty shells; the gunner only aimed and squeezed the trigger. Subsequently, John Browning, an American, refined the piece, using gas pressure rather than recoil for operating power. By the end of the century, all major armies possessed machine guns, but they still had not divined the tremendous impact the weapon would have on the nature of war.

The Revolution at Sea

The revolution in warfare extended to the sea as well. Early in the century most navies (particularly the British) looked askance at steam, because of the vulnerability of the paddlewheel to enemy fire and because of the way steam tethered the ships to coaling stations. But experience in the Crimean War wrote an end to sail. The propelling screw solved the first problem, acquisition of colonies the second. As late as 1870 ships still were being built with auxiliary sail power but, from approximately 1845 on, no new warhsip without steam could reasonably be built.

In combat, the line ahead (ships in single file) was still the normal tactical formation, and broadside fire was optimum. But the tacticians were toying with "crossing the T", a new version of raking, in which by superior speed a fleet in single file could concentrate its fire upon the lead ships of the slower line. Late in the 19th Century the speedy torpedo boat, and still later the torpedo-boat destroyer, assumed the important function of disrupting the hostile line by sinking individual ships. The new tactics were greatly facilitated by the new freedom from dependence on the direction and velocity of the wind.

With the invention of the hot-blast furnace in 1834, a second, concurrent revolution swept the sea as iron competed with wood for ship building. The French constructed armored warships in 1858, closely followed by the British; and the duel between the Merrimack and Monitor

in the U.S. Civil War speeded the conversion to iron and armor plate in Europe. The Monitor also introduced the revolving turret to naval ship building, heralding the advent of "all-round" fire instead of the broadside. And in 1862, the development of the open-hearth process for making steel further improved ship building and naval armor. Another improvement in warships came before the end of the century with invention of the reaction steam turbine, which abandoned the energy-wasting reciprocating piston. Torpedoes, too, at first as stationary mines and later as automotive torpedoes, were introduced. But even though various efforts were made to construct reliable submarines, serious development of underwater craft awaited the advent of the gasoline engine.

Throughout the latter half of the century, there was a race in the development of guns and armor. The shell gun, dramatically employed by the Russians in the naval battle against the Turks at Sinope in 1853, led the way. Steei, rifling, breechloading, controlled recoil, and slow-burning powders spelled increased power and serviceability for weapons. Every advance in the gun stimulated in turn a corresponding advance in the strength and thickness of the ship's armor. In the two decades from 1860 to 1880 armor increased from 4% inches to 24 inches at the water line, a thickness not later surpassed. Yet smaller vessels obviously could not compete in such a race, and armor was restricted to the larger warships, while smaller vessels like the fragile torpedo boat and the torpedo-boat destroyer sought security in speed and in the compartmentation of their hulls. About 1885, the major navies of the world adopted the modern categories of battleship and cruiser. The period of transition and blind experiment which had lasted since the 1850's came to an end, though there was no slackening in the pace of progress.

The Age of Technology

The 19th Century was the laboratory; the first quarter of the 20th Century was the proving ground. The Russo-Japanese War of 1904-1905 should have shown what was in store, though the trend was clear in the American Civil War. But military leaders failed to grasp the true significance of the fantastically increased firepower provided by the new weapons. Neither did they appreciate fully the impact that industrialization, and its concomitant release of the masses for war service, would have on war. The result was a shocking holocaust in World War I.

Land Warfare in World War I

There were, at first, few truly new weapons. While the machine gun "locked" the battlefield, artillery did most of the killing. The French 75mm gun (an artillery piece introduced at the close of the century) and its German 76mm counterpart were predominant on both sides, while special German siege guns quickly destroyed the faith the Allies had put in the defensive capability of the Belgian forts. Improved fire control techniques

and field telephones enabled the artillery to deliver its fire--shrapnel, impact-and-time-fused shells—from defilade positions. The short-delay French fuze, fragmenting thin-skinned projectiles, began to supersede shrapnel. Firing from map coordinates became an exact science, and indirect counterbattery fire assumed increasing importance.

The basic organization for delivering the increased firepower was the infantry division, on each side composed of two brigades of two regiments each of infantry, plus supporting regiments of artillery. At the corps level, additional artillery was present. Corps were grouped under armies and armies under army groups. Mammoth logistical organizations were essential behind the lines to keep the masses of men supplied with food, ammunition, and equipment.

Horrible and unexpected casualties from artillery and machine guns brought the reeling opponents to a stalemate; the spade and barbed wire took over, and with them close-combat weapons—the hand grenade, rifle grenade, submachine gun, automatic rifle, short-range mortar, pistol, and revolver. The machine gun continued to be the dominant infantry weapon in the field fortifications extending from the North Sea to the Alps. Every effort to employ the Napoleonic principle of "Le feu est tout" to achieve a penetration failed. It was possible to blast a gap in a section of the opposing trenches, but neither side could find a way to widen the gap effectively so as to exploit and pursue. Cavalry, the traditional arm of exploitation, was useless against the firepower available. Thus a gap at great cost was quickly plugged by more entrenchment.

Out of the effort to eliminate the stalemate, scientists and innovators came up with two dramatic new weapons: poison gas and the tank; but in neither case did the side that used them first realize the full potentialities of the new weapons before the opposing side found antidotes. The quick development of gas masks soon reduced gas to a weapon of harassment. And the tank, revolutionary as it proved to be later, was too primitive mechanically, and was first employed in numbers too small, to achieve much success. With speed of only three to four miles per hour, it was in effect no more than a mobile armored machine gun nest.

The internal combustion engine, which made the tank possible, advanced the other most portentous developments of World War I: the truck and the airplane. Gallieni's use of Paris taxicabs to send reinforcements for the First Battle of the Marne (actually a very small thing in itself) dramatically demonstrated the potentialities of motor transport for maneuver, and the truck route, Voie Sacree, succoring Verdun, did the same for supply.

A New Dimension: Air Warfare

The airplane was, at first, no more than a reconnaissance vehicle, but as its value for reconnaissance increased, it became important for each side to destroy planes used by the other. Speeds increased; and machine guns were added, creating the fighter plane. In 1915, a synchronizing gear was adopted which allowed a fixed machine gun to fire through a revolving propeller without striking it. Gradually, pilots and planes were organized into squadrons for administrative and tactical control.

At the beginning of the war, there was aerial bombing by German dirigibles or Zeppelins, which were named for an inventive German who had observed Civil War observation balloons from the White House lawn. But the Zeppelins fell before the bullets of the plane; and larger, better planes took over the bombing assignments. Before the war was over, the British had developed a bomber capable of transporting a 1,650-pound bomb (though true strategic aerial bombardment came later). American General "Billy" Mitchell devised a plan for an airborne parachute attack, but the war ended before it could be attempted.

Naval Warfare in World War I

As with the truck, the tank, and the plane, the gasoline engine also led to development of the submarine; the problem of clouds of smoke and fumes such engines released was solved by using electric power to propel the underwater craft when submerged. The Germans excelled with Diesel-powered U-boats (Unterseeboote) which, armed with torpedoes and equipped with the gyroscopic compass, nearly won the war by blockading the British Isles. Eventually, they were defeated by aerial surveillance, Q-boats (armed vessels disguised as innocent merchantmen), depth charges, and--above all--the convoy system. Indirectly, the submarine lost the war for the Germans, for indiscriminate sinkings by U-boats eventually involved the United States in war--and the balance of power was tipped.

On the ocean's surface, before hostilities opened, Britain's Dreadnought, in 1906, rendered obsolete all previously constructed battleships. Combining heavy armor, immense weight of metal hurled by an homogenous group of turreted guns of up to 15-inch caliber, and all-round fire capabilities, ships of the dreadnought class prompted an armament race. As a result, naval designers, searching to combine fire-power and mobility, designed the battle cruiser; gunned to near-equality with the dreadnought the battle cruiser sacrificed a heavy protected armor belt in order to achieve greater speed.

The Germans augmented their submarines with surface raiders, but aerial surveillance and the speed of the wireless telegraph early overcame any

advantage of speed that the raiders possessed. German mines, however, were a menace throughout the war, particularly in such restricted waters as the English Channel.

When World War I ended, the most revolutionary naval development remained the submarine, whose menace was never completely neutralized.

Efforts to Break the Land Stalemate

Similarly, on land, there were inconclusive solutions to the stalemate induced by the immense new firepower. Although The English tanks had proved relatively successful at the Somme (1915) and at Amiens (1917) they had been unable to exploit initial breakthroughs. The Germans had come closer to a tactical solution with their Hutier Tactics, named after the general who first employed the new method against the Russians in the fall of 1917.

The Hutier Tactics involved no startling new method or weapon; this was merely the application of time-proven, basic principles to the new conditions of war. Surprise was the keynote, obtained partly by moving units secretly to attacking positions and partly by reducing preassault bombardments from several hours to a few short furious minutes; the infantry then moved against the hostile entrenchments behind a rolling artillery barrage. Gaps or weak points in the defenses were exploited by infiltration through "soft-spots" by small infantry battle groups which used the light machine gun as the principal attack weapon. Strong points were bypassed, then later mopped up by reserves.

In a series of great offensives in early 1918, the Germans employed this new tactical system with deadly effect in the West. In the first of these, the British front was shattered and the Germans broke through completely. For the first time since 1918, there was open warfare on the Western Front. But eventually, after a series of spectacular successes, the offensive ground to a halt; this was as much due to inability to keep up momentum as it was to the desperate, gallant, defensive efforts of the British. Despite the tactical efficiency of the new infantry tactics, there were serious operational and strategic deficiencies in the system. Four years of warfare had obliterated all roads in the wide battle zone; trenches and overlapping shell holes made this region impassable for wheeled vehicles. The German assault waves simply outran their artillery, their supplies, and their reinforcements. The same thing happened on subsequent German drives, until Ludendorff's army was "bled white". Then the Allies, reinforced by fresh American troops, counter-attacked.

Beginning in August 1918, the Allies counter-attacked in the final, victorious campaigns of the war; the naval blockade and a collapse of morale on the German home front contributed to victory almost as much as American and British successes on the battlefield. For all the array of weapons that the age of technology had produced, no truly effective modern land weapon system had been found. But the Germans had come close with their Hutier Tactics--and so had the British with their tanks.

With the benefit of a dress rehearsal in the Spanish Civil War (1936-1939),by the outset of World War II German military leaders solved the weapon system impasse by devising a combined arms team—not unlike a modern version of the Roman legion—made up of planes, tanks, and mobile infantry and artillery. The new tactical doctrines, which emerged from the German study of their failure in 1918, were introduced with astonishing success as blitzkrieg in Poland (1939). The success was repeated in 1940 to break the western Allies on the Meuse. In both cases, heavy armored divisions, assisted by infantry, achieved the penetration and made the exploitation. But as the war progressed, the role of shock passed again to infantry and artillery firepower, while armor took over cavalry's old exploitation role.

