The Strategy of Technology

Winning the Decisive War

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and Francis X. Kane, Ph.D. (Col., USAF Ret.)

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Preface

A Disquisition on the Strategy of Technology, originally in View 30.

It is probably worth keeping a bit closer to the book.

I mentioned Strategy of Technology in a recent letter to subscribers, and discovered that some had never heard of it. That goes to show that this web site is more complicated than it ought to be, and suggests that I need to do more work on organization to let people know what's here. Herewith a short explanation:

Fair warning: this is done informally and from memory, and I may have one or two details wrong.

Strategy of Technology was written in the 60's and published in 1970. The authors of record were Stefan T. Possony and Jerry Pournelle, and the book, long out of print, was published by Dunellen The University Press of Cambridge, Mass., which no longer exists. There was in fact a third author, Francis X. Kane, Ph.D., (Col. USAF, Ret'd) then the Director of Plans for USAF Systems Command.

The book was a success d' estime: that is, it was quite influential, but sold something under 20,000 copies, and went out of print when the publisher vanished. For a while it was a textbook in all three Service Academies and remained so for several years at the Air Force Academy in Colorado Springs. It was also used at the Air War College in Alabama and the National War College, and it's my understanding that Xerox copies are used (with our permission) in some classes at the war colleges to this day. Strategy of Technology was very much a book for the Seventy Years War (or Cold War if you like); although the principles remain true and important, all the examples are pretty well drawn from that conflict and specifics are directed to weaknesses in the nomenklatura system that governed the USSR in those times.

Over the years we rewrote some of the chapters and published them in various places including my own THERE WILL BE WAR series (books that were about 3/4 science fiction but which contained significant non-fiction essays on military history and principles). Dr. Possony had a disabling stroke in the mid-1980's and died shortly after the Cold War ended; he was lucid enough to know that the USSR was brought down, and that he had been a key player in that game. As one of the authors of the seminal THE PROTRACTED CONFLICT (with Robert Strausz-Hupe and William Kintner) as well as STRATEGY OF TECHNOLOGY, and in countless other ways, he had a major influence in winning the Seventy Years War. In my judgment we would not have won the Cold War without him; he was one of the great men of this century although few have heard of him today.

The book has been out of print for years, and when this web site began I was urged to make copies available here, which I did. I have posted the "revised" edition, which contains most of the first edition, prefaces, and some extensively reworked chapters done mostly by Kane and myself, although Stefan had a hand in some of the earlier revision, and we did discuss the later ones with him. After his stroke he remained aware but had great difficulty in communication, which produced extreme frustration as he tried to convey important thoughts that came out incoherently; a very painful situation for all concerned.

The html code which presents the book with extensive notes was done by professionals working as volunteers, and has some minor flaws, (I would be grateful to anyone who can correct them) but the book can be read here. I have been urged to make it available in Acrobat pdf format, but I have never had the time to do so. Perhaps one day.

When we put it up here we called it an experiment in shareware, and I asked that if you read the book you send me a dollar; a dollar bill in an envelope will do. Some have also added a couple of dollars to checks sent as subscriptions to this web site. Over the years that has amounted to a couple of hundred dollars, and at his birthday party a week or so ago Dr. Kane and I agreed that rather than divide this small sum, I'll just send it all to Dr. Possony's widow, who still lives in Mountain View.

Regina Possony was a survivor of Stalin's prison camps (they met in the United States after both had fled). She was born in Berlin and her father was an influential Communist politician who fled with his family to the USSR on the rise of Hitler; they were of course put into a labor camp. As both Jews and Communists they would hardly have survived in Berlin, so a Russian camp was a stark but better alternative to remaining in Nazi Germany. As a young girl Mrs. Possony had met Albert Einstein on a family visit to the United States, and from the USSR prison camp wrote him a letter addressed to "Dr. Albert Einstein, United States of America". The US Post Office delivered it to him at Princeton University. Einstein was gracious enough to reply, and even to send a small package of food and hygienic goods, which raised her status somewhat in Stalin's estimation. After Stefan's stroke she singlehandedly kept him alive for a decade when no one expected him to live a month.

Stefan T. Possony was a Senior Fellow of the Hoover Institution until he died. He had formerly been a Professor of Political Science at Georgetown University, and a Pentagon intelligence officer for the United States. Prior to the invasion of France in 1940 he was an intelligence officer in the French Air Ministry, to which he came from the Air Ministry of Czechoslovakia. His escape from France during the confusion of the Fall of France was a fascinating story; at one point he contemplated using a kayak to paddle to Spain, but managed to get one of the last tickets to Oran.

He had fled Czechoslovakia during the Nazi invasion. He had come to Prague from Vienna, where he obtained his Ph.D. at the University of Vienna and joined the Schusschnigg ministry opposing the Anschluss with Germany; he was on the Gestapo's wanted list, and left for Czechoslovakia as the Wehrmacht rode in. He used to say that the Gestapo got his library three times, in Vienna, Prague, and Paris. In the 70's and early 80's Stefan was quietly influential, directing several Pentagon studies of Soviet leadership and strategy. His biography of Lenin is still about the best tool for understanding the founder of the USSR. Alas it is long out of print.

Stefan Possony was perhaps the single most important member of my Citizens Advisory Council on National Space Policy which among other duties assisted Dr. Kane in writing Transition Team papers on space and military policy for the incoming Reagan Administration. Possony was one of the major architects of the Strategic Defense Initiative. Strategy of Technology introduced the notion of a strategy of "assured survival" in contrast to "assured destruction" and Assured Survival is the title of one chapter of that book.

Dr. Kane and I would like to revise the book and get it back in print, since the principles seem even more important now than they were when it was written. We're both getting old enough that we wonder if that will happen, but it should. As written it's still worth reading (in my judgment), and several War College students have used it as part of their advanced degree work. Revising it was going to be the project of one USAF officer at the post graduate school, but he was needed as director of a weapons lab and left the school before that could be done. Meanwhile, the book exists here.

Jerry Pournelle

Studio City, CA

Saturday, January 09, 1999

> "A gigantic technological race is in progress between interception and penetration and each time capacity for interception makes progress it is answered by a new advance in capacity for penetration. Thus a new form of strategy is developing in peacetime, a strategy of which the phrase 'arms race' used prior to the old great conflicts is hardly more than a faint reflection.
> There are no battles in this strategy; each side is merely trying to outdo in performance the equipment of the other. It has been termed 'logistic strategy'. Its tactics are industrial, technical, and financial. It is a form of indirect attrition; instead of destroying enemy resources, its object is to make them obsolete, thereby forcing on him an enormous expenditure...
> A silent and apparently peaceful war is therefore in progress, but it could well be a war which of itself could be decisive."
> –General d'Armee Andre Beaufre

0.1 Preface to the Electronic Edition 1997

The quotation above opened the original edition of this book; it was clearly prophetic. The silent and apparently peaceful war was decisive.

This book was originally written in 1968 to 1970, a time when the Cold War was real and the outcome still very much in doubt; it will be recalled that Nixon's Secretary of State Henry Kissinger, convinced that the Cold War was lost, hoped to negotiate détente and come to terms with Soviet International communism; and it was widely assumed in 1975 that the United States had been dealt a major defeat in Viet Nam.

In 1991, just before the collapse of the Soviet Union ended the Seventy Years War, we attempted to edit this work into a form suitable for publication in an electronic medium. This was well before the popularity of the world wide web, and before electronic publishing tools were readily available.

The end of the Seventy Years War brought other problems. The senior author, Dr. Stefan Possony, lived to see the victory which he had done so much to bring about, but died shortly after the collapse of international communism. Dr. Kane and Dr. Pournelle were involved in the development of the space program, and particularly the renewal of the X projects which had been canceled by McNamara in the name of Arms Control (because they were so successful at generating new military technology. New technology wasn't wanted by those enamored of Arms Control strategies.)

For those and other reasons, this book languished for six years with little or no work done.

A generation of students used this book, but a new generation can't find it; the copies still in use in the War College are Xeroxes, the book long being out of print. Meanwhile, new threats loom on the horizon. The Seventy Years War is over; the Technological War continues relentlessly. It is possible that this book is needed now more than ever.

Most of the examples in this book were chosen for their impact on thoughts about the Cold War and the threat of Soviet communism. They are now historical rather than current, and a proper revision of this book would use examples from current threats; alas we haven't time to do that; nor have we time to do a proper chapter on space and space weapons. You will find THOR and SDI in these pages, but they aren't given their proper emphasis. No matter. The principles in this book remain as true today as when they were written; we find little that needs explaining, and nothing that requires an apology.

Jerry Pournelle Studio City, California 1997

0.2 Preface to the Electronic Edition 1991

When this book was originally published, the Cold War was very real. The United States was winding down the agony of Viet Nam, and one heard calls for "one, two, three, many Viet Nams" to bring the United States to her knees.

The threat of nuclear war was quite real, although it was not everywhere taken quite as seriously as it should have been.

The Soviet Union was not seen as an evil empire, but as the representative of the wave of the future.

The result was that the early portion of the book was devoted to convincing the readers that the threat was real, and imparting an understanding of the nature of that threat. That was needed then. It is less needed now; yet some of the early material also introduces the concepts of strategic analysis and the technological war, and those concepts are vital to understanding the principles we try to explain in this book.

A full rewrite of STRATEGY OF TECHNOLOGY would go through and pare away those portions written to respond to the threat of the 70's and would add new examples and analyses to fit the threat of the 90's. Alas, we have not time to do this; our choices are a 'quick fix' or not to publish for some years.

[That paragraph was itself written in 1991; what we did then was essentially nothing. It is clearly time to get this published in electronic form, whatever else we do.]

STRATEGY OF TECHNOLOGY was a textbook in the Service Academies for several years, and off and on has been a textbook in the Air and National Defense War Colleges. We have reason to believe that its arguments were useful in bringing about adoption of a high tech strategy for the US Armed Forces. That such a strategy was adopted is self evident from the victory in Iraq and the collapse of the Soviet empire. How much was due to this book can be debated, but we can at least claim that this book explains the principles of technological strategy.

Some day we will revise the examples. However, the principles haven't changed, and the rapid changes in the Soviet Union as well as the Iraq victory can be explained as consequences of an earlier victory in the 'silent and apparently peaceful conflict which may be decisive' which we called The Technological War.

From time to time we have inserted comments made at times later than the first publication. Those are marked with brackets and dated. We find we haven't had to do much revision of the book, and none of the principles espoused needed changing. We have pointed up new examples of the application of those principles.

Portions of this revised text have from time to time been published in different volumes of THERE WILL BE WAR, an anthology series edited by Jerry Pournelle.

Chapter 1

The Technological War

There are at least two kinds of games. One should be called finite, the other infinite. A finite game is played for the purpose of winning, an infinite game for the purpose of continuing the game.
–James P. Carse, *Finite and Infinite Games*

The United States is at war. Whether we consider this to be the Protracted Conflict initiated in 1917 by the Bolsheviks or something new brought about by the march of technology, the war cannot be escaped. The field of engagement is not everywhere bloody. Except for financial sacrifices, many citizens of the West and subjects of Communism may be unaware of the conflict until the decisive moment, if it ever comes, is upon them. For all that, the dynamic Technological War is most real, and we must understand its nature, for it is decisive. Our very survival depends on our constantly winning this battle.

The Technological War has been raging since World War II. That war marked the end of the era in which decisive military power grew exclusively from the products of the original Industrial Revolution. In the new era, power grows largely – sometimes exclusively – from products based on applied science.

The Technological War is dynamic. There are dramatic peaks in activities as rates of change suddenly accelerate. The theater of operations can change in bewildering ways: recent (1989) events in Europe are a prime example. Ruling classes come and go, alliances are made and dissolved; but the Technological War remains. For the West, the Technological War is an infinite game; victory in one battle, or in an entire theater of conflict, does not end the conflict.

The Technological War is seemingly impersonal because of its new and unexpected sources of change and its global impact. Even so, the Technological War, like all conflicts, is driven by human ingenuity responding to basic challenges and aspirations.

For many years the most basic challenge of the Technological War has been the threat to U.S. security caused by the enmity of the Soviet Union, specifically a small group within the ruling elite of the U.S.S.R. That group within the nomenklatura[1] deliberately chose the U.S. as its enemy after the close of World War II, and renewed the Protracted Conflict against the rest of the world. That conflict has lasted for over seventy years.

The true nature of the Soviet nomenklatura is not fully understood in the West even today. As a first approximation, they may be thought of as the "state engineers" whose emergence under socialism was predicted by Bakunin, and who were first described in popular literature in Milorad Djilas's The New Class. This privileged political-scientific class was the actual government of the U.S.S.R. It arose during the Stalinist purges of the 30's, gained strength shortly after World War II, and consolidated its hold on the U.S.S.R. from the time of Stalin's death until the rise of Gorbachev.

The nomenklatura were the true owners of the U.S.S.R., for not only was the population at large excluded from the political process (except for ritualistic purposes), but also the rank and file of the Communist Party, some 18 million in number, were reduced to executors of the nomenklatura's will. The nomenklatura held the Soviet Union in ownership every whit as much as had feudal landlords; it's position can best be given in the words of Karl Marx, who spoke of the post-1830 monarchy in France as " 'a company for the exploitation of the French national wealth,' of which the king was the director, and whose dividends were distributed among the ministers, parliamentary deputies, and 240,000 enfranchised citizens."

nomenklatura has two meanings: a list of the most important offices, appointment to which requires approval by the Secretariat; and the roster of the personnel who either hold those offices or are eligible for promotion to them. The numbers and names of the nomenklatura remain state secrets. In 1989 Esther Dyson was shown a copy of the Leningrad edition for 1987: a small red book consisting of about 5,000 names and addresses, with no title other than a document number and date.

Although the nomenklatura exists within the Soviet Union, it is independent of the nation in that it owes no allegiance to the country or the people; its major goal, like that of many oligarchies, is to retain its power

[1] In the first edition of this work and in other places Stefan Possony referred to a secret Soviet group which he called "the Brotherhood", and which in some ways corresponded to what we now know is the *nomenklatura*.

and privileges.

This power structure has undergone dramatic changes in the Gorbachev era. It has not been abolished, and it is unlikely that it will be abolished in any short period of time. Gorbachev's official view is that the basic structure of the U.S.S.R. is sound, as was Lenin's view of the world situation; the Revolution was betrayed, but the Marxist analysis of history remains sound. In today's Soviet Union the old nomenklatura is the enemy of *glasnost* and *perestroika*, and must be replaced. The result is likely to be faces among the nomenklatura, and a new basis for its selection – possibly a structure independent of and antithetical to the Communist Party. Even so, the phenomenon will remain, nor should anyone familiar with political history be surprised by that. Michels's Iron Law Of Oligarchy was written well before the Russian Revolution. Replacement of the nomenklatura would require fundamental changes in Soviet economic organization and structure, and so far those are not only not contemplated, but vigorously denounced by Gorbachev as well as by his enemies within the Party.

Thus, despite changes in Soviet structure, the basic conflict remains; and so does the Technological War. Indeed, *glasnost* and *perestroika* , by allowing the new Soviet leadership to abandon obsolete weapons systems, can release new resources which can be committed to the struggle. Military commanders are usually reluctant to reduce the numbers of troops they command; but in fact in the Technological War it is often better to have smaller numbers of highly effective forces than to use one's scarce technical resources to maintain obsolete equipment. For all the talk of a new era in the Cold War, the U.S.S.R. has not noticeably slowed its production of modern weapons, and is not likely to.

In addition to the Soviet threat, there is a second challenge: the threat to the U.S. economy from our erstwhile allies, who, under the shelter of the U.S. military umbrella, have exploited technology to challenge U.S. economic leadership. While purely commercial competition is outside the scope of this book, there is a strong interaction between military and economic national technological strategies. A rational strategy of technology will not neglect the means for expanding the technological base from which military technology is derived. We will return to this point later.

During the 1990's, the major conflict will be between the United States and the U.S.S.R. The natures of both technology and the enemy dictate that this will a be state of Technological War. For all the Gorbachev reforms, the U.S.S.R. is a power-oriented dictatorship, whose official doctrine is Communism: That is, a chiliastic movement which claims inevitable dominance over the entire earth. It is not necessary for all of the individual leaders of the U.S.S.R. to be true believers in this doctrine, and in fact most may not.

Since the Soviet Union is a dictatorship, the usual dynamics of dictatorship apply.

The government of the Soviet Union is divided among the Army, KGB, and Party. The Party and KGB appear to be under the near total domination of the nomenklatura. The Army may not be, but military promotions are largely under the control of the Party and therefore the nomenklatura. The relation between Gorbachev and the nomenklatura is also unclear. One thing is certain: *glasnost* and *perestroika* cannot be implemented without using the existing power structure, and that includes the nomenklatura.

One fundamental fact of dictatorship is that losing factions within its ruling structure forever lose their positions and power. They may retain their lives – the nomenklatura generally do – but they retain little else, and sometimes they do not survive. Thus, such rulers, whether sincere or cynical, have a powerful incentive to conform to the official ideology or line of the top man or group. Moreover, they compete with each other for power. If a powerful faction counsels aggressive expansion – whether out of sincere belief in the ideology, because expansion creates more opportunities for advancement, or because it expects aggression to prop up a tottering regime – failure is the only way through which its influence will be reduced. Every successful aggressive action increases the influence of those who counsel aggression.

If aggressive moves encounter stern opposition, so that the ruling faction is not only not rewarded for its expansionist policies, but finds its national power decreased, changes in the official policy may take place. Such failures, consequent punishment, and resultant troubles for the dictatorship may serve to place in power a more cautious group dedicated to defense of the empire and the status quo.

This was dramatically illustrated by the Soviet failure in Afghanistan.

It is possible that the nomenklatura, faced with rising opposition from both ethnic minorities and even the Russian people, has veered its policy toward one of imperial defense. If so, this will mark an important turning point in history; but we cannot bet the survival of freedom on what may be a temporary policy shift based largely on the life of one man.

Moreover, if there has been a change in policy, it is due largely to the failure of the previous leaders to induce the United States to abandon the conflict entirely. Nearly twenty years ago we argued that the best way to change Soviet policy was to negotiate from strength; we believe the Reagan era has proved that.

There have been profound changes in Soviet leadership and policy since we wrote the first edition of this book. Much of the Soviet leadership has become disillusioned with the inevitability of world victory. At the same time, there is no ideological justification to the rule of the Party – and behind that the nomenklatura – except Communism.

glasnost and *perestroika* may be genuine; they may even work; but these changes will not and cannot remove all the incentives for expansionism, particular if expansion looks easy.

Moreover, aggressive actions may occur because of internal pressures, especially in a period when faith in Communism as an ideological system is declining, and it is possible, although unlikely, that aggressive initiatives will be taken by non-Communist states.

The international situation is complex; and despite all complications the U.S.S.R. is the single most important and strongest opponent of the United States. If the USSR leadership believes it can eliminate the United States, the temptation to do that will be severe. Consequently, American strategists must primarily be concerned with Soviet strategy and the threat posed by the U.S.S.R.[2]

This does not mean that the economic threat to the U.S. technological base can be neglected. Other nations pursue an aggressive strategy of technological competition, often guided, as with the Japanese Ministry of Trade and Industry, from the highest government levels. International technological competition can sometimes reach levels best described as economic warfare, and the outcomes of these competitive struggles can have surprisingly long range effects on the decisive military Technological War.

The nature of technology also dictates that there will be conflict. This will be discussed in greater detail in later chapters. For the moment, we can say that although technology can and should be driven by an active strategy, there is also a sense in which technology flows on without regard for human intentions, and each technological breakthrough offers the possibility for decisive advantages to the side that first exploits it. Such advantages will be fleeting, for although the weaker side does not have weapons based on the new technology yet, it is certain that it will have them in the near future. In such circumstances, failure to exploit the capability advantage is treason to the Communist cause.

It must be emphasized that to the committed Communist, there are no ideological reasons for not exploiting advantages over the capitalists. The

[2]Since we wrote this in 1968-69, the Soviets have invaded Czechoslovakia to consolidate the Empire's power there; invaded Afghanistan; placed tens of divisions on the Chinese border; interfered in the Middle East; used Cuban mercenaries to destabilize a great part of Africa; induced the Communist regime in Poland to enslave its own working class; and established a beachhead on this continent in Nicaragua. Is further evidence of Soviet aggressive tendencies needed?

only possible objections are operational. No communist can admit that a capitalist government is legitimate; thus there can be no "mercy" to a vulnerable capitalist regime.

Therefore, capability combines with ideology to produce a powerful effect on intentions, which, be they ever so pure before the advantage was obtained, cannot fail to change with the increasing capabilities: if capabilities grow, intentions become more ambitious.

Thus, it is futile and dangerous to base modern strategy on an analysis of the intentions of the enemy. The modern strategist must be concerned with the present and future capabilities of his opponent, not with hopes and dreams about his goals. The dynamics of dictatorship provide a continuing source of ambitious advisors who will counsel the rulers of the Soviet Union toward aggressive action, and only through continuous engagement in the Technological War can the United States ensure peace and survival.

Because the goals of the United States and the U.S.S.R. are asymmetric, the strategies each employ in the Technological War necessarily are different. The United States is dedicated to a strategy of stability. We are a stabilizing rather than a disturbing power and our goal is preserving the status quo and the balance of power rather than seeking conquest and the final solution to the problems of international conflict through occupation or extermination of all opponents. In a word, the U.S. sees the Technological War as an infinite game, one played for the sake of continuing to play, rather than for the sake of "victory" in the narrow sense.

The U.S.S.R. is expansionist; aggressive; a disturber power which officially states that the only true peace is that of world Communism. Marxist theory would make the Technological War a finite game, to be ended with a clean win.

The United States has conceded the initiative in the Protracted Conflict, and is to a great extent bound to a policy of reacting to Communist advances, rather than seeking the initiative in undermining Communist power. Because we have conceded the initiative in the phase of the Protracted Conflict which deals with control of territory and people[3], we must not abandon the initiative in the Technological War. We are engaged in a war, not a race, although it may appear to be a race to many of us. But it is a race in which we must stay ahead, because if we ever fall behind, the opponent will blow up the bridges before our runners can cross them.

Given the opportunity, the Soviets will deny us access to the tools of

[3]Robert Strausz-Hupe et al, Protracted Conflict (New York: Harper 1969); Stefan T. Possony, A Century of Conflict, 5th ed. (Chicago: Regnery, 1969); Richard Pipes, Survival Is Not Enough (New York: Simon and Schuster Touchstone Books, 1986)

the Technological War exactly as they have denied access to their territory, which they call the "peace zone" in distinction to the rest of the world which is the "war zone". If we are to be on the defensive in the Protracted Conflict, survival demands that we retain the initiative and advantage in the Technological War. We know that U.S. supremacy does not bring on global war, let alone a war of conquest; we held an absolute mastery during our nuclear monopoly. We can be certain that the Soviets would not be passive were they to gain supremacy.

The Technological War is the decisive struggle in the Protracted Conflict. Victory in the Technological War gives supremacy in all other phases of the conflict, to be exploited either by thermonuclear annihilation of the opponent, or simply demanding and obtaining his surrender. The Technological War creates the resources to be employed in all other parts of the Protracted Conflict. It governs the range of strategies that can be adapted in actual or hot war. Without the proper and superior technology our strategy of deterrence would be meaningless. Without technological advantages, we could never fight and win a small war thousands of miles from our homeland, or prevent the occupation of Europe and Japan.

Up to the present moment, technological warfare has largely been confined to pre-hot war conflict. It has been a silent and apparently peaceful war, and engagement in the Technological War is generally compatible with the strong desires of most of our people for "peace". The temporary winner of the Technological War can, if he chooses, preserve peace and order, act as a stabilizer of international affairs, and prevent shooting wars – continue the Technological War as an infinite game.

There could be a different outcome. If the side possessing a decisive advantage sees the game as finite, the victor can choose to end the game on his own terms. The loser has no choice but to accept the conditions of the victor, or to engage in a shooting war which he has already lost.

Technological War can be carried on simultaneously with any other forms of military conflict, diplomatic maneuvers, peace offensives, trade agreements, detente, and debacle. It is the source of the advanced weapons and equipment for use in all forms of warfare. It renders cold war activities credible and effective. Technological warfare combined with psychosocial operations can lead to a position of strategic dominance.

This new form of warfare has its roots in the past, but it is a product of the current environment. World War II was the last war of industrial power and mobilization, but it was also the first war of applied science. The new war is one of the directed use of science. The manner of its use is shown by the changing nature of warfare. Wars of the past were wars of attrition of the military power which was a shield to the civilian population and the will to resist. The new technology has created weapons to be applied directly and suddenly to the national will, soon with the speed of light.

1.1 Definition of Technological Warfare

Technological warfare is the direct and purposeful application of the national technological base[4] and of specific advances generated by that base to attain strategic and tactical objectives. It is employed in concert with other forms of national power. The aims of this kind of warfare, as of all forms of warfare, are to enforce the national will on enemy powers; to cause them to modify their goals, strategies, tactics, and operations; to attain a position of security or dominance which assists or supports other forms of conflict techniques; to promote and capitalize on advances in technology to reach superior military power; to prevent open warfare; and to allow the arts of peace to flourish in order to satisfy the constructive objectives of society.

Each decade since World War II has seen a dramatic, sometimes sudden acceleration of the application of science to defense. In the 1950's nuclear weapons technology led to a complete revision of strategy and force structures. In the 1960's, missiles and space technology shrank the globe. In the 1970's electronics led to "force multipliers" by increasing the possible accuracies of weapons systems from short to intercontinental ranges. In the 1980's the era of "computational plenty" arrived. In the 1990's we will see an explosion in sensors, in optics, and space exploitation, in laser and other beam technologies, and many other fields, all of which will contribute to active defense against ballistic missiles.

The emergence of this relatively new form of war is a direct consequence of the dynamic and rapidly advancing character of the technologies of the two superpowers and of certain of the U.S. allies. Its most startling application to date has been the Soviet and American penetration of space and the highly sophisticated articulation of specific technical achievements in other aspects of modern conflict – psychological, political, and military. In one generation space went from the realm of science fiction to become the hallmark of Superpower status.

The foremost characteristics of the Technological War are dynamism and flexibility, while surprise is its main strategic utility. World powers can expand their technologies and employ them unhindered by actions short of

[4]We define as technological base the sum total of resources needed to produce and constantly modernize the tools of war and peace. Those resources include scientists, inventors, engineers, laboratories, laboratory equipment, funds, information flow, incentives, etc., as well as industry and the economy as a whole, which we do not discuss in this book.

all-out war. The nature of the technological process reinforces the uncertainty of war and of the enemy's course of action. The indicators of success in maintaining a position of dominance are vague and inconclusive because of dynamism, variability, and uncertainty; thus, unless this form of warfare is well understood, it is possible to lose it while maintaining to the last the illusion of winning.

The importance of this new form of conflict lies in the challenge it poses to the continued national existence of the participants. Just as the Romans deliberately increased their national power by adding seapower to landpower, and just as the major nations of the world added increased their power by adding airpower to their surface power, the U.S.S.R. is adding technological power to its existing capabilities.

The above section was written in 1968. It is now possible to see the effects of Soviet adoption of a technological strategy. They have an entire new line of intercontinental missiles with accuracies sufficient to threaten the entire US land-based missile force; and they have gone into space in a big way, so that they have far more experience in manned space operations than we do. They have also built a full line of naval vessels, including nuclear ballistic missile submarines, attack submarines, and cruisers.

The threat of Soviet technological power is much greater now than when we wrote this book; and our time for meaningful response is much shorter. There is still time, more given the renewed internal struggles in the U.S.S.R., but we have little to waste. The pace of the Technological War has not slowed at all.

Technological advances can produce a small number of weapons with a decisive capability, as illustrated by the atomic bomb. Since some technological changes can occur unobtrusively and yet be decisive, the real power situations are never transparent and never fully understood, so that the power of the opponent, as well as one's own power, remains partially unknown.

This unavoidable ignorance is the source of direct challenge to the security and existence of the participants in the Technological War. Technology itself does not automatically confer military advantages. Blind faith in technology alone can lead to disaster. Like all wars, the Technological War requires a deliberate strategy, and it must be conducted by commanders who understand fully the objectives they have been instructed to reach.

The Technological War is not synonymous with technological research. The instruments of technological research and development are required for successful participation in the Technological War, but their existence does not ensure their proper use. Research itself does not create technology but is merely one of technology's major prerequisites; and technology by itself cannot guarantee national survival.

1.2 Foundations of the Technological War

1.2.1 Fundamentals of Technology Strategy

There are four overall aspects to technological strategy. Enumerating them does not constitute a strategy but merely sets forth certain criteria with which to judge the conduct of the conflict. They are:

- Forces In Being
- Modernization of Weapons
- Modernization of the Technological Base
- Operational Capability to Use New Technology

A power that does not intend to end the Technological War by destroying the enemy must constantly maintain superiority and continuously modernize its forces. At all times, the defending nation in the Protracted Conflict must maintain sufficient forces in being to assure that the enemy does not end the conflict by coup de main, or an overwhelming surprise blow. These forces must have the modern weapons they require, and must know how to use them; must have operational familiarity with them.

> Note that the Iraqi War was fought with weapons already in inventory when the war began. Some key weapons systems were rushed into the theatre and used experimentally, but in general the war had to be fought with what we had: what the troops already knew how to use. Fortunately that inventory included smart weapons despite the opposition of many critics. JEP, 1991.

The result is a highly dynamic process, requiring careful judgment. We certainly cannot depend on our former strategy of industrial mobilization, relying on overseas allies to bear the initial brunt of the war while we convert from a peace to a war economy. We must have a force in being which cannot be destroyed by the enemy, and which can quickly move to counter the enemy's aggressive actions.

> A recent example is the Falkland Islands conflict; Britain had sufficient forces in being to reverse the initial advantages held by Argentina. Had Britain scrapped its nuclear submarines and surface ships [as was indeed planned for the following year] then there would have been no possible response to the Argentine occupation of the Falklands; certainly no response short of all-out war and actions against the Argentine homelands. This could have been very dangerous. The Iraqi war is another obvious example.

Secondly, the force in being must be a **modern** force. It is unimportant if we surpass the enemy in capability to conduct horse-cavalry conduct, or even guerrilla war, if we do not have a force that can fight successfully with modern high-energy weapons. The situation is not symmetrical; if we possess superiority or supremacy, we need not end the conflict by destroying the enemy, and will not do so because of our essentially defensive grand strategy. However, we cannot afford to allow the enemy superiority or supremacy, because he could use it to force so many concessions – particularly from our then-unprotected allies – that the contest would be decided in his favor even if he did not employ his decisive weapons to destroy us.

Finally, we must assure that the technological base from which our forces in being are derived is truly modern and creative. We must be certain that we have missed no decisive bets in the Technological War, that we have abandoned no leads which the enemy could exploit for a decisive advantage over us. For every capability he has, we must have a counter, either through defending against the weapon or riposte against him if he uses it.[5] More important, we must keep a sufficient technological base to allow us to generate the capability to counter any new weapons he constructs or may suddenly invent; and we must stay sufficiently current to allow us to seize the technological initiative when the enemy poses new threats.

1.3 Dimesnions of the Technological War

The dimensions of the Technological War range farther than any conflict previously known in human history. They include the aerospace, from ground-level to trans-lunar space; the ground and the underground deep within the earth; and the surface of the seas and the underwater world we call inner space. The battlegrounds of the Technological War could include every conceivable area in which military conflict can occur. Yet, this is merely the

[5] We wrote this analysis in the 1960's. The principles haven't changed. The action we advocate is now called a "competitive strategy."

endgame aspect of the Technological War. Actual military battle may never take place. The dimensions of the war also include the nonmilitary struggles, psycho-political warfare, ideological warfare, economics and trade, and the educational process. A college campus with students shrilly screaming obscenities at the police, and a quiet laboratory populated with soft-spoken men armed with chalk and blackboards are equally important battlegrounds.

Technological Warfare in its decisive phase will aim at bypassing the other forms of military conflict and striking directly at the will to resist. Military power may be used, and thermonuclear warfare may be necessary to consolidate the victory, but the true aim of the Technological War is the denial, paralysis, and negation of all forms of hostile military power. Often this may be achieved through psycho-political pressure employing tactics of demonstration, terror, despair, and surprise, conducted in concert perhaps with other forms of warfare. Specifically, genuine Technological War aims at reducing the use of firepower in all forms to a minimum.

1.4 An Overview of the Nature of Technology

Before we examine the strategy of Technological War, it is necessary to understand the nature of technology. Contrary to what people have often been encouraged to believe, it is not necessary to be a scientist or technologist to comprehend the general nature of technology, or to employ technology in a strategic contest. Indeed, sometimes specialization on one aspect of technology and strategy prevents understanding of technology in its broader sense.

The following discussion is a nontechnical introduction to the general nature of technology and strategy. Later sections of this book develop each of these themes more fully, but because of the interdependence of strategy and technology in modern warfare, it is not possible to organize this book into discrete sections and chapters. Modern Technological Warfare is a mixture of strategy and technology, and their interrelationships.

The primary fact about technology in the twentieth century is that it has a momentum of its own. Although the technological stream can to some extent be directed, it is impossible to dam it; the stream flows on endlessly. This leaves only three choices. You may swim with the stream, exploiting every aspect of technology to its fullest; you may attempt to crawl out on the bank and watch the rest of the world go past; or you can attempt to swim against the stream and "put the genii back in the bottle".

Since nearly every nation, and certainly both superpowers, swim in more or less the same technological stream, only the first course of action makes sense. To continue the analogy for a moment, there is a fog over the surface of the water, so that you cannot know exactly what and how your opponents – open enemies, or economic competitors – are doing. An opponent may tell you he has crawled out on the bank and is enjoying the view, while in fact he is either treading water or racing away from you. If you do not intend to lose, you have little choice but to swim with the current as long and as hard as you can.

The nature of technology makes meaningless the gunpowder era phrase 'arms race'. It is fashionable at present to speak of the action-reaction arms race, in which each power constructs weapons for fear that the other has done so. According to this theory[6], the primary reason nations arm themselves is that they react to others.

The newest catch phrases are "arms race stability" and "assured stability". These slogans are essentially undefined by their authors, who advocate that the U.S. simply opt out of a Technological War we can't afford. The Soviet Union, under this notion, will also see the advantages of "arms race stability" and likewise abandon the struggle. The money saved by both sides can be invested in social programs and increased consumption.

We make no doubt that there will be other such catch phrases and buzz words, and that they will also remain undefined and only loosely coupled with reality.

In fact, in the Technological War, opposing powers essentially react to the seemingly impersonal stream that carries them along. They really have no choice and never will have so long as the current flows and there is asymmetry of information between them. The technology stream exists independent of the will of those who create technology. The direction and pace, however, are more amenable to control by strategists.

To continue our analogy, the fog over the technological battlefield is made denser by confusion caused partly by deliberate deception and partly by self-deceptions. Only when the Communist states have transformed themselves

[6]The theory is essentially that of Lewis Richardson, who made up differential equations to try to demonstrate the mathematical relationship between the arms expenditures of nations and international blocs, and found a reasonable fit in the single case of the Pre-World War I Entente and Alliance. No empirical confirmation of the Richardson theory has been found, and the specialized assumptions required to make the World War I history fit the theory leave the entire effort in a questionable state. Richardson's theory is presented in L.F. Richardson, Arms and Insecurity (Pittsburgh, Boxwood Press, 1960). His most vigorous champion in the 1960's was Anatol Rappaport, in Fights, Games, and Debates (Ann Arbor: University of Michigan Press, 1960). The results of one unsuccessful attempt to find a modern instance of a Richardson arms race are reported in Pournelle, Stability and National Security (U.S. Air Force, 1969). We have found that in the modern era, expenditures on weapons simply do not fit the Richardson equations.

into open societies and there is a complete exchange of information – that is, when the fog has lifted from the stream of technology – can meaningful efforts to arrange the contest on a more economical and less risky basis be successful. Until that time we must engage in the Technological War.[7]

It is fairly obvious that rationalization of the Technological War will not come in our lifetimes. *glasnost* may be genuinely desired by Mikhael Gorbachev and most subjects of the Soviet empire, but its permanence as a policy is not guaranteed. *glasnost* is especially fragile if the USSR is faced with the opportunity for a decisive win. Finally, we would do well to expect that even if the U.S.S.R. were to change its character, other threats might arise in its stead.

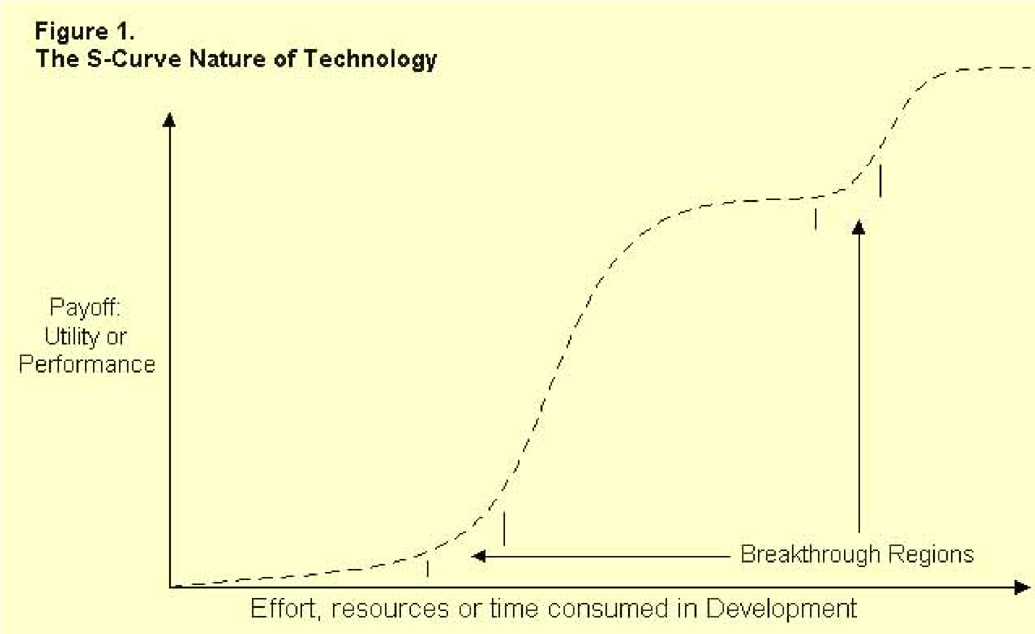
Arms races in the nuclear era differ from those in the gunpowder era in one fundamental way: they are qualitative rather than quantitative. In the gunpowder era, numbers of divisions, tanks, battleships, and aircraft gave rough estimates of the strength of the possessor and his capability to defend himself. It was possible to overcome an enemy by sheer numbers of weapons alone. In the nuclear era, numbers remain important, of course, but the primary strength lies in quality of weapons and their survivability. Nuclear weapons can destroy an enemy's entire military power in one strike if the attacker possess sufficient qualitative superiority. Space technology gives the promise of negating the ICBM as a deterrent to a first strike. This too is a result of the nature of modern technology.

One of the most easily observed phenomena of technology is that it moves by "S" curves, as illustrated in Figure One. Take for example speed; for centuries the speed of military operations increased only slightly as each side developed better horses. Then came the internal combustion engine. Speed rose sharply for a while. Eventually, though, it flattened out again, and each increase took longer and longer to achieve.

To illustrate the S-curve concept, consider the development of aircraft, and in particular their speed. For many years after the Wright brothers, aircraft speeds crawled slowly forward. In 1940, they were still quite slow. Suddenly, each airplane designed was faster, until the limits of subsonic flight were reached. At that point, we were on a new S-curve. Again, the effort to reach transsonic flight consumed many resources and much time, but then the breakthrough was made. In a short time, aircraft were traveling at multiples of the speed of sound, at speeds nearly two orders of magnitude greater than those achieved shortly before World War II.[8]

[7]Note that technological fogs exist even within nations. Corporations keep trade secrets from each other and even within corporations the various divisions and profit centers preserve their competitive advantages.

[8]In common engineering parlance, an increase by an order of magnitude is approxi-



Note that the top of one S curve may – in fact usually will – be the base of another following it. Although the stream moves on inexorably, it is possible to exploit one or another aspect of technology at will. Which aspect to exploit will depend on several factors, the most important being your goals and your position on the S-curve.

Technology is interdependent: advances in one sector of technology soon influence areas which might naively have been believed unrelated. For example, the development of molecular chemistry techniques led to the art of microminiaturization, which allows development of computer technology beyond the expectations of only a few years ago. The revolution in computer sciences has made possible the development of on-board computers for missile guidance, and thus of accuracies not previously predicted. Increased accuracy has made possible the destruction of missile silos with much greater ease and smaller warheads.