The combined arms concept was not confined to the heavy armored divisions. It was present in the infantry divisions as well, for in addition to infantry and artillery, tank and tank-destroyer battalions were almost always present with infantry divisions. Two infantry and one armored division normally made up a corps, and there were also special armored and airborne corps. Several corps made up an army and, as in World War I, two or more armies an army group. But the basic land weapon system remained the division, though special combined arms elements of a division were employed for special operations. These usually were called task forces or, in the case of amphibious operations, battalion landing teams.

Most of the infantry weapons were improved versions of those introduced in World War I: hand grenades, rifles (the American Army used a semi-automatic model), mortars, machine guns and machine pistols, submachine guns, and automatic rifles. Artillery pieces, too, were improved versions of World War I weapons though, in the American Army, the 105mm howitzer assumed the workhorse role played earlier by the French 75mm gun. But the new tanks bore only incidental resemblance to their ancestors. Though some light tanks were used, most were in the medium or heavy class, weighing 30 to 60-or-so tons, and mounting not only machine guns but high-velocity 88mm and 90mm cannon. Speeds averaged around 30 miles an hour, and a gyrostabilizer and power traverse provided flexibility and speed in firing. Some tanks were equipped as flame throwers, others for amphibious operations.

There were also dramatic new developments in infantry and artillery weapons and equipment. Rocket launchers that worked on the Munro Effect (or shaped-charge) principle for penetrating armor put an effective antitank weapon in the hands of the individual soldier. Telephones, both battery and sound powered; portable and vehicular radios, some employing the principle of frequency modulation; all enabled rapid communications down to the squad level. Before the war was over, infrared devices to enable the soldier to see at night were tried; powerful recoilless rifles firing 57mm and 75mm shells were introduced; antipersonnel and antitank mines were employed; and portable flame throwers aided close-in fighting.

By the end of the war almost all artillery was either truck drawn or self-propelled, including a powerful new family of antitank guns. Some artillery was air portable; other pieces could be broken down and transported by pack animals through difficult terrain (the British had employed the same principle with their "screw gun" in mid-19th Century). Anti-aircraft guns, equipped with electronic fire control devices, came in various calibers. A new family of shells was created to exploit a proximity or prosit fuse with a built-in triggering device to explode it above the target without the necessity of a time fuse. Though poison gas shells were plentiful, an unwritten mutual agreement prevented either side from employing poisonous chemical weapons. Shrapnel entirely disappeared and was replaced by the jagged fragments of the explosive shells themselves. American artillery proved far superior to all other artillery in the war, not because of better weapons, but because of a more imaginative and flexible system of fire control, which utilized communications facilities to concentrate great masses of artillery fire on any target within range.

Rockets returned to national arsenals, often fired electrically from a battery of tubes sometimes mounted on tanks. Balloons, too, were used, but anchored to heavy cables to protect cities and invasion beaches from low-flying aircraft. A swift-moving, dependable family of motor vehicles aided maneuver and supply. They ranged from small reconnaissance and general purpose vehicles to great transport trucks. Lightly armored, half-tracked vehicles transported infantrymen in the armored divisions, and an amphibious truck called the "Duck" (DUKW) proved its worth in sea-to-shore operations.

Speed and increased dispersion largely outmoded the elaborate field fortifications of the U.S. Civil War and World War I variety. In place of the trench, soldiers dug individual or two-man slit trenches and "foxholes". When concrete and steel were used in the massive fortifications of the Maginot and Siegfried Lines and a new line of Belgian forts, the power of artillery rendered them relatively useless, as were the fortifications of World War I.

Air Warfare

The airplane, like the tank, bore only slight resemblance to the World War I model. There were frail, single-engine liaison craft that acted as eyes for the artillery; there were fast, highly maneuverable fighters and fighter-bombers; and before the war was over, jet-propelled fighters. There were big cargo planes that brought to fruition "Billy" Mitchell's dream of airborne assault by parachute; and big, but fragile, towed gliders carried men, artillery, small vehicles, and supplies. And there were bombers of various sizes, including those that could transport 5,000-pound bombs at a range of well over 5,000 miles. (Bombs came in various models, including fragmentation, demolition, and incendiary, the latter including some with an inflammable liquid not unlike Greek fire.) Planes were organized by squadrons, commands, groups, and air forces.

The Germans introduced a new mode of warfare with their V-weapotis: one pilotless aircraft, the other a supersonic rocket which was the forerunner of the ballistic missile.

Perhaps one of the most important World War II developments was radar (radio detection and ranging), which was adapted to ships, airplanes, antiaircraft guns, and submarines. Radar was invaluable for detecting the approach of enemy planes; and it enabled operators far in the rear to "talk" bombers onto their targets through cloud and overcast.

Naval Warfare

At sea, the big battleship became obsolete, unable by itself to cope with air attack, but still marginally useful as a floating gun platform. The aircraft carrier became the new capital ship. To facilitate amphibious landings, a new family of naval craft was developed, some designed to carry infantry, others tanks, and others supplies. Improved torpedoes, using pure oxygen under compression instead of air for combustion of the fuel, eliminated much of the telltale wake characteristic of earlier versions.

Against Germany the principal aspect of the war at sea was once more a struggle against the submarine. Again Britain was threatened with starvation, this time by a new, deadly U-Boat tactic of traveling and attacking in "wolf packs". By the end of the war, German underwater craft were equipped with radar and, later, with Schnorke1 "breathing" devices. Sonar (sound navigation and ranging), an adaptation of radar, and improved depth charges proved important measures in combating the submarine. But the old methods of convoys and aerial surveillance were the major factors in defeating the German undersea menace.

On land, sea, and in the air, the age of technology had produced an incredible array of new weapons and improvements in weapons but the ultimate achievement was reserved for the final days of the war. On August 6, 1945, an American plane dropped an atomic bomb on Hiroshima. This was the genesis of a cycle of weapons and weapon systems development still in process, with consequences not yet calculable.

Nevertheless, to those who are concerned with the means and procedures for command and control of these new weapon systems, there is much in the history of past weapons developments, as briefly suggested in these pages, which will permit an educated projection of current trends and some estimation of future alternative possibilities.

From what we have noted in the course of weapons history, for instance, it is possible to infer that dramatic military successes of the past have been due less to the introduction of new weapons than they have upon the imaginative development of a doctrine of command and control which has permitted improved use of previously unsuspected--or inadequately exploited

aspects of the weapons' potentialities. For instance, we have noted that Genghis Khan and his successors conquered most of the known world in a few decades with weapons that had been in existence for centuries. The Mongol victories were due to novel and relatively sophisticated methods of employment of these weapons. Similarly Edward III at Crecy owed his success to the way in which he integrated the long-bow--an old and relatively simple infantry missile weapon—into a coordinated tactical weapon system, while his opponents, who had the equally powerful and more sophisticated crossbow available in adequate quantities, had no thought of a tactical revolution. Another case in point is the way in which the Swiss, after an interval of seventeen centuries, were able to employ pikes in a tactical system comparable in concept and in success to that of the ancient Macedonians.

Accordingly, in any future effort to analyze the potentialities of the new weapons, and the command and control systems for employing them, it would appear fruitful to investigate to a degree not possible in this exploratory survey, the circumstances in history when important weapons of the past were introduced. It would be useful to ascertain the relative significance of the innovations themselves, as opposed to the doctrine, and the control systems, for employment of them. Was it, for instance, the perfected tank at the beginning of World War II, or rather its use in combination with other means at the disposal of the Germans, that gave <u>blitzkrieg</u> its overwhelming effect? And why didn't the Allies use comparable weapons with comparable success?

One approach to the investigation suggested in the preceding paragraph might be a careful analysis of each of the major periods of revolution in warfare, for the purpose of shedding light on why one society was able to adapt a new weapon to a successful method of warfare while another was not able to do so. Related to this is the question raised by evidence that one society was able to develop imaginative leaders who could shape command and control aspects of a new situation into successful application, while an equally advanced society was unable to do so. Were there some special geographic, economic, political, social, or other factors involved? In sum, investigation should seek to isolate at least some of the historical factors that motivated any successful shift from one weapon, or system, to another one and the extent to which doctrine contributed to the success.

LAND-BASED WEAPONS AND WEAPON SYSTEMS: PRE-GUNPOWDER ERA (to 1350 AD)

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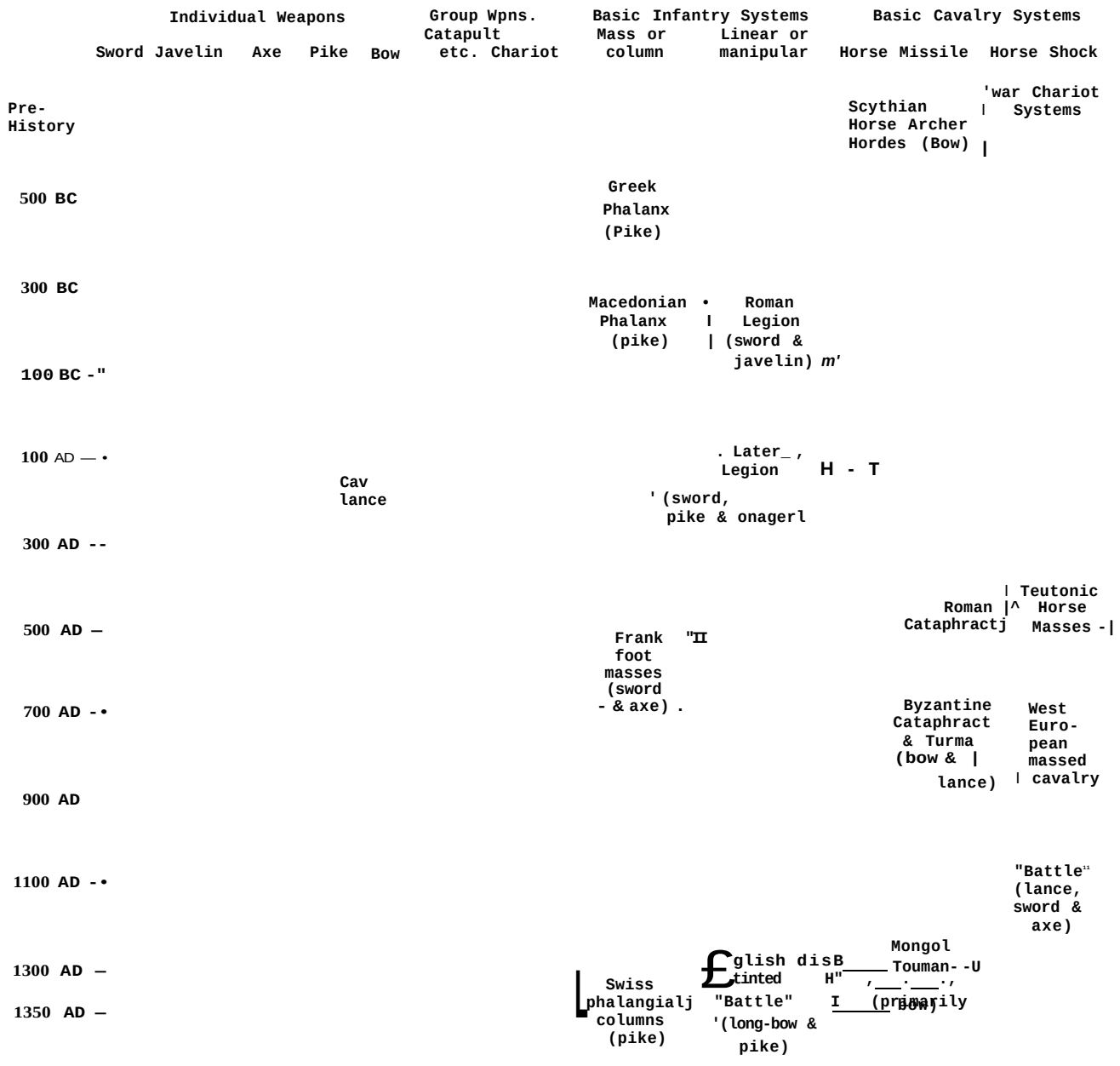