Nuclear research, meanwhile, had developed smaller and lighter warheads; this coupled with increased accuracy has led to the development of Multiple Independently Targetable Re-Entry Vehicles (MIRV), each one of which uses on-board guidance computers. The increased kill capability stimulated research into silo hardening techniques, which led directly to what were called "hard rock silo" designs. That development made it possible to conduct cer-

mately a tenfold increase. Astronomers, be wary.

tain mining operations that were previously financially infeasible. Examples of interdependence can be given without limit.[9]

Thus, technology influences nearly every aspect of national life. In particular, technology influences strategy, forcing strategic revolutions at frequent intervals. There are those who say that strategy never changes. If they mean literally what they say, they have never appreciated the effects of the airplane and the ICBM, the possibilities for surprise attack created by these radical new weapons delivery systems coupled with thermonuclear explosives, and the effect they have on ground battles. If, however, they mean that the principles of strategy have not changed, they are more nearly correct, as we will discuss below.

The important fact is that technology paces strategy to a great extent, and forces the development of new military strategies which take the new technology into account. As we will show, it is dangerous to regard this relationship as one-sided. Technology and strategy are interrelated, and strategy can and should also pace technology.

This is well illustrated by the SDI program. President Reagan was convinced that the U.S. needed a new strategy. That strategy was impossible without new technology. His call for technology to make possible a strategy of 'assured survival' stimulated a dozen technology development programs. It is important to note that most of them worked, and some worked much better than we had supposed they would.

We have not always done badly in this race. Despite the opposition of a number of scientists, the feasibility and potentially decisive advantages of ballistic missiles were early recognized, and a program to develop and deploy these weapons was undertaken. The Thor IRBM was designed, developed, and ready to deploy in just over three years. Submarine launched missiles were developed in parallel. The IRBM was soon followed by the ICBM. Meanwhile, missile research led to capabilities in space technology.

Shortly before the first edition of this book was written, the major computer companies of the world decided that the United States would need no more than a dozen computers, none of them more powerful than the equipment that now sits on desktops in small businesses. The demands for further accuracy in missiles led to developments in miniaturization of components, including on-board guidance computers; the result became a full revolution in computer technology. That revolution's full extent cannot yet be measured.

Despite some spectacular successes, technology appears to many of our

[9]We should note that as part of the budget process to gather Congressional support, major programs such as Apollo and SDI had t identify "spinoffs" which can find application in the commercial world.

national leaders, and most of the Congress, to be an impersonal force. Although America is the leading technological power – perhaps because we are the leading technological power – many of our leaders do not really comprehend technology. As a consequence, technology remains largely a matter of individual initiative. Sometimes we do well. The first edition of this book contained lengthy analyses of our faults. Many have since been corrected.

Unfortunately, we still have no comprehensive strategy for winning the Technological War.

1.5 The Decisive War

The technological contest is a war. It is not a game against an impersonal force, it is a deadly conflict with an intelligent and implacable enemy. We do not suppose that a military commander who conducted his battles as they occurred, understanding neither the terrain nor the enemy and preparing only for the battle that he had already fought, would be properly performing his task. Yet, too often this is precisely what happens in the Technological War, which may be the most decisive engagement in the history of mankind. Technology has grown into the driving force, dictating to strategy; and strategy is conceived of as employment of systems already created by the technologists; that is, strategy is confined to operational decisions. This is akin to allowing the recruiting and supply officers to decide the conduct of a traditional land war.

The danger in the Technological War is that it is closely coupled with the Protracted Conflict, and a decisive lead in the Technological War can be converted into a decisive advantage in military weapons. Note that military power and technological power are coupled, but are not identical; military technology is not in and of itself a weapon system, but it can be used to create weapons systems. Thus a commanding lead in the Technological War can be achieved before a corresponding lead in military technology has been obtained.

As an example, the Soviet Union could, through the development of strategic nuclear defense technology, obtain a decisive lead in the Technological War at a time when the United States still possessed a clear superiority in deliverable weapons. This technology could then be used to create defense systems, and if the United States took no countermeasures during the deployment of those defensive systems, we would find ourselves in an inferior military position.

This is an especial danger if the numbers of strategic offensive weapons has been limited by arms reduction treaties and the Soviets then "break out" of the defensive and offensive limits imposed by the ABM Treaty and SALT. The closed nature of Soviet society makes planning for breakouts rather simple; the open nature of the US makes that nearly impossible. Note that the USSR used the breakout strategy following the 'gentleman's agreement' Test Ban.

During the 1970's the Soviet Union achieved (entirely predictable) spectacular gains in achievable accuracies, and also built large new missiles capable of carrying a dozen and more warheads over intercontinental distances. The United States relied on Arms Control negotiations for security; when these failed, we found ourselves facing a "window of vulnerability" – that is, a period of time during which, if we do not act promptly and intelligently, the Soviet Union could construct a first strike capability. The Soviets continued to deploy ICBM's in large numbers. The "window of vulnerability" has not entirely been overcome as of 1988, although President Reagan's strategic force modernization program took away much of the danger.

glasnost and *perestroika* promise a new era in strategic conflict; they have not eliminated the technological war.

In addition, the USSR has undertaken serious research into strategic defense systems, not merely building on the single system permitted under the ABM Treaty, but also investigating entirely new concepts. When the US began its own strategic defense investigation in 1983, the Soviet Union redoubled its efforts, including construction of large components such as the radar system at Krasnyarsk.

None of this was decisive. Victory in the Technological War is achieved when a finite game participant (ie, one who wishes to bring the game to an end by winning it) has a technological lead so far advanced that his opponent cannot overcome it until after the leader has converted his technology into decisive weapons systems. The loser may know that he has lost, and know it for quite a long time, yet be unable to do anything about it. To continue the above example, if the Soviet Union were able to develop the technology in time to deploy ballistic missile defense systems of his own before ours could be installed and operational, we would be beaten, even though the U.S.S.R. might spend several years in deployment of his own system. Our only choices would be the development of a penetration system that his defenses could not counter (such as manned bombers of very high capabilities)[10], surrender, or preventive war.

Now, in the late 1980's, many believe that development of space laser battle stations will be a decisive move in the technological war. The laser

[10]We would, of course, have not only to invent and develop these bombers but build them in quantity, fly them, train the pilots, etc., and do it all within the time limits of U.S.S.R. deployment.

battle station could, at least in theory, destroy an entire ICBM force in flight, then burn down the enemy's bomber fleet for encore. Such a station once in place could give a decisive lead to its owner.

In practice a space laser battle station would require auxiliary equipment for its own defense, since there are many ways to attack such a system; on the other hand, it is likely that such escort systems would be deployed by any power constructing a large space laser battle station.

The Soviets have raised the specter that other space weapons which they call "space strike weapons" are being developed as part of the US Strategic Defense Initiative. The fact that the Soviets emphasize such a threat at a time when the US has no concepts, let alone a technology which could produce them, raises the concern that the Soviets are developing them, because the Soviets often accuse the US of developing and deploying weapons which they themselves are developing.

Several years after the initial Soviet assertions that SDI raised the spectre of such weapons, the Soviets defined them for Ambassador Henry Cooper, head of the US negotiating team on defense and space talks, as : 1) Ground to space weapons, 2) Space to space weapons; and 3) Space to ground weapons. The U.S.S.R. has demonstrated all three: Galosh interceptors against satellites; co-orbital ASATs; and FOBs, which are bombs in orbit.

If space and ground based ICBM defenses could give us a decisive advantage, they would confer no less advantage on the Soviets if we allow our enemies to develop them without any counter on our part.

This is the unique feature of the Technological War. Military superiority or even supremacy is not permanent, and never ends the conflict unless it is used. The United States considers the Technological War as an infinite game: one which is not played out to a decisive victory. We are committed to a grand strategy of defense, and will never employ a decisive advantage to end the conflict by destroying our enemies. Consequently, we must maintain not only military superiority but technological supremacy. **The race is an alternative to destructive war, not the cause of military conflict.**

In summary, proper conduct of the Technological War requires that strategy drive technology most forcefully; that there be an overall strategy of the Technological War, allocating resources according to well-defined objectives and an operational plan, not merely strategic elements which make operational use of the products of technology. Instead of the supply officer and the munitions designer controlling the conduct of this decisive war, command must be placed in the hands of those who understand the Technological War; and this requires that they first understand the nature of war.

Lest the reader be confused, we do not advocate that the Technological War be given over to the control of the scientists, or that scientists should somehow create a strategy of technological development. We mean that an understanding of the art of war is more important than familiarity with one or another of the specialties of technology. It is a rare scientist who makes a good strategist; and the generals of the Technological War need not be scientists any more than the generals of the past needed to be good riflemen or railroad engineers.

Like all wars, the Technological War must be conducted by a commander who operates with a strategy. It is precisely the lack of such a strategy that brought the United States to the 1970's low point in prestige and power, with her ships seized across the world, her Strategic Offensive Forces (SOF) threatened by the growing Soviet SOF – and with the United States perplexed by as simple a question as whether to attempt to defend her people from enemy thermonuclear bombs, and unable to win a lesser war in South East Asia.[11]

We had neither generals nor strategy, and muddled through the most decisive conflict in our national history.

Much of this changed in 1981. President Reagan's 1983 call for SDI was in response to strategic analyses presented by General Daniel O. Graham and others.

There always were exceptions to this unsatisfactory record of American performance. General Bernard Schriever created a military organization for strategic analysis which was responsible for our early commanding lead over the Soviets in ballistic missiles, despite the fact that the U.S. had allowed the U.S.S.R. many years' head start in missile development after World War II.[12] The Air Force's Project Forecast and later Project 75, was an attempt to let strategy react to, then drive, technology; these, too, were creations of General Schriever's.

In the Navy there have also been notable attempts to allow strategy to influence technology and produce truly modern weapons systems.

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[11]Since this book is intended to be a discussion of principles, not of current specific problems, it may be well in print long after the present war in Vietnam is ended. We venture to predict, however, that for many years after this is written (1970) there will be wars in Asia, including South East Asia and the area formerly known as Indo-China, and their outcomes will be of concern to the United States.

[12]The authors recall the frustration of Wernher Von Braun and other rocketry experts when the last of the V-2 rockets brought to the United States were used, not for the development of rocket sciences, but as supersonic test beds for aircraft parts to avoid spending the funds required for construction of supersonic wind tunnels. This retarded the development of both missiles and supersonic aircraft, of course.

1.6 The Elements of Strategy

1.6.1 What is Strategy

Because there seems to be little understanding of strategy and its effect on the Technological War, we will briefly review some general principles of strategy and warfare. Our purpose is not to teach the elements of strategy, which would require another book, but rather to make the reader aware of strategy and some of its complexities.

According to the traditional concept of military strategy it should mean the art of employing military forces to achieve the ends set by political policy. This definition was formulated by [Sir Basil Henry] Liddell Hart in 1929 and it hardly differs from that of Clausewitz. Raymond Aron follows it almost word for word. France's leading strategist of the 60's commented:

"In my view this definition is too restrictive because it deals with military forces only. I would put it as follows: the art of applying force so that it makes the most effective contribution towards achieving the ends set by political policy...

"In my view the essence of strategy is the abstract interplay which, to use Foch's phrase, springs from the clash between two opposing wills. It is the art which enables a man, no matter what the techniques employed, to master the problems set by any clash between two opposing wills. It is the art which enables a man, no matter what the techniques employed, to master the problems set by any clash of wills and as a result to employ the techniques available with maximum efficiency. it is therefore the art of the dialectic of force, or, more precisely, the art of the dialectic of two opposing wills using force to resolve their dispute.[13]

In our judgment it would be hard to better the above definition provided that we understand force to include the broader concept of power and force. Examining the definition shows us several important aspects of the Technological War and its strategy.

First, we see that strategy involves two opposing wills. This in itself sets the Technological War apart from the simple development of technology. The development of technology is a game against nature, which may be uncooperative, but which never deceives or actively conspires to prevent your success. The Technology War is a contest with an intelligent opponent who seeks to divert you from seeing his purpose, and to surprise you with his results.

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[13] General d'Armee Andre Beaufre, Introduction to Strategy (New York: Praeger, 1965), p. 22.

Secondly, strategy involves the use of power and force. In the Technological War, the more power is extant, the less often force needs to be used in the primary or decisive mode of the conflict. In the place of battles, the Technological War general disposes his own resources so as to maximize the power he holds and at the same time compel the enemy to make maximum dispersal of his. To make the enemy counter each move you make, and dance to your tune, is the aim of a Technological War strategy. In the ideal, if the enemy were required continually to build purely defensive weapons which might protect him from your weapons but could not possibly harm you, you could be said to have won a major engagement in the Technological War. In the contest between wills, seizing and holding the initiative is of importance; as indeed it has been for a long, long time:

You hear that Phillip is in the Chersonese, and you vote an expedition there; you hear that he is in Thessaly, and you vote one there. You march the length and breadth of Greece at his invitation, and you take your marching orders from him.[14]

But if the power ratio is ambiguous, the decision as to who is the stronger will be made by force, which is the application of power in battle. Other things being equal, battles are won by superior technology. But clearly superior technology prevents battle.

1.7 The Principles of War

War is an art; it is not an exact science, although the Soviet Union considers it to be so. Precisely because there is an intelligent opponent, there are real uncertainties about war, not merely statistical uncertainties which may be measurable. Every attempt to reduce war to an exact science has ended in a dismal failure. The advent of the computer and systems analysis, useful as both may be, has not changed this fact, although it has often been forgotten.

Part of the traditional method of learning the art of war is studying the principles of war. These principles are a set of general concepts, like holds in wrestling, and no exact group of principles is universally recognized. Some strategists combine several into one or divide one of those we show into several. The following list will serve well enough for our purpose:

- The Principle of the Objective
- The Principle of the Initiative
- The Principle of Surprise

[14]Demosthenes, First Phillipic to the People of Athens

- The Principle of the Unity of Command
- The Principle of Mass (Concentration of Force)
- The Principle of Economy of Forces
- The Principle of Mobility
- The Principle of Security
- The Principle of Pursuit

It will be noted that some of these principles, if carried to their extremes, would be contradictory. They are intended to serve not as a formula for the planning of a battle, but rather as a set of guides or a checklist which the planner ignores only with peril. They are as applicable to the Technological War as to any other war. At first glance, it might seem that one principle or another might be more directly applicable to the Technological War than the others, but in fact none can be disregarded if success is to be achieved. We will have occasion to refer to them from time to time in the analysis below.

1.8 Strategy and Technology

The United States today has no technological strategy as we define it. However, as the philosophers have noted, "Everyone has a metaphysics, including those who deny it." The same applies to a technological strategy.

Instead of an integrated strategy of technology, we have a series of independent and often uncorrelated decisions on specific problems of technology. This is hardly a strategy. A technological strategy would involve the setting of national goals and objectives by political leaders; it would be integrated with other aspects of our national strategy, both military and nonmilitary (Initiative, Objective, and Unity of Command); it would include a broad plan for conducting the Technological War that provided for surprising the enemy, pursuing our advantage (Pursuit), guarding against being surprised (Security), allocating resources effectively (Economy of Forces), setting milestones and building the technological base (Objective), and so forth. Lesser conflicts such as that in Vietnam would be governed by a broad strategic doctrine instead of being considered isolated and treated as crises.

In our national strategy, far too much attention has been given to current affairs and to specific conflict situations at particular times and places. There has been no serious attempt to integrate the individual decisions, or relate them to a comprehensive grand strategy that is adequate to overcome the challenges. The few attempts we have made to manage technological decisions properly were disastrous; examples are the ludicrous "saving" achieved through the TFX and the equally dismal saving through over-management of the C5A program. We have confused a strategy of technology with centralized interference in the design or production of specific weapons and the imposition of a "standard management plan".

Micromanagement, whether by Congress or the Pentagon, is no substitute for a genuine strategy.

The results of our neglecting technological strategy are easily seen. Our performance in Vietnam was disastrous. We failed to exploit our superior technology to grasp a commanding lead in either inner space or outer space. Our merchant marine where it exists at all flies the proud flag of Panama or Liberia. Meanwhile, many of our young men are sent to fight overseas with weapons that make use of principles discovered by Roger Bacon in the thirteenth century.

> Alas, we see no reason to revise the above after over twenty years. Our failure to understand what the Viet Nam War was about cost us all the blood and treasure we had previously invested; the Soviets have surpassed us in manned space exploitation and ICBM deployment, and are keeping up in missile defense technology; and we were unable to use our technology or military power in the Iranian hostage crisis. Our attempts to remedy this situation have generally made things worse. Endless reviews and meaningless analyses have driven lead times to inordinate lengths. Whereas in 1941-44 we were able to conceive, design, build, and deploy large numbers of new military aircraft within three years, this is inconceivable today (1991).

The reasons for this dismal performance are complex; it is not necessary to understand all of them and it is not germane to blame anyone. Events caught up with us, the stream of technology swept us along, and only recently did we begin to realize the nature of the Technological War. In fact, one reason we have no strategy of technology is that not everyone realizes we are at war; but perhaps the most important reason is the basic failure to understand the nature of technology itself, and particularly the problems of lead time which produce a crisis-oriented design process.

Our opponents created crises, and we have had to meet them. Decision makers at the national level concentrate on fighting today's fire, partly because they hope that the current trouble will be the last but mostly because of the long lead time involved in technology. A President called upon to spend money in any fiscal year actually is spending money to solve the problems of a President two terms later. But even if we try to find comfort in expenditures for research and development, we must understand that these are oriented to specific projects and tasks and do not result from technological strategy.

> During the 1970's, the expenditures in research and development were cut back; the result was that high technology exports became less valuable than agriculture in our balance of payments. SDI refocussed U.S. efforts and halted what had been a continuous erosion of our technological base. Fortunately the Soviets have their problems too, caused by their generally bad management practices; but do note that the Soviet military economy is run on an entirely different basis from their notoriously inefficient civilian economy. Meanwhile, as the Soviet threat to Europe abates, the Technological War does not, for many of our erstwhile allies, now freed from fear of the Soviets, can put even more of their resources into that war – and we have yet to examine the potential of Eastern Europe.

Our misunderstanding of the Technological War is illustrated by our failure to build an organization for conducting technological warfare. The review of the annual budget and of individual projects in basic research, in applied research, in development, and in procurement is the only process by which our technological development is controlled directly. Other influences such as the statements of requirements and the evaluation of military worth are felt only at the level of individual projects. Overall evaluation of the research and development effort and of its relations to strategy is rudimentary.

An example of how irrelevant factors influence our efforts, and perhaps one of the decisive signs of the times: the January 20, 1969 issue of Aviation Week and Space Technology, the most influential journal in the aerospace field, included a report entitled "Viet Lull Advances New Weapons". The article makes clear that the budgetary funding level of many advanced new weapons systems, including research and development, basic technology, and actual system procurement, is largely dependent on the continuation of a "lull" in the Vietnam war. Given a proper strategy for the Technological War and proper command of our efforts, the title should read "Advanced New Weapons End Vietnam War".

1.8.1 1988

Perhaps the most glaring examples of our failure to grasp the fundamentals of a technological strategy are found in our failure to build on the Apollo program to create a space station and build systems for rapid and assured access to the space environment; to develop defenses against ballistic missiles; and to make the transition from aerospace power to space power. Such failures are clear illustrations of that a strategy of technology should be. The goal of this book is to try to prevent future errors of this kind.

1.8.2 1997

We cannot emphasize this too strongly. The Seventy Years War which began in St. Petersburg in 1917 effectively came to an end with the destruction of the Berlin Wall, leaving the United States of America as the only Superpower. Victory in the Seventy Years War, sometimes (in our judgment mistakenly) called The Cold War, did not bring "the end of history" as was naively prophesied by Francis Fukuyama and others.

Fukuyama's thesis was that with the end of the Cold War all nations would now embrace liberal democracy; and liberal democracies do not make war on each other. Therefore, while mankind would now prevail, there would be no more history, which is the record of change, often by violence.

By now it should be clear that all the nations of the Earth have not embraced liberal democracy. It is not inevitable that the United States itself will be governed by what we understand as liberal democracy much beyond the end of this Millenium. Being the only Superpower carries with it the danger of a fundamental transformation from democracy to Empire, and there are powerful forces pushing the United States toward Imperium if not Empire. In any event, there are plenty of regimes motivated by religious fervor, nationalism and tribalism, and ruled by elites or dictators.

The end of the Seventy Years War has not brought lasting peace, nor has it ended the Technological War; indeed, the stakes are now much higher, and the price of entry into the Technological War is far lower; with only one Superpower in the game, a potential Superpower has only one competitor, and that a somewhat complacent one that cannot believe anyone can possibly catch up.

Unfortunately, catching up is quite possible. Just as the threat of a strategic sidestep into space negated much of the USSR's vast missile establishment and threatened the USSR with economic ruin, a real move into space–a real conquest of the High Frontier, if you will–would put the United States in a vulnerable position.

This is not the place to generate scenarios of potential conflicts over the next fifty years; suffice it to say that there remain a number of powers with unsatisfied ambitions and both territorial and economic claims. Some, like China and Indonesia have large populations, an educated elite, high industrial potential, and no great experience with, or desire for, liberal democracy.