Chart 1

Major Historical Events Affecting Weapons and Weapon Systems

1500-1000 BC - Horsed invaders and iron weapons overthrow ancient military systems

C800-700 BC - Assyria builds first military empire; professional specialization in intelligence, command, logistics, training

490 BC - Battle of Marathon; supremacy of infantry phalanx

197,168 BC Battles of Cynoscephylae & Pydna; legion supreme over phalanx

27 BC Augustan legion, fixed frontier fortifications

c.100 AD - Introduction of stirrup permits cavalry lance shock

378 AD Battle of Adrianople; defeat of legion; ascendency of cavalry

e.1000 - Introduction of crossbow

1071 - Battle of Manzikert; decline of Byzantine"cataphract

c.1100 - Invention of trebuchet

c.1200 - Longbow adopted in England

1346 Battle of Crecy; longbow defeats feudal cavalry; beginning of infantry ascendency; possible first appearance of gunpowder in warfare

LAND-BASED WEAPONS AND WEAPON SYSTEMS; EARLY MODERN ERA (1350-1850)*

MAJOR WEAPON SYSTEMS

	Individual Weapons					Group Weapons		Basic Infantry Systems		Basic Cavalry Systems		
	Lance	Sword	Pike	Bow & Cross-bow	Arque-bus & Musket	" S «	Cata-Pult etc.	Cannon	Mass or column	Linear or Manipular	Horse Missile	Horse Shock	Major Historical Events Affecting Weapon Systems
1300													
									Swiss Column	English Dismounted "Battle"	Mongol or Tartar Touman	Heavy armored Cavalry "Battle"	
1350													c.1350—First crude bombards used for siege purposes
									(Primarily pike)	(Longbow and pike)	(Primarily bow)		C.1400--Hand guns & bombards in general use
1400													
1500	—								Spanish colunela, tercio, & successors (Arquebus or musket, and pike)		Reiters (or pistol cavalry)		c.1490--French develop first field artillery
													c.1550--Musket replaces arquebus
1600					Bayonet					Swedish system (musket & cannon)			c.1625--Refonus of Gustavus Aldolphus
1700	_ J								V	West European Linear mass (musket, bay-onet & cannon)			1755—British begin to develop light infantry
													1776--First decisive appearance of rifle
1800									French division columns (musket, bayonet, cannon)	Light Infantry (musket or rifle)			c.1800--Beginning of military impact of Industrial Revolution; Science and industry deliberately used for military purposes; long-range semaphore chains; mass national armies overload existing command and control systems.
1850													

*Period of Dynastic National States; Armies under monarchs or their immediate agents.

LAND-BASED WEAPONS AND WEAPON SYSTEMS; THE INDUSTRIAL ERA (1800-1950)

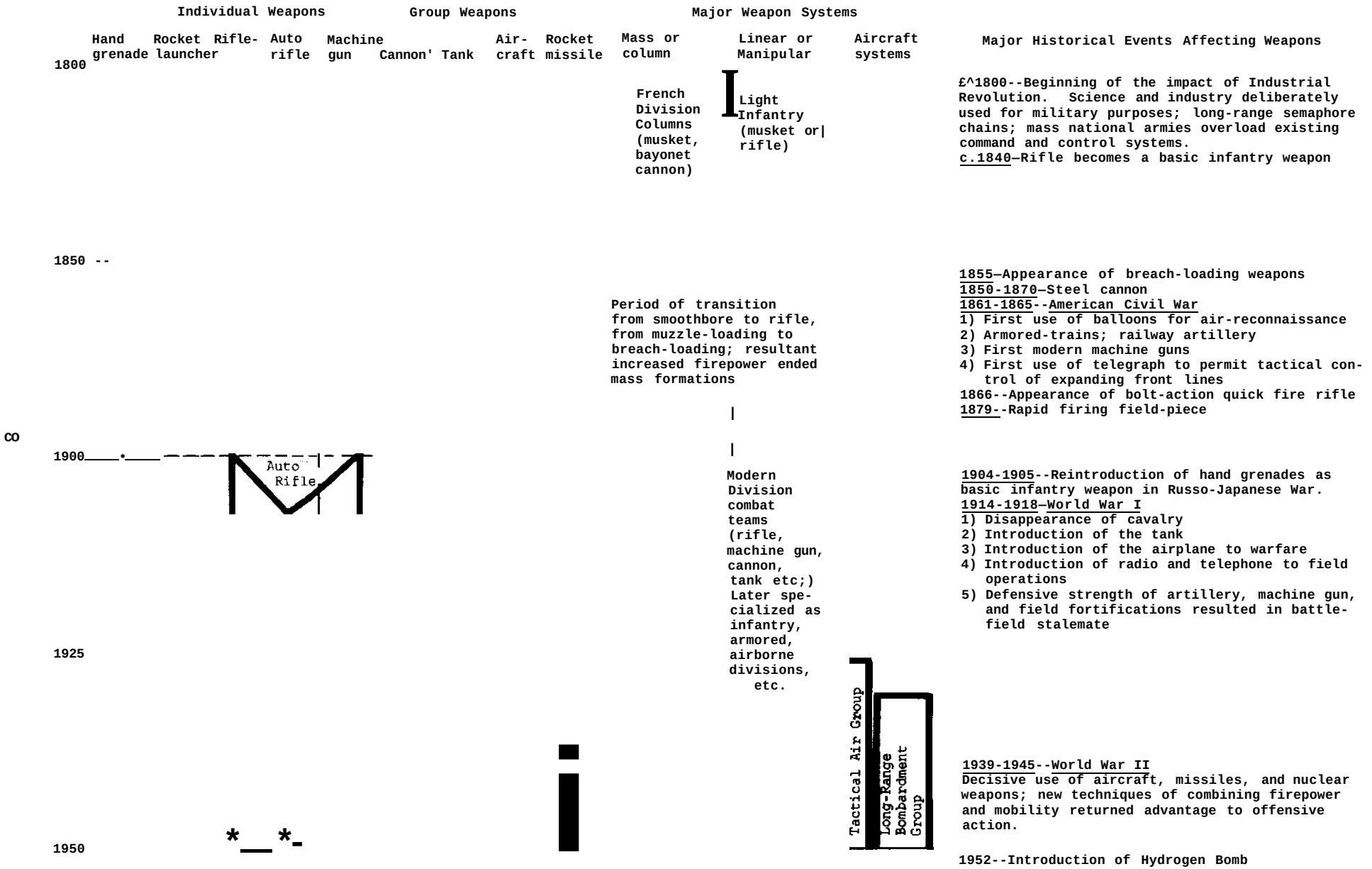

Chart 3

SEA-BASED WEAPON SYSTEMS IN HISTORY

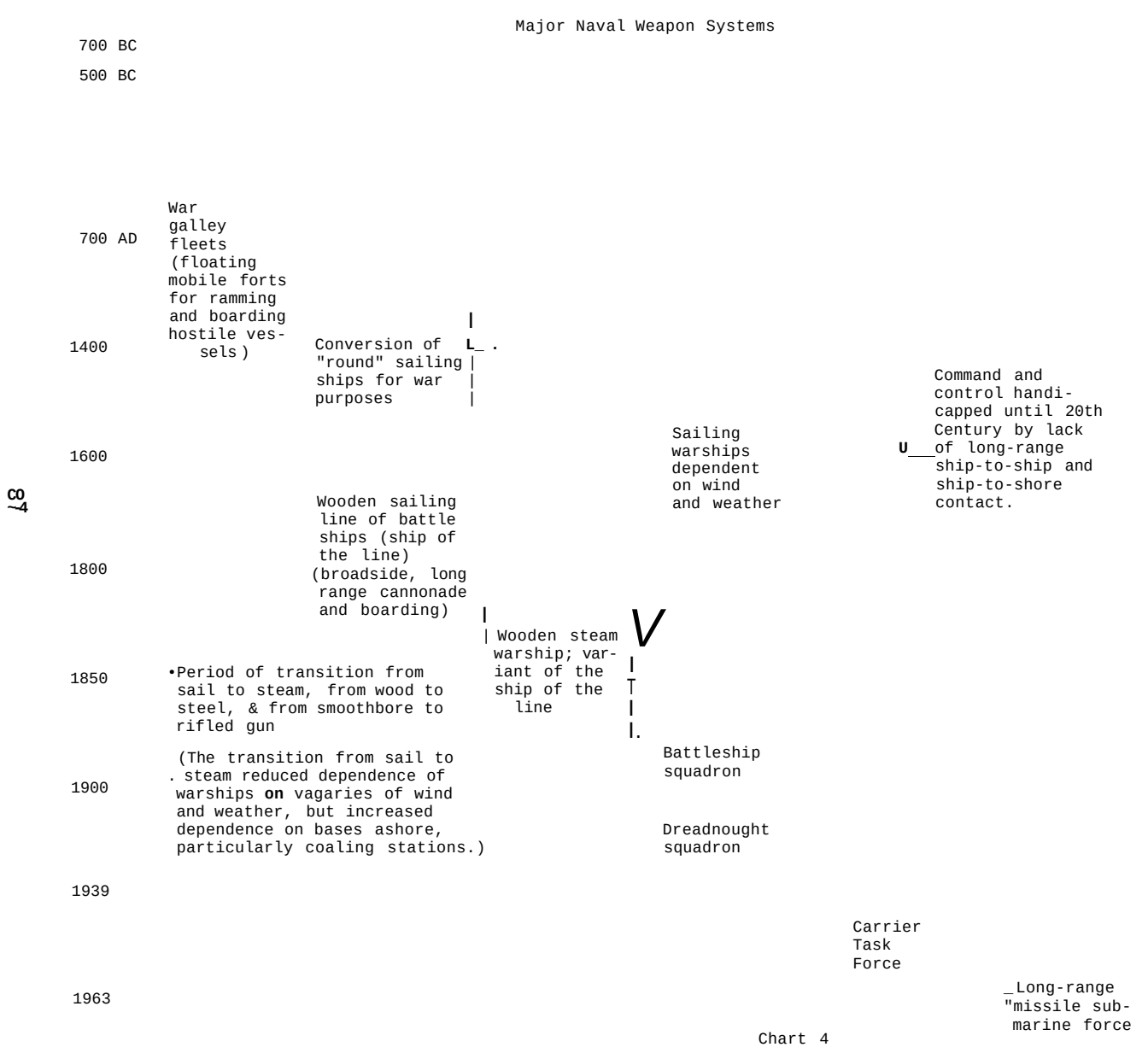

Chart 4

Major Historical Events Affecting Weapon Systems

c.700 BC - Phoenicians develop first war galley
c.500 BC - Appearance of Athenian trireme
480 BC - Battles of Artemisium and Salamis
c.250 BC - Roman modifications; castles, catapults, grapples, etc.
31 BC - Battle of Actium
c.670 AD - Byzantines introduce Greek Fire

800-1000 - Arab navies dominate the Mediterranean
c.1050 - Venice dominates the Adriatic
c.1100 - French and English add castles fore and aft
c.1200 - Invention of sailing ship rudder
c.1400 - First true sailing warships, mounting small anti-personnel cannon
1501 - Invention of gun ports permitting mounting of heavy cannon in hi'11
1571 - Battle of Lepanto, last great galley battle
1588 - Battle with Spanish Armada, first great broadside ship battle
1590 - First armored warships, in Korea

1805 - Battle of Trafalgar; acme of command and control of sailing warship fleets
1821 - Battle of Navarino, last great full-rigged ship, smoothbore broadside battle
c.1830 - First steam warships; side-wheelers
"c.1840 - Introduction of screw propeller
1853 - Introduction of shell gun to naval warfare
c.1855 - Appearance of rifled cannon on ships
1858 - France builds first ironclad warship
1861-1865- Introduction of naval mines
1862 - Battle of Hampton roads, first ironclad battle
1866 - First use of ocean cables for telegraphic links across the sea
c.1880 - General introduction of breechloaders
1885 - Distinction between armored warship classes
1899 - Introduction of wireless telegraphs to link ship to shore & ship to ship
c.1900 - Introduction of submarine as a practical naval weapon
1906 - British introduce the Dreadnought
1918 - British introduce aircraft carrier
1939-1945- Aircraft dominate naval warfare
1961 - First operational, nuclear-powered Polaris submarine

APPENDIX C

A SURVEY OF COMMAND AND CONTROL IN HISTORY

Introduction

Leadership is the most important factor in military success. It manifests itself in many ways. The true leader husbands, develops, and utilizes to the fullest extent all available resources in men and materiel He prepares for battle with wisdom. He exercises tactical skill and ingenuity on the battlefield. He inspires men to feats of exceptional courage and endurance. And, finally, he employs determination and perseverance in the face of adversity. But fundamental to the manifestation of these qualities is the ability to communicate decisions clearly and accurately to subordinates. Intellectual abilities, skill, courage, and the charismatic qualities of a leader are worthless without the means to both issue commands and to control fighting men.

Leadership, and the need for a system of command and control to implement it, are unquestionably as important in today's era of advanced technology as they were in the days of pretechnological warfare. But recent developments may have radically altered the scope of leadership. Faced with adapting methods of warfare-and of command and control- to technological and environmental change, man himself has remained a constant factor throughout military history; his capability to absorb information, and to react to it, has not changed. Yet now, new automated and computerized equipment has provided him with tools which, to some degree, have reduced the effects of his own inherent human limitations. Other technological innovations have increased the factors of space, numbers, ^d destructive powers, while radically reducing permissible reaction time.

These developments pose vital questions for military and civilian planners who must continually strive to assure that men and weapons are fully responsive to leadership through adequate command and control Consider these questions: Has increasing exclusivity in access to information and technology concentrated decision-making at the highest echelons W r rT^?? ^greatly diminished Pledge of the situation at lower levels? Will the consequent vacuum in information on the operational levels create a malaise affecting responsiveness, and the exercise „ llltlve' m times of crisis and emergency? or, Have revolutionary new developments in warfare created basically different requirements in modern command and control systems?

The phenomenon of the appearance of revolutionary new weapons and consequently, the establishment of fundamentally different methods of exercising command and control has been continuous throughout the course ot history, though it is questionable, indeed, whether past turning

points in warfare have been as significant in degree as those which are currently taking place. Nevertheless, a survey of history can surely provide a basis for ascertaining the extent to which the modern revolution in warfare may be comparable to those of the past. Such a survey will, at the very least, reveal trends from which conclusions may be drawn.

Land Warfare Before the French Revolution

From Antiquity through the Middle Ages

During the first 2,000 years of semiorganized warfare, individual leaders commanded irregular groups of fighters by personal force or example and directed them by voice or hand signals. Not until about 1500 B.C. did military organization emerge, generally as simple groups of men who were armed or mounted alike. For nearly another thousand years, military units remained largely undisciplined, poorly trained, and, once committed to battle, generally uncontrolled in the melee of close combat.

In the 16th Century B.C., the growing recognition by Cyrus and Darius of structure and linkage as essential elements of command and control made possible the far-reaching successes of Persia's great military conquerors. The essence of Darius' system lay in the control he established over the empire by forming provinces or satrapies, each garrisoned by soldiers who were commanded by a general directly responsible to the emperor. The provinces were effectively linked to the emperor by an efficient system of mounted messengers, operating over an excellent road net. Capable subordinate commanders were developed by this system, making it usually unnecessary for Darius himself to take the field. When Darius personally commanded major operations, subordinate forces operated semi-independently on auxiliary missions, sometimes by sea. And preceding each major campaign, preliminary expeditions were dispatched to gather intelligence information, which strongly influenced Darius' strategic battle plans.

These innovations, plus an engineering prowess capable of bridging the Bosporus, opened to Darius a wide field for strategic decision. On the battlefield, however, the only crucial decision to be made remained that of when and where to commit the Persian cavalry for maximum shock effect.

By the 6th Century B.C., Greek military leaders applied discipline and training to battle tactics and developed the Greek phalanx--the first important tactical formation in history. Consisting of a solid mass of heavy infantry capable of preserving a rigid organization throughout a series of limited but highly effective maneuvers, the phalanx, despite primitive tactical linkage mechanisms, gave commanders relatively firm control over their men. But decision still remained more a strategic

and pre-battle process than a battlefield prerogative; there was little change in the basic ingredients of success.

Innovations by Philip and Alexander in providing support for the phalanx with cavalry, archers, field artillery, engineering, and a fairly sophisticated logistical system added power and provided greater range for strategic decision. But a basic inflexibility of formation, partially due to the problem of signals communication, made it difficult for a commander to influence the fighting once the clash had come. Voice commands or trumpet signals, heard by men marching forward in silence, were lost in the hurly-burly of combat; the only means of communication available was by messenger. When the messenger became a trusted subordinate, as under Alexander the Great, the rudiments of a primitive staff began to emerge.

Like all military innovations, the phalanx was eventually replaced by another weapon system—the Roman legion. Although based similarly on the use of heavy infantry, the legion, unlike the phalanx, was organized flexibly in cellular units rather than in solid formation. This gave the legion greater maneuverability, but the corollary was less direct control. Nevertheless, extremely strong discipline and esprit, long and rugged training, and the expert use of trumpets, banners, and standards for signalling, made the legion a tight-knit fighting force, responsive to the commander's will.

In the early days of the Roman Republic, the military command system was deliberately designed to prevent excessive individual power. Except in times of crisis, when a dictator might be appointed, two consuls alternated in command of the army each twenty-four hours. In battle each consul had his own wing. Similarly, the tribunes, six senior officers of each legion, rotated in command, though later a legate was often appointed over them as legion commander, at which time the tribunes acted either as subordinate commanders or as staff officers.

As the power and territory of Rome expanded, it became impossible for one or two men to direct all military operations. A large and professionally competent officer corps developed, and from this corps a number of capable generals emerged to conduct innumerable campaigns of conquest, pacification, and retribution.

On the battlefield, under commanders like Scipio Africanus, Marius, and Caesar, a highly sophisticated doctrine of strategic and tactical maneuver arose. But the process of decisions still lay in the strategic and prebattle stages of operations. Nevertheless, the employment of messengers, trumpet signals, and personal example, combined with judicious employment of reserves, enabled these leaders to change the course of an unfavorable action.

The Roman legion remained supreme for roughly five centuries. Except for refinements and modifications, no major developments in military organization or command and control mechanisms occurred. In the latter part of the period, relaxation of discipline in the legions, civil unrest, and a general decline in Roman morale and national dedication accompanied' an increasing use of missile weapons, which prompted dispersal and thinning out of infantry formations. The result of these developments was a significant decrease in the control of the legions by their commanders and a growing inefficiency in operations. The predominance of the legion ended at Adrianople in A.D. 378, when heavy Gothic cavalry defeated the Romans.

The Middle Ages

Before Adrianople, cavalry played only a supporting role to the more powerful, more reliable infantry. After Adrianople, heavy cavalry reigned supreme for nearly 1,000 years. During that millenium, cavalry tactics usually involved no standard military formations, but depended either on (1) the shock effect produced by a charge of mounted lancers or swordsmen, which sometimes disintegrated into a disorderly melee, or (2) the missile effect of mobile, lightly armored bowmen, whose very effectiveness depended upon a fluidity inherently inimical to close contact. Battlefield control, in either case, remained extremely difficult and relatively ineffective. Where discipline and structure were good, however, as in the divisions of heavy armored horse archers of the Eastern Roman Empire, or in the armies of Charlemagne, commanders exercised considerable control over their troops and over the direction of the battle.

The rise of feudal armies brought no improvement, for forces were generally untrained and lacked cohesive discipline, common organization, and unity of command. Since low-caliber infantry served as the base for maneuvering cavalry, the type of decision open to the battlefield commander remained primarily a question of where and when to launch the cavalry from the wings. Thus, structure, discipline, training, and the presence of the commander himself usually remained the arbiters of the battlefield. Virtually no decision except to take flight could be executed once the heavily armored feudal horsemen were committed.

The experience of the multinational forces which engaged in the Crusades, and the development at about the same time of the crossbow and longbow, raised the need for coordinated employment of infantry and cavalry and for discipline and training which would ensure coordination. Thus, by the end of the 12th Century, military anarchy gave way to somewhat disciplined and better organized formations which were more conducive to proper command and control.

On the other side of the known world, the Mongol military system of Genghis Khan made its appearance. In contrast, Mongol armies were extremely we11 organized, highly trained, strictly disciplined, and responsive to imaginative and effective command and control. Mongol leaders had absolute

authority over their men and, in turn, were held completely accountable to their superiors. Carefully planned campaigns were carried out according to previously determined schemes of maneuver and well-rehearsed tactics. While subordinate commanders were allowed leeway to execute a mission, they were tightly bound to conform to the over-all plan of campaign and battle. Extensive use of couriers provided communication between separated columns, and signal flags or flaming arrows ensured direction over tactical movements. Throughout the 13th Century, this extraordinarily sophisticated system enabled the Mongols to overrun most of Asia and to penetrate well into Central Europe.

The Mongol armies were the last of the great cavalry formations, for the defeat of feudal cavalry by English longbows at the Battle of Crecy (1346) signalled the return of infantry ascendancy--not infantry alone, but rather infantry supported by other arms. And during the centuries that followed, organization, discipline, training, and weapon systems overshadowed linkage and proved to be the keys to successful command and control.