The world remains a dangerous place, and a Strategy of Technology remains the most prudent course for the United States; and it is a course we are not properly following.

Chapter 2

An Overview Of The Recent History of the Technological War

We have called the Technological War the decisive war, and have stated that the United States has not always done well in its conduct of that war. The reasons for our repeated failure in technological warfare – despite the fact that we are far and away the most advanced technological power and have expended far more money, manpower, time and resources on military technology than all other nations combined – require careful study. There is no reason why the United States cannot maintain a decisive advantage in the Technological War, and, moreover, do so with the expenditure of no more resources than are now being used up in our present wasteful efforts.[1]

In our national strategy far too much attention has been paid to current affairs and specific conflict situations. Instead of a real technological strategy we have a series of unrelated decisions on specific problems. There have been attempts to integrate the individual decisions, but these attempts have often resulted in even more waste and inefficiency. Examples abound. Consider, for example, the fanciful expectations about the TFX (FB-111), the joint service fighter aircraft program; and the Sergeant York missile, which, originally a reasonable idea, was micromismanaged, given impossible goals to meet, and eventually cancelled.

The fact is, we had no mechanism for generating a strategy of technology. The Joint Chiefs of Staff have been an inter-service negotiating board; and since the officers who serve the Joint Chiefs must depend on boards of officers

[1] We include the elements of the budget which are justified as being a part of our national security effort, but which are not controlled by the commanders of the Technological War and are generally wasted in projects uncoordinated with defense requirements.

drawn from their own branch of service for promotion, there has been little chance that anyone will or can develop loyalty to the Joint Chiefs as an institution.

In the late 1980's, the situation began to change. Under the urging of the Reagan Administration, the Commanders in Chief (CINC's) of the major operating forces (SAC, EURCOM, PACOM, SOUTHCOM, SOFCOM, and SPACECOM) were given responsibility for generating requirements and for both advocating and defending programs. The struggle within the Joint Chiefs thus became one of struggle among the CINC's for resources with the JCS, and especially the Vice Chairman, being the adjustors. The Services started to become responsible solely for personnel, research and development, logistics, and budget, and their role within operations began to disappear. However, there is no technological CINC, and no clear career path for the developing technological strategist within any branch of service.

2.1 Organization of This Chapter

In the pages below we open with an overview of Soviet technological strategy as it contrasts with ours. We will then give examples of U.S. successes and failures in four periods:

- 1950's: ICBM and the nuclear powered airplane
- 1960's: SSBM, Apollo, space techology and satellites, and TFX
- 1970's: MIRV, new fighters, and the Shuttle
- 1980's: B-1; SDI; cruise missiles; MX, and C3/I; B2

We follow with more examples of Soviet achievements during the same time periods:

- 1950's: H-bomb; ICBM/IRBM, Space boosters
- 1960's: Nuclear powered submarines, advanced fighters, tanks
- 1970's: Manned space program; MIRV
- 1980's: Mobile ICBM

We will then examine the lessons learned from these examples.

2.2 Soviet Technological Strategy

Although the Soviet Union begins from a lower technological and industrial base, some of their achievements in the Technoloigcal War have been impressive.

In contrast to the diffusion of effort, centralization of decision making, and micromanagement which characterize American technological strategy, the Soviets have a strategy of focusing their efforts, including basic and applied research. Central direction and control are key aspects of their use of technology. This means that discovery must be on schedule. The motivation of Soviet scientists has been an important factor in meeting goals, but sanctions and punishment are also an important part of the Soviet system. By focusing their efforts the Soviets allow to atrophy those areas which they do not consider important to their strategy.

The Soviet priority system places military technology and fundamental industry a long way ahead of any other aspects of technology. In part this neglect of other technology is then compensated for by purchase of nonstrategic goods and technical processes from the West; scientific exchange programs; industrial espionage and piracy; and general exploitation of Western achievements.

Arms negotiations to slow down the U.S. technological challenge by eliminating key weapons and technologies have always been a key part of the Soviet strategy of technology. The INF is a prime example of this. The Soviets naturally seek to negotiate the elimination of technologies in which they are weak, and to retain those where they are strong.

The INF treaty is a prime example. Under INF an entire class of weapons – nuclear and non-nuclear – was eliminated. Not only were the nuclear tipped IRBM's destroyed, but the non-nuclear systems, while not destroyed, cannot be improved by new technologies. The result was to increase, not decrease, the strategic imbalance in Europe, because the U.S.S.R. has no great need of IRBM systems, while the U.S. and NATO do not have a good substitute.

The Soviet commanders of the Technological War can afford to wait for consumer technology and goods, and concentrate their efforts on winning the decisive war. This remains true during the era of *glasnost*; although there is an emphasis on decentralization of the civilian technology and the production of consumer goods, there has been little noticeable decrease in military spending; this remains true in late 1989, even after the fall of the Berlin Wall. Given that there will be cuts in the overall Soviet military budget, it is highly likely that there will be little to no decrease in military R&D.

The Soviets concentrate their technical and engineering talent on the decision and design phases of technology for those systems which are most important to their strategic goals.[2] This permits them to weigh the relative merits of alternative technical approaches to their strategic goals and use what they have learned from Western technology to aid the production process. Their strategy facilitates finding a near-optimum approach to a variety of goals, and is designed to compensate for their inferiority in overall technical resources. The point is, despite the enormous Western superiority in total quantity of technological resources, the U.S.S.R. has been able to concentrate more effort than we have on selected portions of weapons technology and to gain superiority in many phases of military technology driven by strategy.

In their designs the Soviets make simplicity an important criterion for both production and operation. Success in achieving simplicity leads to low costs of production and, importantly, to high reliability of operation. Simplicity also allows them to operate the systems with personnel who have only rudimentary training and skills, and to reserve their limited supply of highly skilled technicians for R&D.

Because their deadlines are self-imposed, the Soviets can take their time about selecting designs. This was the pattern they followed in military computer technology. After making a survey of Western advances on a variety of fronts, they chose an optimum path to follow.

The West has a defensive strategy. Although we would welcome the disintegration of the Soviet Empire, we strive mostly to preserve the status quo. This imposes few deadlines on the Soviets, who can afford to take their time. Western achievements in the Technological War are not threats to Soviet national existence. The defensive strategy nature of the West prevents us from fully exploiting our advantages. However, there are ways in which we can force the Soviets to react to our initiatives.

Recently, through programs like SDI and high-precision weapons to target command posts, we have started to find ways to exploit our strengths and Soviet weaknesses. The new [1988] buzz word for the concept is "competitive strategies." The result has had spectacular success in recent weeks.

> This may be the place to note that the first edition of this book was written at a time when the US was NOT doing well in the technological war. That changed, partly – some would say in large part – due to this book's employment as a text in the military academies and War Colleges. Things change so quickly now that we cannot rewrite everything; there will of necessity be residual elements of our older polemic against US

[2] The phases of technological development are discussed in Chapter 3.

policy. The fact is, though, that much of what we advocate was adopted in the Reagan era. Alas, not everything; which is the purpose of this second edition.

The Soviet strategy in the Technological War would not be an optimum strategy for the West, precisely because neither motives nor resources are symmetrical. The West has vastly superior resources, and can afford non-specific research to find unsuspected technological advantages. The West can afford to decentralize a part of its decision-making process and employ a variety of technological approaches, particularly during the scientific and advanced engineering research phases of the technological discovery process. Whereas the Soviet Union can afford only one "center of gravity" for their efforts, we can afford several.[3]

As a consequence of the asymmetries of motive and resources, it would be foolish to copy the Soviet strategy for the Technological War. We can afford a more sophisticated strategy, and will have a far higher probability of success. What we cannot afford is the luxury of having no strategy at all.

2.3 The U.S. Conduct of the Technological War

By contrast with the Soviet strategy of focusing effort on the development of specific technological achievements, working on each problem until it is solved, and concentrating their technological forces as may be directed by a carefully-chosen center of gravity, the United States has had a number of projects, some successful and some not; there has been little or no overall technical strategy.

Our technological decision-making process is scattered throughout a number of agencies and departments of the government, most of which are not under the control of the Secretary of Defense and many of which are not represented on the National Security Council. For example, even though it may be supported by appropriations our civil space program under NASA has rarely been coordinated with military requirements, and can hardly be governed by our nonexistent strategy of technology.

When we wrote those words in 1969 it was all too true that there was no technological strategy. During the Reagan era that changed somewhat. Although there never was implemented a full reorganization that would

[3] The phases of technological development are discussed in Chapter 3.

create a technological war plan, at least the subject was taken seriously. General Daniel O. Graham's analysis of moving to space as a "strategic side step" spoke in explicit strategic terms, and had considerable influence on strategic thinking. After the low ebb of the McNamara era there was renewed interest in an overall strategy of technology. The decisive moment came in Iceland when Gorbachev pleaded with Reagan to abandon SDI and strategic defenses; Reagan refused, and thereby brought about the collapse of the Soviet Union, although it was not apparent at the time that this would happen so quickly.

The USSR was at that time spending far more of its national budget on weapons (hardly 'defense') than was admitted by the CIA or Department of State. Possony, Pournelle, and Kane, along with General Graham, continued to insist that the USSR was spending some 30% of GNP on weapons and military power. We privately suspected that it was more (and in fact it was), but official opposition to our 30% estimate was surprisingly hostile. The official US estimate was under 20%.

2.4 The 1950s Era

2.4.1 The Nuclear Powered Airplane

The history of nuclear-propulsion aircraft illustrates the problems inherent in the present system.[4] In an effort to advance nuclear technology while living within budget limitations, the military tried to play scientific politics. Because of the need to justify funds on the basis of practical systems rather than their contribution to the Technological War, at times the military tried to set up requirements for nuclear-propulsion aircraft systems. These requirements were beyond the realm of technological possibility and resulted in opposition from the scientific community. At other times, the military justified funds on the basis of scientific experiment.Footnote 5 Here the generals subjected themselves to the inevitable arguments and divisions among scientists. The decision fell to the timid.

[4] We are not arguing here in favor of constructing nuclear-propulsion aircraft, although a very good case can be made for them. The example of nuclear propulsion was chosen because we spent enormous sums and invested hundreds of thousands of hours of precious technical talent but made very little permanent gain from the program, despite the fact that for a fraction of the resources expended an extremely valuable flying test-bed could have been constructed. The nuclear aircraft program suffered from most of the faults of the U.S. decision-making process and is therefore highly illustrative. Among its problems were: unreasonable expectations, endless review without decision, conflicting goals, inability to determine a single positive approach, and making national security dependent upon the skill of the players of a political game.

There was never an attempt to analyze the problem in its strategic context, or even to consider it historically, such as comparing it to the invention and development of the jet engine. If Whittle's work had been subjected to an experience similar to that of the nuclear engine, we would not have jet aircraft today. In addition to the arguments about technical feasibility, moreover, the question was raised, What can the nuclear aircraft do that the jet aircraft cannot do cheaper and faster? Inasmuch as there were no nuclear-propulsion aircraft and its ultimate capabilities were unknown, this question was hardly intelligent; and although its detractors admitted that the nuclear aircraft could stay aloft for long periods, the significance of this characteristic for our defensive strategy was not understood. More importantly, the far-reaching consequences of practical development of nuclear propulsion were never seriously analyzed.

A further difficulty was that some members of the military never quite understood the problem and some were ready to sacrifice the overall project for systems that could be made available earlier. Others wanted immediately an airplane with performance characteristics superior to those of our most modern jets – as though an entirely new technology does not require lead time and as though a mature chicken jumps out of the egg.

The scientists should not really have mixed in the strategic debate, but they were in fact the only ones who argued the question. They broke up in several small groups, opposing or rejecting nuclear aircraft, nuclear-rocket propulsion, or nuclear ramjets, or dismissing nuclear propulsion altogether. The scientists who have had the greatest impact on the negative decisions affecting the nuclear-propulsion aircraft are the graduates of one laboratory which always was opposed to this program – for good or bad reasons. While they were instrumental in killing the plane they did not appreciably advance the cause of the nuclear ramjet or rocket that they were in charge of developing and that they claimed was a more promising approach.

The politicians didn't understand the problem, either. One Secretary of Defense called the nuclear-propulsion aircraft "a shitepoke which could barely get off the ground."

As a result there were innumerable stop-and-go decisions. While it is true that about $1 billion was spent, at least one half was spent on waste motion. It is said that we have nothing to show, but this is not true. We do have the know-how to fly low-speed, experimental and test aircraft. This is precisely the one type of aircraft we could be flying now, and which someone will one day develop.

This experiment should have been the signal for the military to face up to the technological age, especially to prepare a technological strategy to meet the new Soviet challenge and to organize better ways and implement such a strategy.

In 1988 almost nothing remains of the nuclear propulsion experiments; and although nuclear aircraft may never play a role in the technological war, nuclear propulsion could in future be decisive in space. Unfortunately, the nuclear rocket programs, such as NERVA and DUMBO, were also mired in internecine warfare, and eventually closed down as well.

The mismanagement of the nuclear airplane project is a text-book example of how not to conduct a program.

2.4.2 The ICBM

By contrast, the IRBM and ICBM programs were well developed and well managed in the 1950's. As an example, the Thor IRBM was brought from conception to operational capability in just over three years. (Thor follow-on rockets are used for satellite launches to this day.) Instead of programs designed by scientists to investigate a technology, IRBM and ICBM systems were designed, fielded, and operational in a very short time period, largely because General Schriever instituted dramatically new management procedures, including concurrent development of the components and subsystems.

2.4.3 SLBM

In this period Admiral Red Raborn married the nuclear submarine and ballistic missile in a "special project" which produced the Polaris, and later the Poseidon and Trident boats and Submarine Launched Ballistic Missiles.

The program was important not only because of its direct effect on strategic deterrence, but on its adoption of new management principles, and the demonstration that it was still possible to produce strategic weapons systems in a timely and cost-effective manor without micromanagement from the Pentagon.

2.5 The 1960s Era

2.5.1 Apollo

The Apollo program of manned exploration of the Moon was certainly the outstanding achievement of this Century. It is a landmark of what the U.S. could achieve given a challenge to the scientific and engineering community.

The Apollo program was also the most complex action ever undertaken by the human race. It is interesting to note that the second most complex activity in history was Overlord, the Allied invasion of Normandy in 1944. Although Apollo was accomplished outside the Department of Defense, it was no accident that many of the key leaders, such as General Sam Phillips, were highly experienced managers of advanced military technology programs.

The Apollo program was mission oriented. Its management structure closely resembled a military organization. Instead of micro-management from the top, there was delegation of authority. Tasks were narrowly defined, and responsibility for achieving them was spelled out in detail. As with the ICBM program, parallel processes were set up to investigate alternate ways of achieving critical tasks.

The result was that technology was produced on demand and on schedule. Setbacks and even tragedies such as the capsule fire did not halt the program. On 20 July, 1969, the Eagle landed on the Moon, a little more than eight years after President Kennedy began a task which much of the scientific community said could not be accomplished in two decades.

2.5.2 Military Aircraft

In 1962 Project Forecast identified a requirement for new military aircraft. Systems designs began shortly thereafter.

Unlike the Apollo program, both the fighter and bomber programs were micromanaged from the top. There were endless reviews and appeals.

As a result, the first of the new generation of fighter aircraft was not rolled out until the mid-70's, and were not in the operational inventory in numbers until considerably later; and both the Navy and Air Force are now flying aircraft whose basic designs are twenty years old.

The B-1 fared even worse. Not only was there micromanagement, review, and appeal, but the program itself was cancelled by political authorities. The first operational B-1 was delivered in 1983; we now have a full inventory of 100 B-1 bombers.

The B-1 bomber and the F-14, F-15, F-16, and F-18 fighters are probably the most advanced aircraft of their kind in the world; but the contrast between the 8 years from conception to operation of Apollo, and the 16 and more years from design to operation of these aircraft, is worth noting; particularly when contrasted with the rapid development and deployment of the P-51 and P-47 aircraft during World War II. Recall that the P-51, then the world's most advanced fighter, went from drawing board to combat operation in under a year.

Note also that the reviews and delays characterizing the development and procurement of the B-1 and the new fighters did not save money. The total program costs were considerably higher than they would have been had we set up a management structure similiar to Apollo; indeed, the total costs of these programs exceeded that of Apollo, which was brought in on time and under budget.

2.6 The 1970s Era

2.6.1 MIRV

The major technological developments with stategic implications for the 1970's were new techniques for increasing ICBM accuracy, and the capability for deploying Multiple Independently Retargetable Re-entry Vehicles (MIRV).

These capabilities stimulated spirited debate between the advocates of security through Arms Control and the military services.

Arms control advocates said that MIRV was inherently destabilizing: that is, if each missile had the capability for destroying a large number of enemy missiles, then there would be a military incentive to launch first in crisis situations.

Strategic analysis gave a different answer: given the limited size of the U.S. missile force, any increase in numbers of Soviet systems would pose an increasing threat to the U.S. SOF, especially since it was known that the Soviet Union was developing new techniques for increasing the accuracy of its missiles. The threat to the SOF could be countered by three different means:

1. Increase the numbers of missiles in the US SOF
2. Increase the survivability of the SOF
   - 2.1. Hardening silos or other passive means
   - 2.2. Active defense
3. Increase the effectiveness of U.S. missiles that survived a Soviet first strike.

Of these options, (1) was declared politically undesirable; (2.1) was extremely expensive and given increased Soviet accuracies would soon be impossible; and (2.2) was rejected on political grounds. There remained only (3), which in practice meant MIRV.

The MIRV system was accordingly built, and once the decision was acutally made was reasonably well implemented. However, we should note that the Senate Armed Services Committee tried to prevent the Minuteman III MIRV from becoming accurate enough to attack Soviet missile silos. These efforts delayed the deployment of accurate MIRV by several years.

2.6.2 Shuttle

The most spectacular program of the 70's was the Space Transportation System, popularly known as the Shuttle.

By 1968 it was clear that the Apollo program would perform its mission on schedule. At the same time, the Viet Nam war had created a budget crisis, leading to considerable opposition to the space program. NASA, concerned about retaining its large army of development scientists recruited for the Apollo program, searched for new missions to keep them on the payroll.

The original proposal for the Shuttle was as a large reusable general purpose system for putting heavy payloads into orbit. Simultaneously, the military needed a much smaller and more maneuverable system along the lines of the Dyna-Soar concept.

In order to obtain funds for the Shuttle, NASA combined these incompatible missions, and set out to kill all competing programs. Not only were the remaining fully operational and man-rated Saturn rockets laid on their sides as lawn ornaments, but all Saturn facilities were closed, and even the plans for the Saturn were ordered destroyed as "useless archives." NASA officials conducted a campaign to discredit all possible opposition to Shuttle.

The Shuttle became the "National Space Transportation System", able to meet all possible space missions. The Air FOrce had previously studied a mission in which an orbital surveillance vehicle would be launched in polar orbit from Vandenberg; overfly the Soviet Union; then reenter and land at Edwards AFB after one orbit. It was not a mission that inspired USAF enthusiasm, but the Air Force was bullied into supporting Shuttle, and this looked as good as anything.

Unfortunately, the specified mission requires atmospheric maneuvering, and dictated that the Shuttle would have wings. The wings dictated horizontal landings. They also greatly complicated the system design. A smaller vehicle intended for this mission could have been built, but NASA insisted that Shuttle could do the entire job. Wings plus Shuttle's large payload requirements dictated increasingly large rocket engines to get the craft into orbit.

There were other design changes. The original concept of a spacecraft that would be "reusable like an airplane" disappeared; instead there would be a lengthy refurbishing period whose cost could only be estimated.

The original design for a reusable vehicle proposed liquid fueled booster engines as well as a liquid fueled main engine. The alternative was solid fuel boosters. Developing the liquid booster engines would have cost more money to begin with, but would make for great savings in operational costs; NASA chose to argue for the lower up-front costs, on the theory that once the committment was made, Congress would have no choice but to appropriate the additional funds for Shuttle operation.

The solid fuel engines could have been designed in one piece; however, except for barges on the Intercoastal Waterway, there was no transportation system for shipping such large objects filled with high explosives. The only plant on the coastal waterway system capable of building the one piece engines was Michoud in Louisana. That plant had been closed, and re-opening it would require up-front money. There were also political considerations. The result was that the boosters were designed to be built in segments and made in Utah.

The Congress, partly in reaction to NASA's constant inability to meet either budgets or schedules, imposed funding limits and budget stretchouts. Since delaying a program never saves money, the overall costs grew accordingly. However, this was not the only reason for runaway costs in the program, as NASA continued to make design changes at every stage of the development process.