The Early Modern Era

The introduction of gunpowder, and the development in the 15th Century of the first effective gunpowder weapons, opened an era of experimentation and change in military tactics and organization. The basic problem was to use firearms effectively in battle while protecting their users against the more numerous conventional weapons. This process of integrating firearms into offensive and defensive formations was slow; and trial and error pointed to the increasing importance of unified command and control.

The first formation to gain prominence in this era, however, did not rely on firearms. Nor was it really new. It was the Swiss column of heavy infantry, a reversion to the old Macedonian phalanx. A rigorously trained, strictly disciplined formation of pikemen, the Swiss formation employed mass; it relied on weight together with relative speed or mobility. Despite the introduction of handguns and arquebuses toward the end of the century, tight groups of pikemen remained the basis of Swiss success.

Inevitably, the Swiss phalanx gave way to formations making more imaginative use of new firearms. At the Battle of Bicocca (1522), Spanish arquebusiers, firing in controlled volleys, decimated the attacking Swiss and signalled the coming dominance of the Spanish "square". This new formation employed firearms and other weapons, as well as the basic pike, and used cavalry and newly developed artillery as supporting arms. But slow and intricate drill was required to load and fire the new gunpowder weapons, while arquebusiers, musketeers, and artillerymen were all extremely vulnerable to enemy action when they were reloading. To protect them, the operations of cavalry and other infantry were carefully coordinated. There soon developed the important and basic tactic of a controlled volley by a front rank of men, who would then retire to reload

while the rank behind them moved up to shoot. In like manner, cavalrymen (especially the German reiters) were trained to ride close to the enemy, discharge their pistols, and retire to unload while another line of troopers charged sedately forward (at the trot) to displace them.

By the end of the 16th Century, although tactics had become fairly well universalized, the growing complexity of battle increased the difficulties of command and control. Technology, which had made great strides in weaponry, had yet to devise better forms of linkage than the standard methods of communicating by voice, signal, or messenger. In the heat, noise, and smoke of combat, victory fell to those trained and disciplined troops who were most responsive to their commanders.

Matters were further complicated during this period by the increasing use of mercenary troops, whose high standards of training and experience were offset by their disturbing tendency in crises to demand bonus or overdue pay as the price of dubious loyalty. Hence commanders were faced with a dilemma of alternatives: recourse to militia, undisciplined, poorly trained, and unreliable; or to expensive national standing armies.

Sweden's great 17th-century king and captain, Gustavus Adolphus, adopting the latter course, set a pattern and a model for military innovators during the next century. He employed a chief of staff, who acted sometimes as a tactical commander; a quartermaster, who was responsible for supply, movements, and quartering of troops; chaplains, judge advocates, provost marshals, surgeons; and chiefs of artillery, engineers, intelligence, and scouts. At the regimental level--another innovation--similar organization existed.

The result was a well-trained, disciplined army of combined and supporting arms to provide greater flexibility and power on the battlefield. Volley fire by platoon, rather than by a single row of musketeers, was also introduced; and this, together with improvements in small arms and field artillery, provided heavier and more carefully controlled firepower. Not the least of the Swedish king's innovations was to increase the mobility and maneuverability of his artillery; he employed this arm with skill and imagination.

Like all his triumphs, Gustavus' greatest victory, the Battle of Breitenfeld (1631), illustrated the importance of structure in successful military control. Later advances in weaponry, such as the bayonet which eliminated the need for pikemen, and improvements in fortification and siegecraft brought tactical change but no significant alteration in the mechanism of command and control. This was to be perfected by Frederick the Great, who by discipline and drill secured a considerable margin of mobility over his adversaries. Frederick's victory at Leuthen (1757), like his other triumphs, was a classic demonstration of the results to be achieved by perfectionism in structure and in tactical system.

Sea Warfare: From Ancient Times to Nelson

The procedures and mechanisms for directing and coordinating sea warfare developed far more slowly and subtly than those on land. Initially, armed men used trading or fishing craft to raid seacoasts, to repel raiders, or to transport themselves to sites for land battle. Control was a matter of individual command, involving little training or organization.

The first vessels specifically designed for fighting were produced by the Phoenicians about 700 B.C.: speedy, oar-propelled galleys which they, and later the Greeks, perfected. Naval tactics consisted of boarding or ramming, and sometimes both. Control depended on the training and discipline of individual crews and, to a limited extent, on fleet organization and primitive signalling methods. In order to hold the desired battle formation as long as possible, it was most important to maintain steady, synchronous stroking of oars to the beat of drums, the hammering of a staff against the deck, or other similar devices. Usually, once combat was joined, individual ships operated independently, although an able commander, such as Themistocles in the Battle of Salamis (480 B.C.) could coordinate the movements of skillfully handled vessels. Later, during the Punic Wars of the 2nd and 3rd Centuries B.C., Rome and Carthage developed extensive naval administrative organizations to control the operations of vast fleets raised by both sides. But on the whole naval operations continued for many years as disorganized engagements within sight of land between short-ranged, oar-propelled galleys.

Initially, the introduction of guns did not bring about any tactical changes which required naval command and control mechanisms of a higher order. But in the 16th Century, with the development of the sailing warship equipped with cannon of considerable power, the need for coordinated seamanship and controlled maneuvering increased. The concept of a ship of the line firing its batteries in heavy broadside to inflict maximum punishment began to emerge. The English victory over the Spanish Armada (1588), a triumph of planning, training, discipline, and, above all, long-range firepower, was the result of this powerful broadside combined with tactical maneuvering.

By the beginning of the 18th Century, the Royal Navy had evolved a set of Permanent Fighting Instructions—precise and detailed directives to guide warships in combat. Emanating from the Admiralty, these Instructions established rigid control over tactical maneuvering and restricted not only the movements of commanders but also the types and number of flag signals they could employ. Because the Instructions required absolute obedience to inflexible dogma, the fighting abilities and individual initiative of fleet commanders and ship captains were greatly hampered. Not until the Napoleonic Wars were bold and imaginative sailors like Nelson able to completely discredit the Fighting Instructions. And the resultant encouragement of initiative which granted relative independence to local commanders came, paradoxically, at the same time that an improved code provided far more effective means for preserving tactical control.

The French Revolution and Napoleon

The "nation-in-arms" concept exemplified by the mass armies of the French Revolution and Napoleon multiplied the problems of command and control. To turn the columns of the French Republic from ineffective mobs into the scourge of European battlefields for almost two decades, Napoleon (building on a structure started by Carnot) employed four concepts of control: (1) to obtain speed of movement and concentration, applicable both strategically and tactically, he established self-contained divisions and corps, commanded by experienced subordinates, which he directed not only by masterful advance planning but also by means of the semaphore and telegraph; (2) to harass and deceive the enemy, to keep him off balance and confused while preparing to strike a typically massive and decisive blow at a critical spot, Napoleon used skirmishers to precede his columns and engage the enemy (Though this was not a new concept, Napoleon utilized it more effectively than any of his modern history predecessors.); (3) to smash a gap in opposing formations through which the infantry might plunge, he grouped his artillery in mass, under his own personal control; and (4) to deliver the final stroke, or to counterattack decisively, he employed a reserve as the culminating blow of a series of concentrated punches.

As with Genghis Khan, Napoleon could not have executed his far-ranging campaigns without affording wide latitude for action to some of his more capable subordinates. Sometimes, as at Auerstadt when Davout defeated a far superior force, he was amply repaid. In general, however, personal jealousy and political expediency kept him from permitting his' marshals to become first-rate commanders in their own right; for this he paid dearly in the long run. The ineptitude of his subordinates in Spain, Russia, and Germany led to his empire's decline; and his lieutenants' errors set the stage for his final disaster at Waterloo.

Napoleon operated during the dawn of the Industrial Revolution when mass armies were a reality; but expanding technology gave only a glimpse of the deadly weapons of the future. It was still too early for communications developments to permit improved battlefield control of the new masses and the increasing lethal power available to them. Though Napoleon's genius overcame some of these problems, the period remained, ma sense, an anomaly, for the campaigns of 1812 and 1813 (Moscow and Leipzig) illustrated how the emperor's strategic ambition overran existing and previously successful French command and control procedures.

The Post-Waterloo 19th Century

The great strides in military technology resulting from the Industrial Revolution tended both to complicate and mitigate the problems of command and control. Industrialization, which freed more manpower for the armed forces in time of war, presented commanders with the difficult task of

directing huge masses of poorly disciplined troops. Longer range, greater accuracy, and the higher rate of fire of new weapons encouraged dispersal, broad and rapid maneuver, and a general disinclination to close with a well-entrenched enemy.

Mass, man-killing firepower, and improved communications were the three 19th-century developments that were to transform the art of war. These first appeared in the Crimean War, but had little impact until the American Civil War. Their combined effect produced a tremendous dispersion of military forces, both tactically and strategically, and a consequent decentralization of command. Except in a broad, strategic sense, management of battle passed from the hands of a single supreme commander into those of his subordinates; the supreme commander directed rather than commanded.

Since large forces, widely spread and closely organized, could not be commanded with precision, dispersal and poor control served only to encourage a tendency to straggle. And, as the battles of the American Civil War proved, once relatively undisciplined troops began to fall back in disorder, it was almost impossible to regroup them on the battlefield. Additional aggravation ensued when politically chosen Civil War officers and short-term enlistees proved less susceptible to military control than regular officers and troops with long-term enlistments.

But if technology led to tactical developments that prevented tight command and control, at the same time it did much to reverse this trend. The wide utilization of the telegraph and cable during the Civil War linked commanders with distant units more rapidly and efficiently than ever before. The commander in chief in Washington, if he so desired, could communicate with a division commander in the field so speedily as that division commander could send a messenger to a company on the line. And the telegraph put into the hands of government an adequate means of restricting military commanders who were far from the capitol. In contrast to the experience of Washington in the American Revolution, and Wellington on the Peninsula, the central control possessed by Lincoln clearly delineated military subservience to political, civilian control in a way scarcely known before.*

At shorter range, communications were facilitated by improvements in the semaphore and heliograph, while balloon observations assisted commanders in locating their own as well as enemy troops. Steamboats

*This was also in part the result of increasing democratization of government; see Appendix D.

and locomotives facilitated both decentralization and concentration, while providing commanders greater mobility, more flexibility, better communications, and faster, more reliable means of reinforcement and supply. Whether strategic control was enhanced or diminished as a consequence of these conflicting developments is moot. The fact remained that for the tactical commander on the battlefield means of command and control were still much the same as in Alexander's day at Arbela--discipline, training, voice, signal and messenger, and personal example. The high incidence of battlefield deaths among commanders operating at corps and lower levels illustrates this point, as do the numerous examples of failure of decisive maneuver for want of proper timing.

During the latter part of the 19th Century, European armies experimented with improvements in the military staff system both for prebattle planning and battlefield control. Under Scharnhorst and Moltke, Prussia developed the concept of a General Staff to coordinate and direct the entire national military effort. Combining careful research, meticulous planning, and complete devotion to a logical efficiency, the staff became a dedicated group of officers who provided the commander in chief with the only means by which he could possibly control the huge Prussian army with its varieties of units and equipment. In time of war, the close connection between the Great General Staff and the general staffs of operational units resulted in unprecedented unity and coordination. The control of the General Staff ensured Prussia's successes in wars against Austria (1866) and France (1870-1871) and set a standard for other nations to follow. By the early years of the 20th Century, all major military powers had adopted general staff systems.

World War I

World War I introduced new arms, new tactics, and, indeed, entirely new concepts of warfare. On land, weapons like the machine gun, the automatic rifle, and quick-firing artillery put an end to maneuver in the open and to gallant charges of cavalry or heavy infantry. Instead, the shovel became the soldier's most important weapon. An attack was an attempt by the artillery to blast a hole in the entrenched enemy's line big enough for the infantry to exploit. Thus, proper control of the infantry-artillery team became the most important factor, both offensively and defensively.

In the attack, it was necessary to coordinate preassault bombardments, rolling barrages, and counterbattery fire with the forward movement of the infantry. Defensive fire required equal control, especially when shifting to cover infantry counterattacks. Artillery, therefore, was precisely deployed, and its fire carefully controlled by forward observers, airborne balloon observers, and complicated mathematical calculations.

Emphasis was also given to the proper organization of infantry formations. Experience indicated that, in a formation to be controlled by a single headquarters, efficient span of control dictated that no less than three-and no more than six— units should be grouped together and that, on the lowest tactical echelon, the largest unit which could be effectively commanded by one man was the platoon of fifty or fewer soldiers. For further control, operations were carefully planned in advance and subordinate commanders were enjoined to follow detailed prearrangements, as the tremendous artillery barrages completely disrupted communications. Telephone wires were cut; transmission over relatively primitive radio sets was drowned out; and commanders were forced to fall back on flags, whistles, flares, and signal lamps. The carrier pigeon made a heroic, but inreliable, appearance; and multicolored flares probably proved to be the most reliable means of tactical communication.

A general collapse of high-level control occurred in the opening clashes on land in 1914. This was as true of the ill-fated Russian offensive into East Prussia as it was of the German wheel through Belgium into France. The obvious lesson was that, in operations undertaken on such a grand scale, army and corps commanders required the closest possible supervision over their movements in order to assure coordinated response to unexpected developments. Although inadequate communications were obviously the principal weakness, structure, in spite of stresses and strains caused by the staggering casualties of the opening engagements, held up surprisingly well.

The second phase of World War I (1915-1917) became a stalemate on land. This period was characterized by breakdowns in intermediate commanders' control over fighting units, often down to the company level. Under the pressure of massed artillery and machine-gun fire, formations lost all coherence (frequently before even reaching their jump-off positions). Units often lost touch with adjacent units on their flanks and even with their rear echelons. Information reports on the location of friendly and enemy troops also failed and commanders could not commit reserve forces in a decisive way. More often than not, enemy fire and devastated terrain blocked the approach of reserves and coherence was lost before the point of contact was reached. Under these conditions few decisions were open to commanders; they could repeat maneuvers with other units, call for more and more artillery fire, dig in--or fall back.

Two aspects of this period deserve particular emphasis. The first was the difficulty, indeed failure, experienced by commanders in holding down the scope of commitment commensurate with intended objectives. Nowhere was this more tragically demonstrated than Falkenhayn's experience at Verdun. Here, in all its portent and tragedy, is a clear example of the term "escalation". The simple need for more troops, always more troops, caused Falkenhayn's subordinates, and ultimately the German High Command itself, to reverse their intentions completely. Turning down ardent requests that arise in circumstances like these requires a commander to be utterly assured of his purposes, of his intellectual grasp of the course of battle, and of the control of his forces. In somewhat different context, the British experience at Passchendaele underscores this same point.

The second aspect of the stalemate period was the development, on both sides, of elaborate and successful systems of artillery fire control. By means of them, the infantry in attack was first supported by rolling barrages behind which it might advance and then with timely fire against counterattacks once the objective had been gained. Detailed coordination between infantry and artillery, frequently with pyrotechnic signals, permitted rapid calls for fire. Teamwork between the two arms was the key to penetration of enemy defenses, but the inability to extend this coordination into an exploitation phase remained a major factor in the lack of decisive success.

In land fighting in 1918, during the third phase of World War I, infantry-artillery coordination was a basic feature in a German innovation: the "Hutier Tactics". Producing spectacular results first in Russia, then on the Italian front, and later in Ludendorff's great offensives on the Western front, the new tactics employed small German combat groups which sought weak spots in the line, bypassing strongpoints (to be eliminated later by reserves), and pressed irresistably forward like water pouring across a bed of boulders. Troops were ordered to go as fast and as far as they could. However, the problem of sustaining this type of attack was not solved. Torn-up roads and shell-churned fields impeded essential artillery and logistical support; neither trucks nor horses could keep pace.

Nevertheless, despite these strategic German failures, commanders on both sides brought the tactical aspects of trench warfare largely under their control by combining traditional operational methods in the "Hutier tactics" pattern with the newer linkage provided by artillery control systems and the airplane. The major control procedures included: (1) attack objectives strictly limited by phase lines, on which, once gained, the troops dug in and consolidated immediately for defense; (2) combination of aerial reconnaissance and forward observers with assault troops; (3) tight but flexible control of artillery support against counterattack; and (4) systematic widening of the attack frontage to absorb the pressure of counterattack. These progressive steps, repeated in sequence, restored tactical control to junior officers and noncommissioned officers in assault units, relieving superior officers of detailed combat control. The superior could then devote himself to the all-important command decision of the commitment of reserves.

Concurrently, changes in combat at sea took place. A great diversity of ship types appeared--notably submarines and the great battleships known as "dreadnoughts". In the early years of the war, naval combat doctrine remained relatively inflexible, discouraging independent squadron action outside main formation. But improved electronic direction systems enabled commanders to concentrate battery fires on a single target. And better radio communications allowed control of distant warships.

Among the more carefully controlled sea operations was the convoy system, adopted to combat the extremely effective German submarine campaign. Closely guarded groups of merchant ships, their movements precisely planned and coordinated, followed prearranged courses; but when necessary, because of the longer range of more powerful radios, rapid shifts and regroupings could be put into effect. By introducing new procedures and mechanisms of command and control, both in structure and linkage, from the tactical to the political level, World War I set the pattern for later developments and, indeed, for much of World War II.

World War II

By the end of World War I, commanders on both sides had regained a measure of control over the battlefield; but shortcomings in linkage mechanisms—both signals and transportation—still imposed severe restrictions on the employment of mass armies and increased firepower. The method of restoring mobility to the battlefield was introduced with dramatic suddenness at the start of World War II, when the Germans employed vastly improved transport and electronic communications facilities (particularly at the tactical level) and organizational innovations. To a greater degree than ever before, the combined arms concept was applied. The tank, truck, self-propelled artillery, and fighter-bomber aircraft provided a means for swift exploitation, and vastly improved radios and telephones provided similar means for controlling fast-moving, far-ranging formations. For the first time, all three elements that revolutionized modern war—mass, man-killing firepower, and communications—were present in equal degree. Technology, which had presented the commander with ever-escalating responsibilities in terms of mass and firepower, had at last provided mechanisms sufficient to deal with and surmount them.

Tactically, World War II was primarily a war of maneuver. The pattern set was blitzkrieg (lightning war)—the result of study by the Germans of their exploitation failures in 1918. Classical doctrine in principle, the blitzkrieg concept, based on careful planning executed by subordinates, permitted wide latitude of initiative in attaining the desired objective.

Control of land operations on both sides was accomplished through elaborate pyramidal organizational structures, considerable training and discipline, sophisticated communications equipment, and complex staff, administrative, and command relationships. These factors permitted impressive coordination of infantry-artillery-tank attacks, closely supported by aircraft, as well as close cooperation between different types of aircraft, and amphibious and airborne maneuvers.

These were the most tightly knit control systems in history (exemplified by Allied and interservice unified command at high echelons and regimental or battalion combat teams on the tactical level); but despite this fact, there was great flexibility and initiative in subordinate commands. Small groups, which infiltrated far behind enemy lines, or

which were separated from parent units by distance or difficult terrain; parachute and glider units, which fought almost independently; armored task forces, which sliced into the enemy rear to engage targets of opportunity—all operated within a framework of general plans or directives, adhering to training, doctrine, and discipline as well as advanced communications systems.

The speed of the new warfare introduced new situations for decision-making, particularly those which bore on countermeasures. Delay could spell irretrievable disaster, as in the dilatory actions of French commanders after the Germans jumped the Meuse in 1940. In addition, momentous consequences hung on decisions in battles spread over entire nations. And furthermore, with war of such scope, moving so rapidly, decisions were often irrevocable.

Improved communications, placed in the hands of the heads of state, provided rapid means of personal intervention in military decisions. No longer could a commander cut his communications and operate independently, as Sherman and Grant had done in the Civil War. Yet Allied leaders made relatively few intrusions on the prerogatives of the field. Though Roosevelt and—particularly—Churchill sometimes overrode their military advisers and kept close touch with field operations, for the most part the two major Allied chiefs operated within the framework created especially for conducting the global war—the Combined Chiefs of Staff.* Hitler, well advised by his military staff, did much the same in the early months of the war, although he was quick to take matters into his own hands in Russia, where he created a centralized command system which eventually stultified maneuver and initiative in all theaters. Mussolini left military control altogether to his chiefs. And Stalin's direct political control in Russia was apparent, though the system of political commissars attached to tactical headquarters became of relatively small importance later in the war. In Japan, the military retained control of the government until the closing days of the struggle.

The complex problem of allied control in World War I still existed in World War II. Yet when the United States entered the war, accord with the British on unified command was intrinsic from the start and, in general, decisions at the allied level were remarkably free of rancor. Agreement between the Western Allies and Russia, however, was hard earned, except on the broadest of issues; but separation of the two battlefields ameliorated this condition.

Throughout the war, there were dramatic failures in communications, mainly attributable to the human element. Indeed, this was most tragically evinced in the first hours of the war at Pearl Harbor. But later, there were communications failures at the tactical level, too. In the

*See also Appendix D

invasion of Sicily in 1943, Allied land and naval forces opened a deadly fire in the darkness on planes carrying Allied paratroopers to the attack. And in Normandy, in July 1944, a scheduled Allied bombardment by an air armada, which included strategic bombers in direct support of a ground offensive, was cancelled too late to halt the first waves of bombers, who then mistook the bomb line and inflicted severe casualties on American troops. In Holland, later in 1944, the light radio sets carried by British airborne troops dropped beyond the Neder Rijn River lacked range. In consequence, the high command was unaware of failure of the troops to attain their objective until too late.

Additionally, there were intentional communications failures brought about by commanders who wished to conceal their plans or their reverses from superiors. General Mark Clark, during the drive on Rome in May 1944, after consciously violating instructions from his superior, British Field Marshal Alexander, absented himself from his command post until it was too late for Alexander to intervene. On more than one occasion, Generals Patton and Bradley circumvented SHAEF directives in France. German commanders, under strict orders from Hitler not to give up ground voluntarily, reported withdrawals as forced. In February 1945, the commander of the German Seventh Army ordered his subordinates to submit two daily operational reports: one for transmission up the chain of command to Hitler; and another—true—report for army use. At lower levels on both sides, commanders sometimes colored reports to spare themselves and proper decision-making was often impeded.