Shuttle program expenses grew until each Shuttle craft cost more than $2 billion. The first Shuttle flew on April 12, 1981, more than three years after it had originally been scheduled. During that time we lost Skylab, an operational space station, which could have been rescued had we retained the Saturn rockets which NASA deliberately destroyed.

No Shuttle ever met its design criteria for payload weight or refurbishing costs. Shuttle Challenger was destroyed by the failure of the joints in one of the segmented solid booster rockets.

2.7 The 1980s Era

2.7.1 B-1

The Reagan administration ordered the ressurection of the B-1 program which had been cancelled by President Carter. The procurement was turned over to a slimmed-down organization, and, with little interference from above, the full inventory of 100 aircraft was delivered on time and under budget, in under four years.

2.7.2 SDI

During the 1980's, the Strategic Defense program has clearly been the dominant area of competition in the Technological War. When the decade began, most scientists and miitary strategists believed that defense against the ICBM was impossible. How could you hit a bullet with a bullet?

Nevertheless, on March 23, 1983, President Reagan challenged the scientific community to develop a meaningful ballistic missile defense system. As happened with the ICBM and Apollo programs, the response was nearly incredible. Within two years a range of new applications of technology in the areas of propulsion, sensors, guidance, and even production were generated. By 1988 there were a number of alternate systems which could meet the challenge.

We will draw the lessons to be learned from these examples in later sections and chapters. First, we should examine the way technological planning is now conducted.

2.8 The Present Assumptions Governing U.S. Conduct of the Technological War

The assumptions that appear to govern our conduct of the Technological War are shown on Chart 3. They derive from a misunderstanding of the nature of war and from a failure to appreciate the nature of technology. Because these assumptions are based on an improper appreciation of the real world, it is no surprise that despite our enormous expenditures the United States has failed to exploit its advantages to take a commanding lead in the Technological War.[5]

As of 1988 there remains a window of vulnerability: new advances in both defense and offense technologies now make it possible for the U.S.S.R to develop a Full First-Strike Capability unless we act swiftly and skillfully.[6]

[5]There have been a number of changes in the situation since we wrote this section. Many of them have been beneficial, and some have even been due to the influence of the first edition of the book. Unfortunately, there is still insufficient appreciation of the relevance of technology to national strategy.

[6]Advances in guidance technology have made the entire land based missile force vulnerable to a first strike; meanwhile, the oceans are becoming more transparent through such means as cosmic ray backscatter, synthetic aperture radars in space, and other means. A Full First Strike capability does not imply the total disarmament of the enemy. It does imply reducing the enemy's retaliatory capability to the point at which he cannot do unacceptable damage to the aggressor. "Unacceptable" means different things to different nations.

Fortunately, the Soviets under Brezhnev were unable fully to exploit their opportunity; even so, they were able to construct a highly threatening ICBM force, and their lead in strategic nuclear forces continued to grow during the Brezhnev regime and beyond. Meanwhile, the Soviets began an extensive program of R&D into missile defense systems, and deployed some long term components of a working continental missile defense system.

Although the present U.S. assumptions are based on a false picture of strategic and technological reality, they are all the assumptions we have, and they generate what little strategic direction our efforts are given. The assumptions, and the various directives which can be derived from them, therefore merit a great deal more study than has been given to them in the past.

CHART THREE: Assumptions Governing U.S. Technological Strategy

- The United States is the Superior Technological Power, and thus, inevitably, the Superior Military Power.
- We are not engaged in Technological War, and if we were, we would inevitably win.
- The United States has the potential of making any desired advance or application of technology to military power whenever it is needed.
- Incompatible missions can be combined, with a resulting saving of money.
- Technological education benefits defense, regardless of where, and in what field, it is obtained.
- The Time Factor is on our side, or at worst, neutral.
- The Soviets also wish to halt the Technological War.
- Technological War can be (or already has been) halted by Agreements and Treaties.
- The "Technological Explosion" relieves us of the necessity for making decisions in the Technological War.
- A Defensive Strategy is synonymous with Not Taking The Initiative; rather it implies Avoiding The Initiative in most aspects of national power. Defense means reacting to Soviet Initiatives.
- Defense is incompatible with Deterrence.
- All technological decisions should be made by civilian scientists, and technological research vital to military power should be carried out under civilian supervision, and preferably by civilian agencies such as NASA.
- The military should fight battles, but not prepare for or prevent them.
- The military principles of Surprise and Pursuit are not applicable to the Technological War.

Other postulates, derived from the assumptions on Chart 3, include the proposition that since we are not at war, we do not need an overall technological strategy and should not seek technological surprise even if it is possible to obtain it; that since the U.S.S.R. is also interested in stabilizing the "arms race," we should not exploit our advantage by engaging in technological ppursuit even if we could so exploit them; and that since we can do anything we imagine and the technological explosion will inevitably produce anything we need, there is no necessity for an orderly accumulation of the building blocks to expand our military technological base.

If these propositions were put to the managers of our military technology in the explicit form given here, it is likely that many of them would disagree. Yet, an examination of the history of our technological management indicates that each of these factors is at work.

For example, the exploration of space, probably the most important military medium of the future, has been given to civilian agencies that are often unresponsive to military requirements. Worse is the artificial distinction imposed on development of space technology in the National Space Act of 1959. This Act creates a civil space agency, NASA, exclusively for "peaceful purposes" in space. The effect was to constrain the use of space for military missions.

NASA by law is not supposed to respond to military requirements for space systems. Admittedly, various pragmatic expedients have been followed to coordinate the separate civil and military program requirements, such as the Aeronautics and Astronautics Coordinating Board, and the Space Task Group of 1969, but those efforts could never produce an integrated national space program to execute a national technological strategy for space applications.[7] We have yet to establish environmental laboratories in space to develop the basic building blocks for making the use of space the routine operation that a military mission must be.

Similarly, the National Defense Education Act doles out money for technological training with no regard to whether those who have received it will participate in or will hinder national defense.[8]

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[7]Meanwhile, the Strategic Arms Limitation Treaty requires the U.S. to use "national technical means" for verification of Soviet compliance with the treaty. According to the London International Institute for Strategic Studies, this means observation satellites, particularly the large "Keyhole" systems. The special needs of these systems are also imposed onto the design of space systems, and apparently influenced the shuttle design. The result is one more conflicting set of requirements, and leaves the design of purely military systems up in the air, or to agencies not responsive to military planners.

[8]We do not imply that any large number do hinder national defense; the point is that no steps have been taken to ensure that they will help.

Many decisions on military technology have been centered in the office of the Director of Defense Research and Engineering, who is sometimes a scientist with no military training. When we have achieved advances or breakthroughs in military technology, we often halted short of exploiting them and attempted to negotiate with the Soviet Union to put them back in the bottle.[9] In general there has been little planning for technological surprise, no integrated strategy of technology, and no understanding of the meaning of technological pursuit.

> The above analysis was written in 1970. By 1989 the situation had changed, although not as much as it should. Our educational establishments have so deteriorated that normative scores on both the Scholastic Aptitude Test and the Stanford-Binet IQ Test have been lowered; our space program was cut back to a single Shuttle system which was then mismanaged, delayed, and stretched out; and our manned space program was non-existent through the last part of the 70's. Then, when the Shuttle Challenger was lost, instead of rethinking the situation and generating new means for routine access to space, we spent more than two years redesigning new launch vehicles. By late 1989 the consequences of the 1983 SDI decision, coupled with the sheer weight of US economic power and the total incompetence of the Soviet economic system, brought about heavy pressures for change within the Soviet system. This has not changed the fundamentals of technological warfare. It has bought the West a respite. [1989]
>
> The respite was followed by the collapse of the USSR, giving the US a chance to rethink our strategy of technology. We are not making good use of this opportunity. The US is at present the only 'superpower' but this situation need not be permanent. TECHNOLOGY HAS A WAY OF EQUALIZING vast disparities. The Dreadnought made obsolete much of the naval establishment of 1900. Space weapons can do the same in the year 2000. [1997]

2.9 The Abandonment of the Initiave

Of the present assumptions, probably the most dangerous is that it is sufficient simply to react to Soviet initiatives in the Technological War. By failing to seize the initiative, we place ourselves in a clearly impossible situation: either we must maintain such decisive superiority over the Soviets at

[9] Current examples are space, ABM, MIRV, and the use of deep underwater technology for military purposes.

any possible point of breakthrough so that we can concede to them a long lead time and still be able to counter their new weapons; or we must abandon superiority to them whenever we fail to do so.

Wealthy as we are, with enormous reserve power in the form of our industries and laboratories, we cannot keep this posture forever. The abandonment of the initiative is probably the most expensive mistake we have made in the Technological War.

Until SDI there was little conscious effort to use the initiative to drive the U.S.S.R. to decisions which add to our security. For example, we have announced that we will develop penetration aids for our missiles, and deploy those as needed to overcome the Soviet missile defense system. This strategy presupposes high confidence in our estimates of the characteristics and limits of their system, which is a dangerous assumption because the U.S.S.R. is a secretive society about which it is difficult to obtain reliable technological information; but that is not the only hazard. Since the Soviets proceed to exploit defense technology while we merely study endlessly whether or not to pursue what needs to be done, the chances are that they will understand defense far better than we; and understanding defense technology is at least as important to the designers of our penetration systems as it is to our defense systems designers. For lack of a sophisticated understanding of the nature of defense technology, we may fail to understand Soviet defense capabilities and limits.

By contrast, we could have deployed a series of penetration aids, some of which are quite inexpensive, forcing the Soviet Union to adapt their defenses to our offense. As they made such an adaptation, we could change the nature of our offensive weapons, engaging in technological pursuit and forcing them to waste their resources reacting to our initiative. Admittedly this kind of strategy is not simple, but the point is that it was not seriously considered.

In fact, though, we did nothing of the kind, but once again relied on negotiations and treaties. Under the 1972 Anti Ballistic Missile (ABM) Treaty, both the United States and the Soviet Union agreed to build no more than one ballistic missile defense system; and that system was supposed to protect missiles or the national command. The Soviets chose to protect the missiles near Moscow; we soon abandoned our defensive systems entirely.

> Fortunately, this policy was reversed after 1983; but it is instructive to understand the situation prior to the SDI effort. Most of this analysis was written prior to 1980.

Under the ABM Treaty, neither side was to build battle management defensive radars, or to test certain ballistic missile intercept systems. The

Soviet phased array radar near Abilokovo is clearly in violation of that treaty; so was teh Kraskyarsk radar (by their own admission). As of 1989 the United States has not begun construction of the radars and other auxiliary equipment needed for a large-scale ballistic missile defense system, nor have we made any other move to seize the initiative in this phase of the Technological War.

We did announce our new policy of SDI. This will be discussed in more detail in a later chapter; for the moment, it is sufficient to note that although strategic defenses cand be decisive in the Technological War, SDI is formally defined as a program of pure research, and is not integrated with any scheme for deployment. The United States remains utterly defenseless against nuclear ballistic missile attack.

We also could be devoting some of our technology to making life difficult for the U.S.S.R. in other theaters and areas of the world. It is unlikely to do any great harm if we manufacture small, short-range handguns of extremely inexpensive design and either scatter them broadside in Cuba or threaten to do so. This would, of course, be a diversionary move intended to force some kind of reaction from the other side and cause them to waste their resources. It has no great merit other than as an example; but nothing like it has even been discussed.

We have taken few military initiatives in space. The list of Soviet 'first' in space is long.[10] Our manned space program was in trouble long before the Challenger disaster. Skylab, the world's first operational space station, was launched (without crew) on May 14, 1973. Key elements of the environmental control system failed to deploy, but on May 25 the first Skylab crew arrived and soon managed to make the space station operational. On November 16, 1973, Skylab 4 carried Jerry Carr, Ed Gibson, and Bill Pogue to the space station, where they remained for 84 days. That was the last mission to Skylab, and the last American manned mission until the flight of the Shuttle Columbia in 1981. On December 18, 1973, the Soviet Union launched Soyuz 13. The crew remained in orbit only 7 days; but over the next fifteen years, the Soviets sent up Soyuz flights of increasing duration, until on February 19, 1986, they launched their MIR space station, and on March 13, Soyuz T-13 docked with MIR and placed a crew aboard. There have been many crew changes since, but MIR has been continuously manned from 1983 to present.

Skylab was not visited again after the February, 1984 return of Carr, Gibson, and Pogue. Manned space was utterly neglected during the Carter Administration. On June 11, 1979, the space station's orbit decayed the

[10] We did deploy the GPS navigation system, which we discuss elsewhere.

Skylab burned up in the atmosphere.

In 1982 in a speech at Edwards AFB, President Reagan announced an intention to "look aggressively to the future by demonstrating the potential of the shuttle and establishing a more permanent presence in space." On January 25, 1984, in his State of the Union address, President Reagan directed NASA to develop a permanently manned space station within a decade. After the initial excitement, it became known as "The Incredible Shrinking Space Station"; every year it was redesigned to have fewer capabilities while costing additional billions of dollars. The present design calls for a station smaller than Skylab.

Meanwhile, our efforts to investigate the military potential of man in space continue to languish. We have no serious program for making space a theater of military operations; instead, we require the military to describe their mission requirements in detail before they are given a chance to explore the space environment and discover its potential. Because they cannot solve this dilemma, we do not capitalize on the military potential of space.

This unfortunate state of affairs continues in the 80's, with the added new wrinkle that space installations are now said to be too expensive and too vulnerable. This will be discussed in detail in the chapter on space systems.

Our missile programs have not yet been designed to maximize the variety of threats and missions inherent in using the aerospace, so that the Soviets have had to do little in the way of wasting resources to be ready for what we might do. By abandoning the initiative we give the enemy the chance to concentrate upon his strategic plans entirely unmolested by the options that we do not take up; and where, by accident, we do achieve a breakthrough ahead of the Soviets, we do not develop the new technology at all.

Yet, a defensive strategy does not imply abandoning the initiative. Properly conducted, a defensive strategy can be stronger than the offensive, particularly if the defender enjoys resources superior to those of his opponent – as we do. The essence of a good defense is not so much a good offense as planning for surprise – which requires that the defender exercise initiative and ingenuity.

2.10 Surprise[11]

The foremost characteristic of a good defense is timing. The side which first achieves a new advance can gain advantage can gain significant advantages

[11] We analyse the role of surprise in the Technological War in a later chapter. The present section is intended as a brief introduction.

in the Technological War by exploiting it to the fullest, keeping the opponent uncertain of what may be developed and how it might threaten him, and forcing him always to guard against surprise. A major goal of strategy should always be to achieve surprise, regardless of whether the strategy is offensive or defensive. Weapons systems and scientific research programs should be designed not only for minimum cost, technological elegance, and logistic ease, but also to create maximum uncertainty in the mind of the opponent. Surprise may result from the proper use of technology, but its main impact is upon the enemy's mind.

Surprise may be achieved through the sudden unveiling of a secret weapon. It is more often achieved through the novel use of a familiar system, as in the use of the B-52 against the guerrillas in Vietnam. Surprise is still more often achieved by taking an action the enemy did not consider because, although he knew perfectly well you were capable of performing it, it was completely outside the doctrines he thought governed your actions. This miscalculation may result in a paralysis of thought, because now the enemy has no idea of what to expect next. If you were capable of doing that, what else might you do?

The first bombardment of North Vietnam could have been used to create such a state in the minds of the enemy, had we not gone to such pains to make him aware of just what limits we placed on our future actions. A classic example of surprise is Guderian's thrust through the Ardennes followed by deep penetration of France, producing the collapse of the "finest army in Europe".

Another common method of achieving surprise is through the exploitation of small advantages. Sometimes very small technological differences can be decisive; for example, in air combat during World War II, a speed differential of 20 miles per hour was crucial, even though it was only a small percentage of the total speed of the two airplanes involved. A 10 percent performance advantage in a radar can work a similar result. In war, there are very few prizes for having the second best equipment, even if it is almost as good as the enemy's; if before the combat you thought yours was better, the resulting surprise could be as disastrous as the actual inferiority.

Sometimes surprise can be achieved by deliberate manipulation of the expectations of the enemy, through the design of military equipment to maximize certain crucial variables at the expense of others. The Spitfire was designed to have a faster rate of climb and more firepower than the Messerschmitt, yet it was inferior in most other respects. It was then employed in an operational environment which made use of its advantages and minimized its disadvantages. The result was the disaster to the Luftwaffe that we call the Battle of Britain. Yet, to an aeronautical engineer or an aerodynamics scientist, the Messerschmitt was clearly the better airplane. German scientists and pilots alike were victims of a deliberate policy of technological surprise.

The above example is worth studying. In particular, it should be noted that victory was produced by the combination of aircraft design and strategy, which required careful analysis of far more than aerodynamics and engineering. The victory was won by military decisions, not scientific theories.

2.11 Science Is No Substitute for Military Judgment[12]

The Spitfire example is illustrative of the principle that science, computers, and systems analysis cannot make military decisions, although they can be greatly useful. It was not merely the Spitfire's advantages but the strategy which used them effectively that gave victory in the Battle of Britain. The art of war is the art not only of using your advantages to best account but also of creating advantages you did not previously have by inducing the opponent to make mistakes. It is rather difficult to simulate this on a computer.

2.12 Systems Analysis and Military Decisions: The TFX

The current miraculous substitute for military judgment and creativity is called systems analysis. The authors are familiar with the techniques of systems analysis and often employ them for certain limited purposes. When, however, these techniques are used as a substitute for strategic analysis the results are usually disappointing. One outstanding example is the TFX.

The problem of the TFX (FB-111) is not that it will not fly. Although its crashes have received spectacular publicity, as this is written (1970) the aircraft has in fact a better safety record, for this stage of introduction into the force and number of hours flown, than any attack bomber in recent history. The difficulty of the TFX is that it is not the best airplane for any mission it can fly, and was deliberately designed that way.

This difficulty is the result of trying to save money by designing the plane to do reasonably well at many different missions, at the sacrifice of

[12]For an early discussion of this subject, see Colonel Francis X. Kane, U.S.A.F., "Security Is Too Important To Be Left To Computers," Fortune, April 1964. Reprinted in Barnen, Mott, and Neff, Peace and War in the Modern Age (Garden City, N.Y.: Doubleday Anchor, 1965).

performance in all. Thus we have an airplane which is a very good second best to the new MiG in the air superiority mission; and although useful in other missions, it is not as good as the aircraft we could have for those roles, yet it is costing more than the optimum plane for any single mission would.

In the first edition we did not argue against the continued introduction of the TFX into the force. If called the A-111 and used for the attack-interdiction mission, it remains a good airplane. During the bombing of North Vietnam, the FB-111 was so clearly superior to anything else we had that a sortie by three TFX gave results equivalent to strikes by up to 40 other aircraft, and at far less cost. (FB-111 was also effective in the strikes against Libya.) This illustrates the well-known principle that in general the most technologically advanced system is the cheapest system when it must actually be employed in war.

However, the TFX is not an optimum attack bomber. It costs far more than the attack bomber we should have built and must build in the 1990's. It suffers from design defects directly traceable to the effort to make it useful for other missions, and these defects contributed greatly to the much-publicized crash record of the TFX. For a lot less money we could have had not only a better attack bomber but a second airplane to give close support of ground troops – something the TFX was also supposed to do but for which it was so badly designed that it was never attempted. It was also supposed to be able to fly from aircraft carriers; that too was never attempted, but the requirement delayed the aircraft and influenced its design.

Analysis of the TFX is compounded by the political interference with the military source selection boards, and the awarding of the production – over the objection of eleven military boards – to a Texas company instead of the greatly-favored Boeing, of Seattle. This was not, however, the crucial decision in the TFX mess. Given proper design, almost any competent airplane company can build a good airplane, although some will have more difficulties and charge more than others. The critical problem of the TFX was in the systems analysis-spawned concept of the airplane, not in the subsequent efforts of the engineers to build an airplane to a set of impossible specifications.

The original concept of the TFX was born during a visit by then President Kennedy to an aircraft carrier. The Navy, in a misguided attempt to impress the Commander In Chief, landed a variety of aircraft on the carrier, prompting Kennedy to ask Secretary of Defense McNamara why there were so many different kinds of military planes. McNamara did not know, and after a few moments of thought decided there was no reasonable cause, and that a great deal of money could be saved by building general purpose machines. Then, in a burst of insight, he promised the President that not only would there be a reduction in the number of kinds of aircraft, but that both the Navy and the Air Force could use it, thus reducing costs still further.

The interservice airplane was itself a questionable concept, inasmuch as the missions and roles of the two services differ greatly. However, it would be possible to create such an aircraft, provided that its purposes and intended missions were not impossibly contradictory. It would be highly difficult to do so, and an aircraft required to take off and land on carriers would almost inevitable have more performance restrictions than airplanes designed for use from Air Force land bases; but the savings in costs of construction, stores, inventories, etc., might be sufficient to justify degrading the performance of, say, an attack bomber or close-support airplane.