There were intelligence failures, also. And, again, Pearl Harbor was one of the most dramatic examples. Others were: the French failure to divine the main effort of the Germans through the Ardennes in 1940; and the American failure to detect the German concentration in the same Ardennes in 1944. Even after the D-Day invasion of France had begun in 1944, German intelligence failed for a long time to realize that it was the main Allied landing. And in another instance, the first German blow against the Soviet Union in 1941 gained tactical, if not full strategic, surprise.

These failures, however, were far from being the rule. In stable situations, telephones (as low as squad level) enabled commanders to bring rapid fire support to bear and, in offensive operations, radio networks down to intracompany systems permitted commanders at higher levels to get quick information on which to base their decisions. Radios also made possible tight control of tanks and aircraft, even in far-ranging operations, and enabled fighter aircraft to act sometimes as artillery support. Radio also facilitated ship-to-landing craft and ship-to-shore contact in amphibious operations. Although there were occasional instances of misdirected artillery fire because of human error, in general, radio, telephone, and electronic computer in the fire direction center provided trustworthy means of artillery fire control. Old methods of control also

could be adjusted to the new situations. Commanders might exercise control by the strength of the forces they provided for a mission, by committing additional forces or reserves, by specifically designating objectives or phase lines, by using liaison officers, and by personal contact.

Perhaps one of the most dramatic illustrations of the effectiveness of the new procedures was the control exercised over the Royal Air Force Fighter Command early in the war in the Battle of Britain (1940) when a numerically inferior British fighter force, aided by strict control and direction provided through radar, radio, and telephone-equipped ground observers and tied in closely with ground antiaircraft defenses, defeated German attempts to clear the British skies as a prelude to invasion. While the fighter pilot might retain considerable latitude once engaged in aerial duel, he rose to the fight only at the signal of a centralized command in a procedure that minimized the possibility that defensive strength might be drawn off the main target by feint.

The fact was, improved communications at last effectively linked the fighting front—air, sea, or land—from bottom to top and in the process provided commanders with the information they had to have in order to make the proper decisions. Capture of the Remagen bridge across the Rhine, for instance, flew progressively up command channels with such remarkable speed that Eisenhower's decision--involving a complete change of plan—was made approximately seven hours after the first U.S. troops rushed across the structure.

The linkage mechanism of transportation also served both sides well. The only real problems lay in shortages and in the mechanical limitations of the vehicles, ships, or planes, The Russians never were as well off for transport as other nationalities, but with U.S. aid and their own ingenious use of horses, they made do apparently without serious limitations on operations. In the last year of the war, the Germans were drastically short of planes of all types, of aviation gasoline, and of trucks and self-propelled artillery. On the Allied side, not until late 1944 were sufficient landing craft available to remove restrictions on amphibious operations, and not until 1945 were transport aircraft on hand in sufficient numbers to deliver an entire airborne corps in one lift. These shortages influenced, of course, the decisions as to employing amphibious and airborne troops and in some instances were decisive. Enough transport aircraft to deliver simultaneously all three airborne divisions engaged in the Allied attack in the Netherlands in September 1944 might have meant unquivocal success in that operation. But in general these shortages acted more as a restraining influence on the range of strategy or tactics rather than on success or failure.

Similarly, though trucks, tanks, and self-propelled artillery made possible exploitation thrusts to a depth of several hundred miles, throwing enemy communications into disarray in the process, mechanical limitations and the sheer size of the task of supplying large forces at such distances eventually brought the drives to an end short of total victory. At such point, another phase of relatively stable warfare ensued until a new breakthrough could be achieved and another exploitation staged. In all theaters, particularly in the Pacific, the range of land-based fighter aircraft or the availability of carrier-based planes, limiting the scope of amphibious operations, influenced decisions.

Yet just as with signals communications, transport basically was capable of doing the job demanded of it. When coupled with improved structure—organization specifically designed for the job assigned, like the regimental combat team, the armored combat command, the battalion landing team—the new methods of communication and refined adaptations of the old had at last caught up with mass and man-killing firepower on the battlefield.

Conelusions

Because of the burgeoning technology, the complexities of command and control have reached staggering proportions since World War II. At the tactical level, proper organization, discipline, training, and communications have permitted a continuation of World War II's happy combination of control and initiative, as particularly exemplified in Korea by UN forces. But the possibility of unleashing increasingly "gross" acts by increasingly lethal weapons has imposed increasing responsibility at all echelons of command. Whether augmented training to cope with these complexities will render personnel on lower levels so sensitive to the results of their acts that they will question, or even refuse to accept, a "go" order is a subject that warrants further study. As yet, there does not appear to be a clear consensus of how to relate responsibility and initiative to a theoretically "permissive" control system.

At higher levels, problems of command and control are raised by huge armies and air forces equipped with incredible firepower, vast fleets with self-contained air forces, and unprecedented new arms and delivery systems in the process of development. So far, the twin concepts of structure and linkage have been adequate to hold centrifugal military forces in check. Yet the future imposes the necessity of finding clearcut restraints on man's ability to destroy himself while, at the same time, insuring a command and control system that has validity and produces compliance.

APPENDIX D

A SURVEY OF THE HISTORY OF POLITICAL INVOLVEMENT IN MILITARY COMMAND

I. Introduction

Control of its military power is a prerogative of organized government, stemming from the fact that the military constitute an arm of government and are, therefore, subordinate to the authority of the head of state. This principle of political control, loosely termed "civilian control" in this country, has existed throughout the course of modern history.

It is pertinent to note that Jomini and Clausewitz, the two prominent students of war whose writings have most affected professional military thought since the early part of the 19th Century, attest to the validity of the principle but are careful not to attempt empirical delimitation between political and military control. Jomini stresses that primary consideration must be given to "la politique de la guerre" or political factors in war. "We give this title," he writes, "to the combinations by which a statesman [italics supplied] must judge whether war is proper, opportune, or even indispensable; and what must be the diverse operations essential to accomplish his objective."[1]

He further points out that the unexpected psychological and political factors which will be encountered in prosecuting a war cannot be resolved by tables of probability. Hence, plans of operation must be modified in accord with circumstances, although for their execution one must remain faithful to the principles of the art."** And again, Jomini warns that the statesman [italics supplied] must seize upon such modifications as circumstances and localities dictate."[3]

Clausewitz says:

> The subordination of the political point of view to the military would be unreasonable, for policy created the war; policy is the intelligent faculty, war only the instrument, and not the reverse. The subordination of the military point of view to the political is, therefore, the only thing which is possible.

Deep-rooted American solicitude that "civilian control" be held inviolate stems as a corollary to the axiom enunciated by Clausewitz. Fear of tyrannical military dictatorship dates back to the time when war was considered "the sport of kings", and the whim of warrior-kings dictated the fate of the population. This dread was aptly expressed by Governor John Winthrop of the Massachusetts Bay Colony in 1638. At that time, when the Ancient and Honorable Artillery Company of Boston applied for

the first volunteer militia charter in the Thirteen Colonies, he said:

> ...The Council considering from the example of the Praetorian Band among the Romans and Templers [sic] in Europe how dangerous it might be to erect a standing authority of military men which might easily in time overthrow the civil power, thought it fit to stop it betimes...^

Individual civilians and/or civil bodies have intervened in military operations throughout historv. Hence the gamut of historical experience in wide; it runs from delineation of policy to complete command and control of military field operations.

II. Europe

In 17th-century Europe, control of military operations by influential nonmilitary individuals was notable in both France and England. For instance, Cardinal Richelieu, who was Louis XIII's chief minister, exercised a very direct personal control over France's domestic and foreign military operations.[6] And in England, the Cromwellian "Instrument of Government" (1653) was forerunner of the "Declaration of Rights" (1689), which radically changed the administration of the English government. (By the terms of this instrument, while the head of state remained as titular commander in chief of the national forces, ultimate control passed to Parliament. Henceforth, standing armies could not be maintained in peacetime without Parliamentary sanction, which was implemented by control of the national purse-strings.) As a result, William of Orange, when he became King William III by Parliamentary edict (1689) found his powers as traditional commander in chief drastically curtailed by cabinet ministers.^

Concurrently (1643-1715), Louis XIV was assisted in his brilliant military era by three of his civilian ministers: Louvois, minister of war, who reorganized old armies, developed campaigns and improved the welfare of the troops in the field; Colbert, minister of finance, who schemed to reorganize the navy, advised on and planned colonial and maritime expansion; and Vauban, the great engineer, who wore three hats--as civilian administrator-advisor, military commander, and master engineer.°

During much of the Seven Years' War, England's armed forces operated under tight political control. William Pitt (the Elder) was appointed Secretary of State in 1757 and used his powers lavishly in the conduct of the war. Dictatorially, he directed operations overseas through linkage, which was remarkable for that era.9

The French Revolution (1789-1799) was, of course, in the beginning, chiefly a civilian-led rebellion against the decaying remnants of the French monarchy. The man who became known as "the organizer of victory"

of this people's revolt was Lazare Nicolas Carnot, distinguished engineer, mathematician, physicist, and former soldier. Carnot's operational control of French armies was direct and ruthless and, by 1792, he had affected changes in French military organization and doctrine which led directly to a series of remarkable French victories.

Eventually, Carnot became responsible for "deputies on mission" or the civil control of promotion and demotion of officers at the front. An able military man in his own right, he himself constantly joined—and inspired—the armies in the field and, throughout his career, instigated new tactical and logistical procedures.10

In the 19th Century, the Franco-Prussian War (1870-1871) presents an outstanding example of political control of the military. At that time, both Napoleon III and his adversary, Prussian Chancellor Bismarck, involved themselves with the operations of their respective armies. Late in 1870, Napoleon appeared in the field to command his French armies, adding difficulties to France's already disastrous position; his defeat at the Battle of Sedan caused the fall of his empire. Bismarck, from the beginning of the war, irritated the German General Staff with his tendency to concern himself ("meddle" was the professional label) in military affairs.[11] After the victory of Sedan, the Chancellor became even more involved, conceiving a plan for receiving direct communications from field commanders; later, he also concerned himself with operational details for the siege and capture of Paris.

During World War I, political control on the Allied side was haphazard at first, but later became clear-cut and formalized.[12] Lloyd George, British Prime Minister, exercised such control that, in the spring of 1918, he actually refused reinforcements to Haig, his field commander; and Clemenceau, French Premier, often stated that war was far too serious a matter "to be left to the generals".

In the Allied Supreme War Council, Lloyd George, Clemenceau, and Italy's Orlando exerted continual influence upon military commanders and even attempted to pressure President Wilson to remove General Pershing from command of the AEF.

At the outbreak of World War I, Winston Churchill, first Lord of the Admiralty, had played **gn** active and effective role in mobilizing the British navy. Later, hurchill personally participated in the defense of Antwerp after the Germans had invaded Belgium. Churchill's role in the decision to undertake the Dardenelles campaign (1915), and in the planning for that operation, exceeded that of cabinet minister (as, in fact, did Kitchener's as Secretary of State for War).

In World War II, Churchill's role in command and control began with his direct supervision—as First Lord of the Admiralty (September 1939-May 1940)—over Royal Navy operations during the Norwegian campaign.

Later, as Prime Minister and Minister for Defense, he carried his dynamic influence through the strategic level into tactical planning for the employment of both troops and weapons. His directives, admonitions, and orders to individual commanders in the field ripped through the maze of traditional chains of command. "Phantom", his own personal forward reconnaissance network, composed of liaison officers equipped with adequate and rapid means of communications, kept him advised of daily operations on all fronts, frequently well in advance of military situation reports.

On the Axis side, Adolph Hitler's personal control of field operations was absolute, though it should be noted that this political control was exercised ad absurdum and contributed greatly to the fall of the Third Reich.

In the Soviet Union, Joseph Stalin's control of field forces was tight; it is clear that political overlordship intervened frequently in tactical situations (as, for instance, the halt outside Warsaw in 1944), but the extent of this involvement is not fully known outside of Russia.

III. The United States

With the coming of the American Revolution in 1775, the Continental Congress resolved to exercise supervisory control over all military operations through a Congressional committee. Commander in Chief Washington kept in close touch with this civilian group, which was often understandably discouraged with the lack of progress and of victory in the lengthy war. Nevertheless, in only one major instance did the committee intervene directly in field matters. In 1780, Congress appointed General Horatio Gates as Washington's co-equal, in command of the newly established Southern Department, created to deal with the British shift in concentration to the South. Gates was ignominiously defeated at Camden (August 16, 1780), and Washington's responsibility as pver-all Commander in Chief was soon restored by a penitent Congress.[1]^

Within a few years following the Revolution, the framers of the Constitution wrote into that document their convictions for political control over the military—convictions based on experience in the American Revolution combined with their heritage from England. With a few minor modifications, the framers reproduced in the Constitution the division of authority over the military which prevailed in England and the colonies in the middle of the 18th Century.[15] In effect, the President inherited the powers of the English King, and Congress, the powers of the English Parliament. The major difference lay in war-declaring power for, by vesting Congress alone with that power, the framers altered British practice and established a significant precedent in the evolution of constitutional government.

The obvious intention of the framers was to grant the President almost unlimited authority as commander in chief of the national armed forces, including—if he so desired—assumption of personal command in the field. The one, clear-cut limitation on this authority was the constitutional prerogative of Congress "to raise and support armies [and] to provide and maintain a navy". [b]

Not until the last decade of the 19th Century was there further attempt to define the President's authority. Then, two Supreme Court decisions reaffirmed his unlimited control: "The object...is to vest in the President the supreme command over all the military forces, such supreme and undivided command as would be necessary to the prosecution of a successful war". And,

> Congress has the power not only to raise and support and govern armies but to declare war. It has, therefore, the power to provide by law for carrying out war. This power necessarily extends to all legislation essential to the prosecution of war with vigor and success, except such as interferes with the command of the forces and the conduct of campaigns. That power and duty belong to the President as commander in chief [italics supplied]
> But neither can the President, in war more than in peace, intrude upon the proper authority of Congress, nor Congress upon the proper authority of the President.18

Meanwhile, political intervention in military command and control had been exercised on numerous occasions. President Madison and his cabinet, on August 24, 1814, actually took a brief part in battlefield command at Bladensburg. Before he fled that field, however, Madison told his War Secretary, John Armstrong, who was issuing orders to the American commander, Brigadier General William H. Winder, that "the military functionaries should be left to the discharge of their own duties, on their own responsibility".!⁹ Several years later, during the Mexican War, the presidential prerogative was invoked by President James Polk in two instances: first, by his repudiation of General Taylor's armistice agreement with the Mexican commander, General Ampudia, at Monterey in 1846; and second, by his arbitrary (but legal) removal of General Scott from command in Mexico in 1848.[2]^

In the Civil War, there were numerous examples of political intervention, both presidential (legal) and congressional (strictly speaking, illegal). In the latter case, following the Union defeat at Ball's Bluff, Virginia, in 1861, Congress established a Joint Committee on the Conduct' of the War, "to keep an anxious, watchful eye over all the executive agents who are carrying on the war at the direction of the people". This group, predominantly Radical Republicans, believed, in the words of a member, that: "We are not under the command of the military of this country. They are under ours as a Congress." Throughout the remainder of the war, this committee plagued both the President and the military command, often dictating military policy by sheer political power.[2]!

Both Presidents—Abraham Lincoln and Jefferson Davis—took active part in the formulation of military policy and even in actual direction of military operations. Although Lincoln realized his military limitations, he assumed personal command of the Federal armies for a while, exercising this command through his Secretary of War, Edwin M. Stanton, from March 1862 until July 1862. During that time, the office of the General in Chief remained vacant; but after the disastrous Second Bull Run Campaign, General Halleck was named to fill that position. Lincoln's Civil War experience demonstrated that, in his desire to obtain a formula for victory, he and other inexperienced civilian authorities resorted to experimenting with military affairs.[22] Not until 1864, when Lincoln "found" Grant, did he have a general to whom he was willing to entrust full military responsibility.

On the Confederate side, President Jefferson Davis, an experienced West Pointer, frequently intervened in field operations and "became too involved in the details of the Confederate War Department ... in minor matters of army administration, to the annoyance of his five successive Secretaries of War, and to the despair of many of his generals".[23] As opposed to Lincoln's relationship with Grant, Lee seemed to feel obliged to continue to check out his every action with the President, after Davis belatedly made him General in Chief.

Militarily, the Spanish-American War of 1898 was a relatively minor event; but associated with it, is one unique example of civilian intervention in military affairs. Assistant Secretary of the Navy Theodore Roosevelt, soon after the USS Maine was sunk in Havana Harbor (February 1898), without consulting professional naval officers or his civilian chief, sent a message to Commodore George Dewey, ordering his squadron to Hong Kong. "Keep full of coal," Roosevelt ordered. "In the event of ... war your duty will be to see that the Spanish squadron does not leave the Asiatic coast, and then offensive operations in the Philippine Islands

During World War I, there were only two conspicuous instances—both limited to initial strategic decisions—when there was political intervention in military operations. These were: participation in the ill-fated Allied North Russian adventure of 1918 and the American Siberian expedition in 1918-1920. Once in the war, President Wilson was meticulous to avoid interference with his professional military command. He gave his field commander, General Pershing, free hand and unqualified support, while his War Secretary, Newton D. Baker, faithfully carried out the President's wishes. Overseas, Wilson's representative on the Supreme War Council, Major General Tasker H. Bliss, loyally protected both his chief and Pershing from the sometimes insidious, frequently dictatorial efforts of Allied chiefs of state to intervene in American command and control. [3]

In World War II, insofar as the United States was concerned, political intervention in strategic command and control was ubiquitous in the delineation of policy and grand strategy, since the Big Three-Roosevelt Churchill, and Stalin-dictated it, and the Allied Combined Chiefs of Staff and the U.S. Joint Chiefs of Staff directed it in the various theaters of war. President Roosevelt was almost as meticulous as Wilson in leaving purely operational matters in the hands of military subordinates whom he trusted. 'In one instance, however, because of political pressure, the President insisted that General Chennault be given greater operational latitude in China than was deemed advisable by Generals Stillwell, Marshall, and Arnold.

IV. Conclusions

The Korean War, with its limited and precise objectives, reaffirmed the concept that political command and control must override divergent views of the military in the field. The summary relief of General Douglas MacArthur by President Truman emphasized this fact.

The modern, nuclear-age trend toward increased political involvement in command and control has been repeatedly demonstrated in various cold war noncombat crises. In the Cuban-Soviet missile affair, for instance it is alleged that White House directives cut through the normal Navy ' chain of command with instructions to individual warships.

n™ ^ Try. fa f that the em Ploy™ fey U.S. troops of nuclear weapons now depends--by law-on presidential assent is evidence that the nuclear age has pushed the command and control responsibility of the President directly to the front ranks of combat. It would appear essential, then that an exhaustive study be made to evaluate the potentialities of this situation, both as regards the national defense and the effect of such imperative, personal control on both initiative and discipline in successive levels of military command and control.26

Notes

1. Antoine H. Jomini, Tableau Analytique (supplement to Traite des Grandes Operations Militaires; Paris: 1830), p. 5.

2. Ibid., pp. 10-11.

3. Ibid., p. 57.

4. Karl von Clausewitz, On War, quoted in R. Ernest Dupuy and Trevor N. Dupuy, Military Heritage of America (New York: McGraw-Hill 1956), p. 187.

5. As quoted by R. Ernest Dupuy, Compact History of the U.S. Army (New York: Hawthorne, 1956), p. 19.

6. William L. Langer, Encyclopedia of World History (Boston: Houghton Mifflin, 1952), p. 387. See also J. F. C. Fuller, A Military History of the Western World (New York: Funk & Wagnalls, 1955), II, pp. 46-73, passim.

7. Langer, op. cit., p. 431

8. Langer, op. cit., p. 442.

9. John C. Long, Mr. Pitt and America's Birthright (New York: Stokes, 1940), pp. 245-331, passim.

10. Alfred Vagts, A History of Militarism (New York: Meridian Books, Inc., 1959), pp. 113-114.

11. Walter Goerlitz, The German General Staff, 1657-1945 (New York: Praeger, 1961), pp. 91-93.

12. Since the United States was not an Ally, political control in this country is considered separately, infra.

13. Winston S. Churchill, The Second World War (Boston: Houghton Mifflin, 1946), VI Vols., passim.

14. R. Ernest Dupuy and Trevor N. Dupuy, Compact History of the Revolutionary War (New York: Hawthorne, 1963), pp. 360-373.

15. U.S., Constitution, Art. 1, sec. 8 and Art. 2, sec. 2.

16. Ibid.

17. U.S. vs Sweeney, 157 U.S. 281 (1895)

18. Ex parte Mllligan. 4 Wall. 2, 139 (1866); Swaim y U.S.. 28 Ct. CI. 173, 221 (1893) affirmed 165 U.S. 553 (1897).

19. R. Ernest Dupuy and Trevor N. Dupuy, Brave Men and Great Captains (New York: Harper, 1959), p.83.

20. Charles W. Elliott, Winfield Scott (New York: MacMillan, 1937), pp. 553-575, passim.

21. R. Ernest Dupuy and Trevor N. Dupuy, Compact History of the Civil War (New York: Hawthorne, 1961), pp. 50-51.

22. Dupuy and Dupuy, op. cit., passim.

23. Ibid., p. 284.

24. As quoted by E. B. Potter and Chester W. Nimitz (eds.) in Sea Power (New Jersey: Prentice-Hall, I960).

25. Dupuy and Dupuy, Military Heritage of America, p. 388; R. Ernest Dupuy, Men of West Point (New York: Sloan, 1951), pp. 130-152, passim.

26. A provocative discussion of the ideal political-cum-military relationship to be expected in the United States today may be found in: John W. Mas land and Laurence Radway, Soldiers and Sailors (Princeton: Princeton University Press, 1957), pp. 40-46.