The really crucial decision came when Secretary McNamara decided that the TFX should be both an air superiority fighter and an attack bomber. Once these roles and missions were mixed, the airplane was doomed. Such a multi-mission aircraft looks extremely good to the budget-minded. By assigning proper numerical values to various levels of performance on different missions, adding them up, and calling that effectiveness, you get a figure which – compared with the cost of producing several different types of airplanes each of which is optimum for a mission – makes it the best airplane you could ever buy. The TFX will remain a wonderful general-purpose craft until it fights the airplane that takes first place in the air superiority mission. In war, there is no prize for second place.

In fact, the TFX was intended to perform not two but four incompatible missions, and to do so for both the Air Force and the Navy. In its original conception, the TFX was intended to be: (1) our general-purpose all-weather air-superiority (or dogfighting) fighter, with the possibility of being a continental defense interceptor as well, (2) a reconnaissance-strike attack bomber, (3) a long-range, deep-interdiction attack bomber for all-weather missions, and (4) a close-support, attack-weapons delivery platform for missions in combination with ground troops. We note here that the TFX is not a strategic bomber and was never intended to be one; attempts to call it that were for the political purpose of hiding the fact that our bomber force was approaching obsolescence in the 1970's.

TFX designers were therefore called upon to do the impossible. The requirements for missions 2 and 3 above are not completely incompatible, and cost considerations may well dictate a single airplane for these two purposes; at the moment, the TFX could have been the best craft in the force for either of these missions. However, each of these two missions is incompatible with the air-superiority mission, so that after years of delay the Congress approved the design and construction of the F-14, F-15, and F-16. Because of the long lead times involved in airplane development, before the F-15 was operational the Soviets had will have at least one generation of fighters superior to anything we could put in the sky.

The TFX was not the best airplane we could have had for missions 2 and 3. It is too expensive, for a start. The compromises made in its design to make it useful as a fighter and a close-support weapons platform not only degrade its performance as an attack bomber but are extremely expensive. For a lot less money we could have an attack bomber as superior to the TFX as the TFX is to the older planes that are still the mainstay of the tactical air force.

Despite the incompatibility of missions, the proposed TFX designs were evaluated on the basis of a single number: the effectiveness of the proposed airplane for all four missions. This is similar to the point system for determining the winner of the Olympic Decathlon or the Modern Military Pentathlon, by which the winner of a single event may be ranked behind the man who has taken second or third place in all contests of the decathlon. A second criterion employed was the degree of commonality between the Air Force and Navy versions of the plane, that is, the percentage of parts the two versions had in common. This criterion compromised the aircraft design, and eventually was worse than useless because the completed airplane could not land on carrier decks. The Navy finally canceled its orders for TFX and began design of an aircraft suited to the Navy mission environment.

Thus, instead of bringing the heralded savings of billions of dollars, the completed aircraft cost more than would three separate airplanes optimized for individual missions; the Navy got no attack bomber at all; and the Air Force finds itself with an airplane useful only for the attack bomber mission, and not optimal for that. Finally, because of political interference in the selection of an airplane producer, the TFX was built by a company that had a reputation for delivering aircraft late and with high cost-overruns. At this time (1970), the airplane is grounded until studies can reveal the cause of the latest crashes. Instead of having a splendid general-purpose aircraft, the services are presently fighting a war with airplanes that were in the inventory when the TFX was designed.

Fortunately, the United States was never required to fight new Soviet MiG aircraft with the TFX.

2.13 The Limits of Scientific Military Analysis

The use of numbers to calculate effectiveness – that is, taking a number of different missions or parameters and adding or otherwise combining them to get a single criterion measure – was once known in engineering as the figure of merit fallacy. In the McNamara era and after, the civilian leaders in the Pentagon promoted the figure of merit fallacy to the major principle by which we chose new weapons. Most Congressional staffer continue to operate this way.

If the weapons are to be chosen by scientists through scientific means, some such figures of merit will be necessary. Used properly, they are quite useful because they are not inherently misleading. What is misleading is the fallacy that military decisions can be made by scientific means.

The problem with scientific criteria and analyses is not that they are false or useless, but that they are incomplete. It is simply not enough to use cost-effectiveness or "most bang for the buck" as the means of choosing weapons. (One of the authors can remember when he was designing a small missile for use in defeating an enemy field army near friendly inhabitants. The nuclear physicist working with him was near to tears when he discovered that he had to design a very clean weapon with a rather low yield. "Why, for that much fissionable material and weight," he said, "I could give you a megaton." It took some patience to explain that a megaton delivered near the city would defeat the purpose of the weapon system.)

In other words, some systems that are militarily best are not necessarily the scientifically most elegant, as the Spitfire was hardly the "best" aircraft to the aerodynamicist, or the new MiG to the TFX systems analyst. It is the nature of the military decision that it has to take into account a large number of factors, most of them uncertain and in no way amenable to mathematical modeling.

In some cases, of course, scientific calculations are of immense value. If you are trying to discover how many missiles you must aim at the enemy to achieve a given probability of killing a target of (assumed) hardness, given an enemy attack of (assumed) effectiveness which will knock out a given portion of your force (surviving force to be calculated from assumptions), the systems analyst can be of great help in telling you how many more missiles you have to aim at the target because your own birds have a given reliability (calculated from insufficient testing data).

He can tell you what improvement you must make in this theoretical reliability to knock out the target system with the force you already have.

He can even construct a little cost-effectiveness model in which he analyzes whether it is better to spend your money on improving the reliability of your present force or buying new missiles. His calculations will, of course, be based on assumptions about what the reliability improvement research will cost, and he will probably ignore Pournelle's Law of Costs and Schedules in the calculation[13] but he will come up with a recommendation which at least has the merit of letting you see where it came from and on what it is based. What systems analysis cannot do is tell the commander if it might be better to not use this force against a particular target at all, but rather attempt to achieve surprise or in some other way defeat the will of the opponent rather than his forces.

Strategy in the Technological War must be based on strategic analysis, not systems analysis. The decision process must employ an appreciation of the enemy, the operational environment now and in the future and the principles of the art of war. It cannot simply be based on a highly artificial figure of merit.

2.14 Other Fallacies

Before we take up the nature of the technological decision process, it will be helpful to discuss some additional common fallacies. These are important not because they are common today but because they seem to be attractive to technological planners. A list of common fallacies, not exhaustive but illustrative of the more attractive errors, is shown on Chart 4. Some of these have been touched upon above and require no detailed analysis.

[13]Pournelle's Law of Costs and Schedules states that "Everything takes longer and costs more." It was independently discovered by J. E. Pournelle and Poul Anderson in the early 1950s.

CHART FOUR: Common Fallacies About Technology

- The march of technology can be halted by agreement.
- The centralized decision is the best decision.
- Centralized decision making = strategy
- Small advantages are not decisive, and probably not important.
- Symmetry of motives or actions.
  - The enemy won't do what we won't do. ("Why should he do that?")
  - The enemy is not doing what he is in fact doing. ("He can't be that stupid, and it isn't cost/effective.")
- Overkill
- If it's been constructed, it's obsolete.
- Technological advances in the military arts are automatic.

2.15 Technological Process

The first and last of the fallacies shown on the chart may seem to be self-canceling; that is, it may at first appear that no one could hold both simultaneously without being aware of the contradiction. This is in fact not true. It is possible to believe that technological progress can be halted through treaties and agreements, and yet also to imagine that advances are automatic; moreover, in our judgment, much of the technological policy of the past ten years has been based on these twin delusions.

The belief that technological progress can somehow be halted comes, we believe, from an imperfect understanding of the nature of technology, and in particular from failure to consider the interdependence of technological discoveries. There is no possibility of halting all scientific research or engineering development; yet you cannot predict in advance what the results of a particular discovery will be. For example, modern computer science, plus the development of complex mathematical models of the laws governing the combinations of particular molecules to form atoms, have made it possible for the chemist to make "dry lab" experiments with new chemical processes, discover new compounds, and determine much about their nature, all without soiling a single test tube. The research is carried on entirely by computer simulation. This technique is adaptable to weapons technology for the discovery of propellants, war gases, nonlethal incapacitation agents, "psychological" gases, and dozens of other militarily useful agents. As nuclear forces are better understood, most weapons tests may be conducted in the same way. An agreement by all governments to halt research and development in military chemistry or nuclear physics simply cannot be enforced, even if the governments actively strive to do so.[14]

Other examples of the interdependence of technology include the following: the utility of various fiberglassing techniques, developed for automobiles and boats, in rocketry and space warfare; the great increase in the accuracy of the ICBM from 1964 to 1968, not as a result of deliberate application of technology but merely through the reduction of International Geophysical Year data, which gave a better understanding of gravitational anomalies and thus reduced the largest single factor in the ICBM error budget; the military communications revolution brought on by the civilian invention of the transistor, which was also the prerequisite of the Minuteman. Unless you are determined to halt all technological progress – which is inherently impossible – you cannot stop the progress of military technology. No agreement can bind, because the stream of technology will flow on despite any effort to swim upstream.

Information about technological progress in the United States and the Soviet Union is not symmetrical. Despite the expenditure of billions of dollars for intelligence, the United States has incomplete knowledge about the state of Soviet technology in many military fields. If we are determined not to exploit our technological advances, we can not be sure the Soviets are not exploiting theirs; soon enough, we may find that they have been doing so, and that their exploitation has given them a decisive advantage.

2.16 Centralized Decisions

We have mentioned above that centralized decision making is no substitute for a strategy. Indeed, in the absence of a strategy centralization of the decision process is the worst mistake possible because it suppresses innovation in discovery and application. The military services cannot themselves generate a technological strategy, cannot orchestrate our technological research, devel-

[14]Such simulated tests will never be effective in competition with real tests, of course. The point is that no agreement or inspection can halt research. Agreements can slow it down – but at the risk of the enemy making discoveries through his use of ingenuity.

opment, and procurement into a grand design; but they can pursue rational substrategies which may be the best we can obtain. Until we have a workable mechanism for making use of military inputs and conducting strategic analysis to generate workable policy guidelines for achieving a strategy of technology, decentralization is probably the best protection against paralysis at the top of the decision pyramid.

Even when strategic analysis is conducted regularly and a national strategy for the Technological War is generated, over-centralization of technological decision making is useless at best and can be disastrous. In World War II (The Great Patriotic War, according to the U.S.S.R.), the major weakness of the Soviet army was the tendency to make all decisions at the top, the generals going so far as to order the placement and deployment of individual companies. This is not strategy.

A strategy provides subordinate commanders with the information they need to make intelligent choices and trusts them to carry them out. The strategist may well be unable to determine the best approach to a particular technical problem, just as a brilliant staff officer may not be able to place a company of soldiers for maximum defensive effectiveness. Even though the strategist may know better how to command a rifle company than its present commander, the strategist is not there. He cannot know the peculiar problems and strengths of this particular company; he cannot know that Privates Roe and Doe are individually worthless but nearly unbeatable in combination. The same is true of technological decisions. The human element of scientific management counts at least as much as the human element in military management. There is little to be said for the kind of centralization which centers all decisions at the top, saying in effect to those who must carry out the orders that they are untrustworthy; and there is much to be said against it, especially that over-centralization burdens the top.

2.17 Small Advantages

The notion that small advantages cannot be decisive stems from an imperfect understanding of the military arts. There is no prize for second place in combat. A system that is second best in each of ten areas is excellent until the moment it must be used in combat; then it is nearly worthless. Many examples of small decisive advantages come to mind: for example, in an air battle conducted with air-to-air missiles at long ranges, a two-mile difference in radar ranges can result in one side being destroyed before it even detects the other. Small percentage improvements in missile accuracy can result in enormous increases in target kill probabilities. Moreover, if you have misgauged your position on the technological S-curve (see the section on the nature of the technological process), what is expected to be a marginal improvement may in reality be quite a large one. Refusal to make small improvements usually stems from lack of desire to improve the force at all; that is, from failure to conduct technological pursuit and exploit your advantages to leave the enemy well behind.

2.18 Symmetry of Motives

Failure to exploit advantages, through technological pursuit or through a deliberate effort to achieve surprise, is often caused by the assumption of symmetry of motives and behavior. We are all too prone to believe the enemy will never do what we ourselves would not do, and if it is suggested that he would, we cannot understand why. This is the result of faulty intelligence and imperfect understanding of the enemy's objectives and philosophy. Similarly, we may be overconfident in our own analyses, believing that certain technological enterprises are worthless. We then refuse to believe the intelligence we do obtain when it shows the enemy is doing something we would not do. For years there was hard evidence of Soviet deployment of Anti-Ballistic Missile (ABM) systems; actual photographs showed installations employing radars not remotely useful for air defense and oriented such that they could only be part of an ABM system; yet the official word from the top was that they were air defenses or else mere sham. It had been proved that ABM was technologically impossible, thus the Soviet Union would not build them: ergo, they were something else.

The trouble with that kind of analysis is that the enemy may know something we don't. The Soviet operational tests of nuclear-tipped ABM systems in which they shot down several incoming RVs (reentry vehicles) and destroyed one of their Cosmos satellites with a nuclear interceptor may well have given them information which we could never gain because shortly after their operational tests they induced us to sign the Treaty of Moscow (atmospheric test ban). If, for example, nuclear weapons in outer space have much greater kill effects than we think, and operate at longer ranges than we have postulated, Soviet deployment of ABM systems would be quite justified. Several physicists have attempted to prove to the authors (on purely theoretical grounds, since the United States never conducted any real tests designed to get empirical data on the effective range of nuclear weapons in space), that the ranges could not be greater than we have postulated. The scientists eventually conceded that something might be achieved in exotic ways, but then contended that the Soviets could not know about them and certainly could not have tested them. Yet, the U.S.S.R. has continued to pour concrete and build an ABM system which we knew could not work. It would appear, from our present efforts, that the ABM effort is worthwhile after all; our blind refusal to believe the obvious cost us several years.

Incidentally, the Soviet ABM system, from its location and orientation, is obviously directed against the United States, not China; anyone familiar with the principles involved would know this. U.S. theorists simply cannot conceive that the U.S.S.R. might be willing to build a less-than-perfect defense system; therefore certain members of the technological community, finally convinced that the U.S.S.R. was in fact deploying ABM, decided to explain these efforts as China-oriented. Self-deception, once begun, can continue to absurd lengths.

> The above was written in 1969. It has since become clear that there are numerous ways to intercept ballistic missiles. Regardless of what the Soviets knew then, they continued not only to search for, but to prepare for technological breakthroughs. We did not being serious research into new ABM technologies until 1983, and in 1988 we have yet to do serious preparation for implementing what the laboratories have discovered.

2.19 Overkill [15]

The ”overkill” argument appears to us to be self-contradictory, especially when presented by an advocate of Mutual Assured Destruction. On the one hand, the greater the forces in the inventories on each side, the greater the destructiveness of war if it does occur – something surely known to the leaders in both Washington and Moscow. Thus it is unlikely that anyone would deliberately engage in thermonuclear strikes against another's homeland. On the other hand, it is when one or both sides have more weapons than targets that wars can begin. Furthermore, the technological race inevitably makes previously invulnerable forces quite vulnerable as time goes on. Reliabilities of aged equipment are lower than those of new.

The best protection against losing one's second-strike force to an enemy first strike is constant updating of the force; but the second best protection is to keep in the inventory numbers that seem superfluously large, so that some marginal improvement in the enemy's counterforce will not result in a decisive advantage. The more weapons in inventory, the larger the surviving

[15] The Secretary of Defense's heavy emphasis on numerical data from Viet Nam often dictated inappropriate military tactics and strategies. As one operations officer explained, the goal wasn't to kill targets, it was to fly sorties.

number of weapons, no matter what the respective percentages of kill may be; the larger the surviving force, the less likely the enemy is to strike in the first place.

Overkill is a good phrase, but, unless one assumes that military planners and political leaders are moral monsters and strategic idiots, it is unlikely that weapons of mass destruction will be accumulated simply for their own sake. To those who believe that motives of the services are in fact tinged with moral imbecility, no analytical work is likely to appeal.

2.20 Fear of Obsolescence

A common argument against investment in technological weapons systems is the engineering maxim "If it works, it's obsolete." This is a hangover from the mobilization strategy of the thirties, and stems from misunderstanding the nature of the technological revolution in war. It is true that whatever system one deploys, it is likely that if one had waited a few years, a better one could have been constructed. If this were carried to its extreme, nothing would ever be built.

Technology is dynamic by nature. Whenever a new field of technology opens up, the people who will use it must learn how. They must be trained, and become operationally effective. In the case of aircraft there must be pilots. For space systems there must be satellite controllers.

Because of the long lag between generations of military bombers, the U.S. pilots of the B-1 and B-2 must be retrained. Because we have neglected manned space for years, military astronauts will have to be trained from scratch.

Had we waited until third-generation missiles were available before we constructed any (and had we also left the bomber force as it was), the world would not be as safe as it is today. A time comes when systems must be built, even though we know they will be obsolete in future years. Proper technological strategy will plan for such obsolescence, will seek systems of maximum salvage value, flexible enough for refit with the latest advances in technology. A proper strategy also forces the enemy to react to what you have done, so that he too must deploy hardware to avoid losing the Technological War.

The fallacy that prototypes and research are all that are needed should have been laid to rest by the experience of the French in 1939. The French army had – and had possessed for quite a long time – prototypes of aircraft, armor, and antitank weapons far better than those of the German army. The French did not have these weapons in their inventory because still better ones were coming. While they waited for the best weapons, they lost their country.

Military action must be routine; it cannot be extraordinary, planned months in advance like a space spectacular. Operational experience with a weapons system is required before operational employment doctrines can be perfected. Troops must be trained, logistics bases developed, maintenance routines learned, idiosyncrasies – and modern technological gadgetry is full of them – must be discovered. This cannot be done if the latest technology is confined to the drawing board or laboratory.

Clearly, all the above arguments doubly apply in the space era. Military space missions can only be routine when we have personnel experienced in performing them.

2.21 We Don't Need to Do Anything

Finally, we come to the quaint notion that since the stream of technology moves on inexorably there is no point in wasting resources on developing military technology. It will come of itself, without effort. This is, of course, nonsense. It is true that technology has a momentum which cannot be halted; but the direction and timing can be changed drastically. The interdependence of technology will eventually produce improvements in weapons whether you want them or not; but it does not guarantee sufficient improvement when the enemy has been devoting considerable effort to his own improvements while you have been waiting for what will come inevitably. In keeping with our analogy of the stream, those who simply drift with it will be carried along with little effort but those who swim with the current will be far ahead.

A force is at work that produces technological advances without regard to our intentions, but major specific advances in military capabilities result from deliberate human action. Technological discoveries may be self-generating in their own due time, but the timing can be speeded up. Advances not resulting from planned action cannot be fitted into an overall strategy, and often are not even recognized as militarily useful until long after they have been discovered. Although other advances are uncontrolled, their use is not.

2.22 An Illustrative Case History:

Initial deployment of GPS NAVSTAR took place in the late 1970's with partial operational capability to become available in the early 1990's, and full capability later in the decade. Dr. Francis X. Kane, Col. USAF (ret.) was one of the original planners of GPS, and closely followed its career.

First, we must note that the GPS NAVSTAR satellite navigation system will revolutionize the way the world lives and operates. Although its applications are just beginning to be understood by the world at large, they have been known and forecast by strategic analysts for more than a quarter of a century. The reasons why it has taken so long to bring about the happy marriage of concept and technology provide a case history of how hard it is to introduce advanced technology into our military forces, and indeed into our society.

Any strategy of technology has to cope with the brakes on innovation applied through ignorance, bias, prejudice, lack of foresight, and short-term special interests. The planner's task is to overcome ignorance, bias, prejudice, and lack of foresight, and to fight special interests. Only by perseverance can he capitalize on the potential of new technology. History is replete with examples of this problem. GPS NAVSTAR is only one of them: but it is the one which may yet show that the problem can be solved.

In 1963-64, under General Bernard Schriever's leadership, USAF planners conducted a top-down analysis of the relationships between strategy, policy, military requirements, and advanced technology. The study was called Space Policy and Doctrine (SPAD).[16] They studied the relationships between military functions: offensive and defensive systems, communications, weather, reconnaissance, surveillance, and navigation, on the one hand, and advanced space-based technologies and programs on the other. They soon found that our space-development program was not giving sufficient attention to space-based navigation, which, it appeared, could serve an almost infinite variety of military and civilian uses.

True, at that time the U.S. did have an operational satellite system: TRANSIT, which had been developed for the Navy by the researchers at Johns Hopkins Laboratory. The system did a good job of meeting the Navy's stated requirement: to determine the positions and locations of ships and submarines. Today, hundreds of thousands of agencies, units, and individuals, both civilian and military, use TRANSIT. The ships are from all countries, including the U.S.S.R. (to whom we provided a limited number of satellite receiver sets).

However, because of its design and performance, TRANSIT cannot be used by many others who need precise position- location information. Obviously, TRANSIT is independent of the weather. Navigators do not need to have clear weather in order to take sightings, but they do need several minutes to receive signals from the satellite and calculate position locations. Moreover, TRANSIT does not provide instantaneous read-outs (for example,

[16] We did deploy the GPS navigation system, which we discuss elsewhere.

for pilots of high-speed aircraft), and the calculations are too complex for a tank driver or a jeep driver to make, especially in rough terrain or under fire. These 'dynamic' users need a different type of system.

To overcome some of these problems, in the sixties the Navy developed a technology program called TIMATION. The objective was to develop and test orbiting clocks of unprecedented accuracy. That technology was supported by the Office of the Secretary of Defense.

At the same time, the USAF planners at Space Division together with Aerospace Corporation had developed and analyzed a new concept for a system called NAVSAT. This called for a constellation of four satellites at near geostationary orbit over the United States. One satellite was to be geostationary and the other three were to be in slightly inclined orbits, so that viewed from the ground, the three outer satellites appeared to rotate about the one at the center. These four satellites would be available at all times to navigators on the surface or in the air over the U.S.

The revolutionary aspect of NAVSAT was that the user, wherever he was, would be able to receive signals from the four satellites nearly simultaneously. He could then correlate the four signals and compute his position with unprecedented accuracy. Predictions at the time were for position-location accuracy on the order of 10 meters.

Extensive analysis was conducted to determine the number of users and examine the revolutionary effect of NAVSAT on military operations. The range of applications covered low-level bombing by fighter aircraft; high-level bombing; reconnaissance of targets with precise location known; strikes by aircraft or missiles; missile launches; anti-submarine warfare (ASW); surface-ship location; submarine navigation; amphibious landings, perhaps in remote regions; operation of aircraft from austere bases; en-route navigation by civil and military aircraft; helicopter operations; tank navigation; jeep and foot-soldier position-location; mapping; range operations; and even navigation by other satellites. There are thousands of potential users.

The NAVSTAR planners were certain that the world would unite to make a reality of that potential. Instead, the list of nay-sayers was as long as that of the users who stood to benefit from the system. The nay- sayers fell neatly into the four categories that are all too familiar to innovators:

1. Who needs it?
2. It won't work!
3. It costs too much!
4. Even if it does work and doesn't cost as much as I thought, I still don't want it.

In the Air Force's Research and Development Program, the budget for new concepts and new technologies was very small. However, a long internal struggle, characterized by numerous reviews and demands for more data, finally resulted in a funded program called simply "621B." This was a competition for concept formulation to cover military requirements, technical analyses, costs, program formulation, and organizational development – all simultaneously.

The Air Force spent several million dollars on operational and systems analyses in order to determine the military requirements the system would have to meet. Almost every conceivable military operation was considered. Aircraft operations (weapons delivery and air defense) were high on the list. Among the ground targets were bridges, airfields, transportation, and hardened bunkers. The war in Vietnam provided data on types of targets and on force effectiveness in such operations. For example, the many nearly futile attacks on the Paul Doumer Bridge dramatically illustrated the effects of inaccurate weapons-delivery systems, in spite of the efforts of experienced and dedicated airmen. The accuracy that a global positioning satellite (GPS) system would have provided would have let the pilots "drop the spans" in only a few attacks with few weapons.

Similarly, more accurate artillery fire, made possible through precise location of the Fire Control Center and individual pieces in the battery, could have produced dramatic improvements in "fire for effect."

Air refueling, rendezvous at sea, and concentration of ground forces and close air support demonstrated the utility of operating in a "common grid" and with very precise timing; reconnaissance and surveillance for tactical target location and eventual mapping with extreme accuracy would have provided that common grid.

Anti-submarine operations using a variety of sensors would have permitted accurate delivery of weapons by aircraft, surface ships, or submarines.

A virtually unique application was the potential use of the GPS system for air operations from austere bases, particularly bases in remote areas. If an airfield wasn't equipped with navigation and landing aids, GPS transponders located next to its runways would provide "differential navigation" with accuracy on the order of a few feet. This application would be equally useful for small civil airfields.

Precision location of satellites on orbit and ballistic missiles on test ranges would also be possible. In brief, knowledge of precise location and time would permeate all aspects of military operations and have equally dramatic civil applications.

It seemed strange, then, that with so many potential beneficiaries, the answer to the question "Who needs it?" was "No one." No program, whether it was the F-15 or the F-16 or a satellite system, wanted to sponsor any project that would disrupt its own plans, increase its costs, and (worst of all) give anyone else a free ride. Like many public programs which in theory belong to everybody, in practice the NAVSAT program belonged to no one. In fact, 621B was a rival for funds and a potential threat to every existing R&D and operational navigation project.

In the end, after many different lengthy field tests of NAVSAT technology, the individual and combined opposition of the services was overruled by the Office of the Secretary of Defense.

In the technical analysis, the story was much the same. The challenges were numerous. "It won't work because of ionospheric effects." "It won't work because you're in the wrong frequency band." Various distinguished groups agonized over such issues. They usually reached the same conclusion: "The theoretical analysis appears sound but there are very few data to support it. At no time did anyone say "I know the answer to the ionospheric effects" or "You should be in 'L' band because..."

The only sensible answer to these objections was the one that prevailed: to conduct tests and to collect data on technical performance and military effectiveness. Even that process was a slow one that met with constant opposition. Finally, though, R&D satellites were approved and developed; twelve were launched into orbit. Prototype receivers were built for a limited set of users: a fighter-bomber, a helicopter, a ship, and an individual foot-soldier. Literally hundreds of tests were conducted, their time and duration being determined by the four satellites' presence in the proper locations.

Satellite positions were a problem because the birds were in low earth orbit rather than geostationary orbit. If the original system design had been followed, four satellites would have been constantly "in view" over the U.S., and the tests could have been run whenever the user platforms were available. That option might have accelerated the program; nevertheless, a different constellation was used for a number of reasons, primarily survivability and power required for transmission of signals at lower altitudes.

The original NAVSAT study identified nearly 30,000 potential military users. The total number of military and civil users was and is in the hundreds of thousands. The users were classified according to their level of performance, and thus according to the kinds of electronics they needed. Obviously, high-speed aircraft, particularly fighters, had the most stringent requirements. It became clear early in the technical design phase that a combination of inertial navigation systems, GPS receivers, and computers would work in concert to meet pilots' needs. At the other end of the requirement scale were the surface users: trucks, tanks, and foot soldiers. Instead of the signals from at least four satellites, the low-speed users could do very well with the signals from three or even two of them.

Because the system was to be a global one, the users and satellites had to be linked by a ground network that would control the satellites and keep them in position. A prototype was built at Vandenberg Air Force Base. The user tests were conducted principally at the Yuma Test Range, but ships in the San Diego area were also involved. The results proved conclusively the technical nay-sayers were dead wrong.

Perhaps the biggest brake on the development and deployment of the GPS system was its overall cost. The cry "It costs too much!" went on for years. In fact, principally at the insistence of the Congress, a novel control mechanism was imposed on the program. The Congressional budget legislation stipulated that GPS had to show that it would cost no more than the money saved by phasing out other navigation aids (LORAN, OMEGA, and TRANSIT). Naturally, the sponsors of these programs had no intention of letting them be de-activated in order to pay for the GPS system. In the end, however, such a schedule was drawn up.

That Congressional constraint was followed by another, which proved almost fatal to the program: make the non-DoD users pay. A scheme was developed that involved designing an integrated circuit (microchip) that contained the essential codes. The chip would be changed periodically; in order to use the system, users would have to buy updated chips. The impracticality of this idea fortunately led to its demise.

Finally, there were the nay-sayers whose attitude was "Even if it works and I can afford it and it improves my operations, I still don't want it." Their argument was that satellites would always be vulnerable, and therefore the GPS system could operate only in peacetime. They had no intention of depending on it for military operations. To meet this objection, the constellation was changed so that the satellites were deployed in six planes, with three satellites per plane and three others on orbit. The satellites would be hardened to resist the effects of radiation. Last, three other satellites were to be procured to replace any birds that were lost for any reason, including hostilities or direct attacks.

Another set of objections came from the "guidance mafia": the people who make inertial guidance systems for ballistic missiles. Typical is a dialogue with an internationally renowned scientist who chaired an adversary group. His comment was: "Don't develop the GPS system; spend the money on inertial guidance." That resistance still remains.

The most discouraging attitude, however, was that of some of the principal users. During the early phase of the program, NAVSTAR planners made an extensive analysis of air operations in Vietnam, comparing the actual performance of weapons-delivery systems in a large number of raids with the improvement in effects which would result from GPS-level accuracy. The analysis showed not only more target destruction, but also lower aircraft and crew losses, and an overall cost reduction. When the results were released, the reaction was "You don't understand the war. We're not destroying targets. We're flying sorties and dropping bombs."[17]

Furthermore, the GPS system fell victim to the "18-month rule," of the Viet Nam War, which was our counterpart of the British "ten-year rule" that had prevailed in the thirties: There will be no war for ten years; therefore if this program takes more than ten years to develop, we can well afford to wait. The same approach held in Vietnam: If it takes more than 18 months to field the system, we won't need it. Obviously GPS would have taken more than 18 months to implement; therefore...

The long struggle to deploy the NAVSTAR GPS system culminated in another bureaucratic innovation: multi-year procurement of the entire constellation of 24 satellites. Just as it seemed the positioning revolution would finally begin, the program met another setback. The satellites were scheduled to be launched into orbit by the Shuttle. The Challenger disaster and the resulting hiatus in launches have delayed those operations for at least two years. Nevertheless, the revolution will still begin in the 1990's when the full constellation has been placed in orbit and thousands of receivers will be in the hands of the operating military forces. Civilian applications such as surveying, oil exploration, and navigation will be commonplace. Before the end of the century NAVSTAR will have affected everyone's life, perhaps in ways we can still only guess at.

NAVSTAR illustrates both the positive benefits of strategic analysis – the system was invented that way – and the difficulties that bog down or halt the actual deployment of systems relevant to a strategy of technology.[18]

Most of these difficulties stem from insufficient study of the technological process. We turn now to a description of the march of technology.

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[17]Meanwhile, the Strategic Arms Limitation Treaty requires the U.S. to use "national technical means" for verification of Soviet compliance with the treaty. According to the London International Institute for Strategic Studies, this means observation satellites, particularly the large "Keyhole" systems. The special needs of these systems are also imposed onto the design of space systems, and apparently influenced the shuttle design. The result is one more conflicting set of requirements, and leaves the design of purely military systems up in the air, or to agencies not responsive to military planners.

[18]The "overkill" argument goes in and out of fashion. In 1969 it was very much "in". In 1988 it appears to be less so, but it will probably rise again.

Chapter 3

The Nature of the Technological Process

Today's revolution in space and weapon systems technology is a result of the revolution in science, notably in physics, of a century ago. The first step was an intellectual breakthrough made during the period when Maxwell, Hertz, and Mach were making their discoveries and led to Einstein's Theory of Special Relativity. These intellectual advances were a breakthrough because they eliminated some of the restrictions imposed on scientific thought by classical principles. By proposing new theories, individual scientists established a new era in science. Several characteristics of this revolution are noted on Chart 5.

CHART 5: The Intellectual Breakthrough

- Work of men of genius.
- Required two generations before science accepted and understood the implications of their work.
- The basic advances were made over 100 years ago.
- The discoveries were in the realm of pure science.
- The time of the breakthrough was unpredictable.

The second step is a process of translating theory into a device that appears to have some usefulness. The essence of invention is the instinctive or intuitive confidence that something should work and the first rough test of whether it will in fact work. We note several characteristics of this step on Chart 6.

CHART 6: Characteristics of Invention

- A creative art.
- Exploits science, and may support science as well.
- Invention is in the realm of technology, not pure science.
- Invention can be a lengthy process.

The third step toward a breakthrough results from a decision made at the management level, be it in industry or in the military. Such a decision is based on recognition of the potential importance of the invention. The essence of the decision is to allocate resources to translate an invention into a product that is materially useful. In the military this is usually a weapon system, a major component, or a piece of equipment.

The purpose of the decision is to gain an advantage in time or strength over competitors – in the market in the case of an industrial breakthrough or over potential enemies in the case of a military breakthrough. The decisions and actions of the enemy have an effect on the decision makers who seek to achieve a breakthrough. The characteristics of this third step are shown on Chart 7.

CHART 7: The Management Breakthrough

- A decision is made based on recognition of the importance of a scientific principle or invention.
- The choice has major implications for future capabilities.
- The time required for decision is shorter than the time needed for invention.
- The decision allocates resources, and usually leads to a production decision.

In the last step the invention chosen by management is developed as a system and produced in appropriate numbers. An essential part of the engineering breakthrough is the advanced development or prototype. The construction of a pilot plant by industry provides the bridge between the breadboard model and full-scale production. The military have taken several approaches to this aspect of the engineering breakthrough. We have built prototypes of aircraft prior to production. In our development of missiles we telescoped the construction of the prototype and production into a single phase under the concurrency principle. In our space effort we had planned to create building blocks such as Dyna-Soar and Titan III booster before the manned military space program was shut down. The distinction is further blurred by development of one-time, unique systems, such as our command, control, communications, and intelligence systems, which have been evolutionary as new devices and systems have been introduced into ongoing networks and command centers. The characteristics of this fourth step are shown on Chart 8.

CHART 8: The Engineering Breakthrough

- Exploits the realm of engineering and technology, not science.
- It is a deliberate product of technology with a useful purpose in mind.
- Success in this stage is the only real addition to capability.
- Requires a shorter period than scientific discovery or invention.

This division into steps, into bits and pieces, is for illustrative purposes only. We should recognize that scientists sometimes take on the role of technologists, that technologists have made scientific discoveries, that production may require invention, and that scientists, engineers, and managers participate in the decision process. It would be misleading to try to summarize all the many activities of a multitude of individuals in complex technological relationships in four simple steps. Historical experience is complex and the four steps we have discussed are only indicative of broad areas of human activity.

Also, there is no uniformity in this process. At times, individuals have tried to stimulate closer ties between science and technology; Galileo and Newton, for instance, tried to cross-fertilize these two fields. Diesel's attempt to apply the law of thermodynamics (made possible by the high pressure steam engine) led to the invention of the Diesel engine, but the forecast that it would be the best engine for aircraft was clearly wrong.

However, our interest is in the use of science and technology as elements of strategy and conflict. Let us look at these four steps in this context. The revolution in physics that began with Maxwell and Mach led to new theories, which in turn led to independent work by Fermi and others. By contrast, the atomic bomb was the result of determined effort. The policy breakthrough in this historical example was the decision by the president to spend the large sums of money required to construct a useful weapon. It was based on recognition by the scientific community, notably by Einstein, Wigner, Szilard, and Fermi, of the practical implications of an advance in basic science.

In the case of the ballistic missile the direct relationship between science and weapon is not quite as dramatic and clear-cut as in the example of the atomic bomb, partly because war rockets are ancient. However, Goddard's initial investigations of rocket propulsion and Oberth's theoretical calculations played key roles in the German development of the V-1 pulse-jets and V-2 rockets. Here is an example of an invention being recognized and resources being allocated for an engineering breakthrough. The Germans made this decision in 1932, and chose two different approaches, rockets and jets. The first V-1 and V-2 flew about ten years later.

The German engineering work played a significant role in Russian rocket development and in our own as well. For example, both the Redstone and the Russian T-1 and T-2 used oxygen and alcohol. However, the technical paths diverged at this point. The Russian strategy was to pursue an engineering approach to missile development. We, on the other hand, chose to await an invention in nuclear weaponry to give us a lightweight, high-yield, nuclear bomb. Once this invention had been realized, we made the decision to allocate resources to our missile program and sponsored the many engineering breakthroughs in guidance, airframe construction, and reentry technology required for operational missiles.

In summary, then, we see that the atomic bomb followed the four-step pattern; however, in the missile field the division is not so clear-cut, notably because the policy breakthrough came so late that technology from other areas of research had caught up with missile technology.

In its broadest sense the term technological breakthrough applies to the entire process when it results in advances that thrust us into a new era of military capabilities. However, the term is used also in connection with limited parts of the process. A new theory may be described by scientists as a breakthrough. An inventor may describe his work as a breakthrough. The engineers working on a specific part of the problem of production may describe an advance they make as a breakthrough. This is most likely to occur when an invention is necessary for production; use of the term breakthrough has some validity because without the invention, production would not be feasible or efficient.

The key step in the process is step three, the policy breakthrough. A decision in the realm of the engineering breakthrough cannot be considered in isolation from effort allocated to steps one and two. The importance of the policy breakthrough cannot be overemphasized.

In attempting to bring order and control to the technological breakthrough, we have in the past concentrated on steps three and four in the process. We have studied management and decision procedures in more detail than the intellectual breakthrough and invention. We have brought a great effort to bear on production so that systems are made realities in a minimum of time. We consider it a major breakthrough when the time covered by steps three and four is reduced from eight years to five years. We have not made a similar effort to reduce the total time covered by the entire process.

At present, the period covered by the intellectual breakthrough and the invention cannot be reduced. This is an unavoidable consequence of our scientific and technological effort, partly because steps one and two lie outside the military sector. In their broadest sense steps one and two are the consequence of our society, and our contemporary society has not organized an effort to influence these steps. The way we approach invention has changed: in the past, invention was usually the work of an individual; today, we are making an institutionalized effort to stimulate inventions. But this change is not always productive, because it may stifle the loner and out-of-step creativity.

Once again there is much to be said for both sides of this argument. The team approach is not always superior to an individual approach to an invention. Some creative individuals cannot work as members of a team; others function best as part of a team. Furthermore, some parts of science notably chemistry, seem to require a team effort to make advances; but in the field of physics and mechanical engineering, more advances seem to be made by the individual working alone. On the other hand, there is the difficult task of interdisciplinary work. Regardless of the approach followed, it appears difficult to reduce the time necessary for intellectual breakthroughs or inventions and it is unpromising to organize according to pat formulas.

It may well be that recognition and acceptance of new theories and inventions will always require a period of mellowing, testing, and evaluation. Early dissemination of the new idea would help – provided its significance is recognized. Some say that new ideas never win by persuasion; they merely take over as their opponents die off. In any event, a new theory usually has little impact within one and often even two decades. This brings us to another aspect of the breakthrough.

From the point of view of technological strategy, our principal concern is in the time when such advances occur. The invention of a new jet engine today would not produce a new era in military capabilities as did the first jet produced by Whittle. Conversely, the invention tomorrow of a practical way of using focused energy beams as weapons would alter radically the whole sphere of military activities. Time is especially crucial in technological maneuver.

Whether the breakthrough is a surprise to the enemy or is an advance that he anticipates but cannot counter, the side making the breakthrough should plan for technological pursuit to maximize the gain made possible by the new advantage. Pursuit has proved difficult in warfare. The losses sustained in winning the battle frequently have reduced the momentum of the winner. Also, uncertainty about the conditions of the loser has made the winner act with caution.

In technological conflict pursuit is facilitated by the circumstances surrounding the breakthrough. Rather than causing losses, the technological success increases the power of the side making the advance, and success often heightens morale. The breakthrough can reduce the amount of uncertainty about the enemy's technology position.

These circumstances point out clearly that significant technical advances must be exploited. The concept of pursuit has a valid role in technological conflict. This is well-illustrated by Soviet space activities. Once they achieved a clear advantage over us in space they engaged in a form of pursuit to negate our attempts to make any advances in this new arena of conflict.

Moreover, this advance was used as the basis for maneuvers in other forms of conflict. In 1961 the Soviets broke the "gentleman's agreement" on testing nuclear weapons in the atmosphere, and then prevented the "neutral" powers from criticizing them. This advantage in another aspect of the technological conflict is an example of technological pursuit.

The full consequences of the Soviet decision to ignore the spirit of the 1972 ABM Treaty and go ahead with ballistic missile defenses while simultaneously improving their ICBM force and greatly increasing its numbers, were not recognized until 1983. The expansion of Soviet ICBM capability may have been one of the most crucial moves of this century. After 1983 the US began the painful process of catching up, but we have not yet done so.

Pursuit is not the exclusive province of the aggressor. The defender should plan on pursuit when he has acquired an advantage over the aggressor. Up to the present, we have yet to engage in pursuit to overcome the Soviets. On the contrary, we have halted short of using our superiority in aeronautics, nuclear weapons, computers, or missiles to cause the Soviets to modify their goals, strategy, or operations.

As the side on the defensive, we have one advantage which comes not from our technological strategy but from our resources. That advantage is mobility. We can change the priorities of our efforts and counter new threats as they appear. The richness of our technology makes this mobility possible.

(This was amply illustrated in the SDI program, where we were able to investigate a number of alternate approaches to ICBM defense. Unfortunately, we have not done as much to exploit these advances as we might.)

The crucial problem is to meet the threat on time. This is especially vital for us because we are on the defensive, have never tried to achieve surprise, and have never engaged in technological pursuit. The Soviets need not be as concerned about the time dimension of technological conflict, since they know that our goal is to maintain the geopolitical status quo and not to overthrow the Soviet *nomenklatura*. Thus, our advances pose threats only to their near-term goals abroad, and never to their security at home.

3.1 U.S. Policies and Technological Progress

As we stated in the last chapter, the United States has no overall policies with regard to technological development. In part this is due to the decentralization of technological resources in independent private industries, and is a benefit to our overall progress. Unfortunately, we have no policy or strategy at the governmental level, although paradoxically we do suffer there from overcentralization of the decision process. However, our central decision makers are not guided by strategic considerations and projects are related to each other mainly through budgetary actions. Various projects have their goals and we make extensive efforts to relate projects to each other, but the relationships do not come from a felt need to execute strategy. Without strategy, there is no mechanism for integrating goals, tasks, and priorities, and there is no criterion for the weighing of risks and costs.

Our technological effort is guided to some degree by conflicting policies. For example, we assert frequently that we are advancing along a board front. Also, we minimize direction and control, for in that way we assist progress. Consequently, innovation and invention are where we find them; we abhor invention on schedule. From the point of view of Protracted Conflict, however, we do not have an integrated technological strategy.

We do have budgetary controls. Each project is made to compete for funds, generally on the basis of the skill of its managers in playing financial and political games and the persuasiveness of its supporters. This is probably inevitable in a democratic society, but the results are sometimes bizarre. Projects are often assigned to different regions for purely political purposes. At one time the U.S. Air Force found its technological resources scattered from Boston (electronics) to San Bernardino, California (ballistic systems), and managers of crucial Air Force space projects still spend as much time on airplanes as they do at work.

These are some of the major restraints we face in regaining the commanding lead we once held. There are others. Some lie in our technology itself: although technological research can be directed and certain lines of research emphasized, there are limits. The first jet could never have been produced in 1900 nor the first atomic bomb in 1915.

Another restraint is the technology base. The space systems now in operation are an outgrowth of our missile technology. We have, in the past 20 years since the first edition of this book, begun to recognize the importance of technological building blocks, and have constructed some of the necessary facilities such as environmental laboratories on earth and underseas, although, except for the very temporary Skylab we failed to build a manned orbital laboratory.

Considerations of strategy impose still another restraint. We must have at all times the in-being force necessary to win wars. This means being ready for operations at every moment in the foreseeable future while providing simultaneously the foundations for major advances in future capabilities. These are requirements that compete for resources. Our in-being capability is not static; we cannot allow it to dwindle or become obsolete. Thus, modernization of our forces must be continuous but it cannot detract from having sufficient power at any given time.

This restraint is compounded by a third restraint, which is financial. There is an upper limit on what we can expend to advance technology in general and on what we can allocate to develop specific systems. For example, no amount of money spent in 1935 would have given us our first ICBM. Unlimited resources in 1950 would not have give us Apollo 11. In attempting to achieve a technological breakthrough we must reckon with restraints imposed by funding.

These restraints have their greatest impact on step three. In the policy breakthrough, the attitude toward technology plays an important role. If decision makers are convinced that advances occur automatically, if they believe that contemporary technology can give us at any moment an unexpected but major advance in military capability, they will be restrained from taking effective action. Such an attitude makes them reluctant to choose a weapon or warfare system to be developed and produced because a breakthrough would make it obsolete and unnecessary.

A belief in millennium tomorrow is based on the unstated assumption that advances come automatically because of the nature of our present environment. From a cursory glance at past breakthroughs it should be apparent that they are the result of deliberate human action, that is, a combination of goals and work to attain goals. Nevertheless, the result of this attitude is a belief that choices are unnecessary because advances are spontaneous.

Another aspect of this step is a seeming paradox. The decision maker, while awaiting a technological breakthrough at any given time, feels he is suffering from an embarrassment of riches. As he faces the choice of a course of action he sees so many ways to proceed that he finds it difficult to choose any one of them. Furthermore, the rate of advance makes him hesitate. For if he chooses, he may soon find that the system selected has been made obsolete before it is usable.

These aspects have important repercussions. The first is that they delay decisions. Secondly, the decision makers press the military planners to examine minutely the entailed decisions which spring from the courses of action possible. Additionally, they press them to forecast with certainty these anticipated effects. A recourse to science is the planner's response to such impossible demands.

Here we should note another paradox in this process. The scientist and technologist are responsible for advances in knowledge and in applications. Authority in these fields does not per se provide insight into what is either commercially or militarily useful. The management level in industry uses scientists for technical advice but does not depend on them for managerial decisions. However, in the military, management procedures are designed to have scientists participate; thus while individual scientists can initiate an advance other scientists can restrain the project.

Past attempts to put more objectivity into our decision making by considering cost-effectiveness and by using computers for war games had only a limited validity. They contain an inherent danger because the results are inevitably biassed, even forced, by the assumptions governing the game. If the simulation designers do not recognize crucial factors, those factors will have no effect on the game results. The main decision is still that of a choice of strategy which, in turn, must reflect an assessment of the enemy's strategy.

Many strategic considerations do not lend themselves to computer simulation, because they cannot take into account all the relevant factors. As an example, in the computerized war game situation the surprise element is usually not considered and, therefore, a basic distortion may be introduced. Modern computers are useful to determine patterns and to help in visualization, but they don't substitute for the strategist.

The challenge is to create and execute a technological strategy. Technology should be the servant of the strategist, who must be a thorough student of strategy and its history.

The weapon system as such is not the goal of technology. The weapon system is the tool of the soldier or of the man carrying out a selected strategy. This is true even of push-button weapons. Conflict occurs between men or between societies.

3.2 Technology and the Economic Base

Technology develops faster than the economic base. This elementary fact prevents us from taking advantage of all technological possibilities. Technology grows according to geometric progression, whereas the resource base grows, at best, according to an algebraic progression. Sometimes it even retrogresses. Included in this resource base is the human factor, and that may not grow at all.

The heart of the matter is not just a question of inventiveness and organization of the scientists or the scientific base. It is the optimal utilization of economic resources and the proper integration of the technological, economic, and strategic resources. This integration is essentially a two-way street. The strategist must be able to request technological solutions for his problems, which can range from space warfare to propaganda. But in turn the technologist must tell the strategist what the potentials and limitations of his strategy will be.

3.3 The Technological War General

In technological warfare, generalship is the key to success, as it always has been in every conflict. The difference today is that generalship on the battlefield is perhaps less important than generalship exercised many years before a battle is joined. This is especially true of the generalship that goes into the design and development of weapon systems. The general who wins the battle is usually the man who held decisive control ten years before the fighting started and who, at the moment of battle, is either dead or retired.

Note that this applies equally to Commanders in Chief, and behind them to the Congress. Andrei Gromyko has met fourteen American Secretaries of State during his tenure as Soviet Foreign Minister. Cyril Korolov commanded the Soviet space program for a considerable period of time. The Soviet tyranny, by its nature, has the advantage of being able to make and keep long range plans. An American President, by contrast, must spend money and make unpopular decisions that bring results during the administration of his successors. The temptation to let the future take care of itself is intense.

Technological generalship must anticipate strategy, tactics, and technological trends. It must develop weapons, equipment and crews. Such developments must be anticipated in advance of trends.

Generalship in battle still is of great significance, especially because of the surprise element in modern war. Here the general must be the man who can get the maximum performance out of the systems he actually possesses.

He must have an inventive mind, to carry out modifications that become desirable. If he cannot overcome a technological lead by the opponent he must be able to devise tactics or stratagems to carry out his mission despite technological inferiority. While not necessarily a battle leader – although battle leaders are still required – he must be a great thinker. He must have full knowledge of his weapons systems and those of the opponents. Finally, he must be able to think through the lessons of the battle, even as the battle is being fought.

Implicit in this description of generalship is the assumption that the leader is striving to reach selected goals and that he is using initiative in his actions. Our technological strategy of the future must try to take the initiative in a selected field and to defeat the Soviets clearly on as many occasions as possible. For example, there is no reason why guerrilla warfare and counterinsurgency should be their exclusive domain. Technology can make it possible for us to contain them in these forms of conflict as well as in nuclear war. Fortunately, as the lessons of Vietnam were learned we have devoted some attention to the technology of people's war.

3.4 Conclusion

The U.S. goal is to make the Technogical War remain an infinite game; one which will never be "won" in the sense that one side eliminates the other through armed conflict, especially nuclear war.

The challenge is clear. We are engaged in a conflict for technological dominance. The center of our power position is threatened by the Soviet drive to surpass us and become superior. While the relative technological position is important to political, economic, diplomatic, and psychosocial struggle, it is vital to military conflict.

Superiority in military technology is the prerequisite of strategic success. This is especially true in the era of aerospace nuclear warfare, when a surprise attack made possible by an unexpected technological advance could lead to sudden defeat of the seemingly strongest power. The danger is especially acute in the current period when expanding technology can be used to implement aggressive ideology. In spite of the richness of U.S. resources, two resources are neutral: time and will. The time advantage goes to the one who has the will to grasp the initiative.

In order to use time successfully, we need an integrated technological strategy. Such a strategy will require basic changes in American organization and decision-making processes. To survive, we have no choice but to pioneer.

THIS PRINCIPLE HAS NOT CHANGED. [1997]

Chapter 4

Strategic Analysis

In war, the morale is to the physical as three is to one.
–Napoleon Bonaparte

In Technological War, organization and leadership is to the morale as six is to three.
–Possony, Pournelle, and Kane.

The starting point for strategy must not be that which is possible; we must discover what is necessary and try to achieve it.
–General d'Armee Andre Beaufre

Note to the Second Edition: The first edition of this book was part text and part polemic: the strategic situation in 1969 was at a low ebb, and the threat from the Communist Empire was large and growing. Since that time there have been some beneficial changes. The United States began to take seriously the Technological War. Although the Soviet Union continued to engage in Technological War, the US stayed just far enough ahead to prevent a decisive advantage. The Reagan Administration shuttered the Communist 'window of opportunity', while internal stresses within the Communist Empire continued to grow.

The small computer, itself a fall-out benefit from military research and development (for on-board missile guidance systems), had a near decisive impact: a power without computational resources in an era of "computational plenty" suffered a great handicap. On the other hand, it was impossible for the Soviet Union to introduce the small computer and maintain the management and control of information. Arthur Koestler pointed out in 1946 that the necessary and sufficient condition for the end of totalitarian tyranny was the free flow of information and ideas within the totalitarian society. The small computer, as the ultimate instrument of samizdat, makes information control impossible.

The Soviet Union was thus presented with an impossible set of choices: introduce modern technology, and thus inform the Soviet population of the true conditions both abroad and within the Empire; or suppress that technology, and forfeit its benefits.

Brezhnev chose the latter course. Andropov and his protégé Gorbachev, possibly because as KGB officials they were acutely aware of the internal problems of the Empire, chose the former. The repercussions of that decision are nowhere near over: as we write this, there are riots in Bohemia, and a new Prague Spring – if not a new Defenstration of Prague – appears likely.

The other key decision was the U.S. venture into SDI: that is, a decision to open a 'second front' in the Technological War. This intensified the dilemma described above.

As a consequence of these changes in world circumstances, much of the specific analysis in this and other chapters is no longer applicable. On the other hand, the principles on which that analysis was based have not changed one whit. Winning the Technological War is as vital as ever: we must not forget that *perestroika* and *glasnost* are not acts of kindness, but strategic decisions which allow the Soviet Union to continue its efforts in the Technological War.

We have partially revised the text in this chapter, but much of it remains as it was written in 1968-69. We wish to repeat: circumstances change, but principles do not; and if some of our text now appears to rail against problems already solved, we hope the reader will recall that this book played its part in solving them. STP, JEP, & FXK, Fall, 1989

As we have repeatedly stated, the Technological War must be fought as are other wars; that is, it must be fought according to a strategy. A general who simply muddles through, overcoming each obstacle as it comes to him, fighting battles at the dictation of the enemy, and preparing only for battles already fought would soon lose the war. Yet, too often it is thought that the Technological War, which may be the most decisive engagement in the history of mankind, can be fought with precisely this technique. Technology is made the driving force, dictating to strategy; and strategy is conceived of as the employment of systems already created by the technologists, that is, strategy is confined to operational decisions. This is akin to allowing the munitions manufacturer to decide the conduct of the war.

Proper conduct of the Technological War requires that strategy drive technology; that there be an overall strategy of technology, not merely strategic elements which make use of the products of technology. Instead of the munitions designer controlling the conduct of the war, it must be in the hands of those who understand technological warfare; and this requires that they first understand the nature of war.

Lest we be misunderstood, we wish to underscore the following point most forcefully: we do not say that scientists must somehow create a strategy for technological development. Nor do we advocate turning over the conduct of the Technological War to the average flag officer or captain of industry.

This is in fact the source of one of the major weaknesses of the West in the Protracted Conflict: there are very few experts in technological warfare. It is hardly surprising, for there are few senior people in the United States who have ever studied strategy, and fewer of those have turned their attention to a strategy of technology.

The first edition of this book was used as a text in the War Colleges and two of the service Academies, so that at least some of the officer corps has been exposed to the concept of a technological strategy; but there are no universities teaching technological strategy or the essentials of it, and there are few apprenticeship programs.

A Brookings Institution study recognized a facet of this problem, pointing out that the senior service schools were teaching officers how to "manage' but not how to understand, let alone develop, strategies and fight wars. This is being partly overcome by programs such as the USAF "Warrior" and the National Defense University computerized war games, but we have a long way to go.

One of the problems of the United States is our quaint belief in the administrator, our belief that a man capable of governing a large automobile company will be a good strategist and can safely be entrusted not only with the titular leadership of the services but with a dictatorial power over them extending to the silencing of all verbal opposition. We have coupled this promotion of administrators or executives with a tendency to centralize all decision processes, particularly those involving budgets and funding. These beliefs were the major architects of our defeat in Viet Nam. The problem is not trivial.

4.1 The Creation of Technological Strategy

To illustrate what is meant by a strategy of technology, we will trace the steps in the creation of military technology; and we mean by military technology those systems which are used in the Technological War, not merely weapons. Laboratories are an obvious example of tools of the Technological War that are not weapons. Others could include logistics systems; civilian hardware useful for the nation building mission; irrigation systems and sea water conversion plants; agricultural techniques and equipment. The list is endless.

We also wish to emphasize something very strongly: we are not proposing the creation of new layers in the decision process. We do not intend this analysis of organizations for rehumanizing strategy and generating a strategy for the Technological War to be taken as recommendations for creating new organizations for solving the wrong problems, and new structures to be added to the old.

What is needed is a fundamental restructuring of the entire decision process to allow government of the Technological War according to a strategy, rather than by a series of independent technological or scientific decisions. Once strategy governs the decision process, many of the present delays are likely to vanish. They must be made to do so. Time is the most important dimension of the Technological War, both to maintain the necessary lead and to save money.[1]

4.2 The Elements of Technological Strategy: An Overview

The elements of technological strategy are shown on Chart 9. It will be seen that the heart of the process is something we call strategic analysis. In other times this was called War Plans; for the Technological War the scope of analytical work must be broader than that of the old War Plans division of the European General Staffs. Strategic analysis is a process which generates a plan: it seeks the proper use of available and future weapons of the Technological War, orchestrates them, and produces the actual engagements. These may take the form of research plans, hardware construction, intelligence operations, or even military battles. The latter are unlikely in a Technological War until one side has achieved a decisive advantage.

At the top of the structure is the political leadership of the nation. This element makes resources available, particularly funding. It sets the grand strategy of the nation – that is, whether the nation is to go on the offensive or defensive, be expansionist or static, be interventionist or isolationist, and so forth. In addition, the political leaders must support the personnel engaged in

[1]The first edition of this book proposed a number of changes in decision structure. Some of those were made in the 1980's.

Table 4.1: CHART 9: Strategic Analysis

<table>
<tr><td rowspan="4">Strategic Analysis</td><th>Government Support</th><th>Technology</th></tr>
<tr><td>• Leadership
• Budget
• Grand Strategic Decision Process
• Public Morale</td><td>• Science
• Research
• Engineering
• Production
• Management
• Procurement
• System Analysis</td></tr>
<tr><th>Non Military Conflict</th><th>Military Arts</th></tr>
<tr><td>• Psychological Operations
• Economics
• Trade
• Diplomacy
• Internal Security</td><td>• Strategy
• Intelligence
• Counterintelligence
• Logistics
• Operations
• Command
• Military Analysis
• Non Violent Warfare</td></tr>
</table>

the Technological War. It must be concerned not only with the morale of the technological soldiers but with the nation at large, justifying the necessary expenditures, explaining the purposes of each approach taken, and combating indifference and defeatism. Unless the political leaders properly perform their mission, the Technological War cannot be won.

The second major element in the creation of a strategy of technology is what is called the military arts. This includes subelements such as commander, strategists, and intelligence personnel. They must understand the significance of the moves made by the enemy in the Technological War, and formulate strategies for overcoming them. For example, if the enemy decides to engage in warfare, open or covert, at a level of hostility where the United States is weak, the military strategists must have available contingency plans for changing the nature of the war, either through controlled escalation or otherwise, to a kind of war in which we dominate. The military strategist must have an appreciation of our capabilities and limits as well as those of the enemy, and he must continually revise his estimates of what modern technology can accomplish.[2]

[2]This process has in part been implemented since the first edition of this book. The result is known as competitive strategies.

nologists, both scientists and engineers, obviously are essential to the Technological War at this point. Through independent research, they create new technology which may or may not be useful in the conduct of the technological conflict. They discover scientific laws and principles which may be exploitable as military or nonmilitary weapons. They should be guided in their research by the requirements of the military, by the military roles and missions that require improvements or that have been conceived of but cannot as yet be performed.

Others will be engaged in pure research which may or may not be useful in the Technological War but is beyond the charter of the strategist to direct or control. However, while we recognize the value of pure research, such as that carried out by Einstein and Fermi, we note that the creation of military technology from their physical principles was the result of a directed effort. We do not advocate over-control and micro-management of the research process and scientists in projects funded by DOD; however, some direction and control is necessary.

Modern technology is fluid; often specific items of technology can be created on demand through focusing of effort. The Soviet Union employs this method consistently to preserve resources, and has achieved many notable successes despite a paucity of reserouces compared to the West. In the United States the development of the hydrogen bomb, a key event in preserving the freedom of Western Civilization, was largely the creation of a focussed effort despite the fact that it was unwanted by many scientists, some of whom believed it unfeasible.

We want to be understood clearly: scientific research and discovery are in large measure products of free inquiry and human freedom. This fundamental point has been confirmed in a dramatic manner by the performance of the U.S.S.R., which depends to a surprisingly large extent upon the pure science produced in the Free World, but which, within the limits of its capabilities, has had an astonishingly good performance in the military applications of scientific discovery.

No one can predict the ultimate use of any research in any of the pure sciences. Except for navigation, astronomy was of no military use before the space age. Yet the mathematical techniques developed by the astronomers to solve the four-body problem helped to overcome one of the greatest difficulties in antiaircraft defense. Therefore, as a general principle, no scientific investigations should be starved, let alone suppressed. However, those researches that appear to have no strategic utility and most probably will not be useful for several decades surely need not be accelerated or be given priorities – even though they may be of extreme utility in the next century. It would be entirely sufficient to allow such work to proceed at a normal pace.[3]

s that many lines of basic research can be safely regarded as of great strategic importance, even though we may be unable to predict specific applications. For example, the steady exploration of atomic particles may, in the end, yield no strategic value, but the overwhelming odds are that a better understanding of the structure of matter will result in entirely new tools and materials. Discoveries in medicine, biology, psychology, and agriculture could have massive impacts on strategy.

Hence we believe this to be a matter of common sense: first, to support particularly those lines of pure research which promise an early strategic payoff; second, to regard technology as a task and end-product of all sciences; and third, to devote far more time and resources to analyzing research discoveries from the point of view of their possible strategic utility. In other words: do not hamper any research; support heavily research that has a predictable payoff; and reduce uncertainty concerning the military and strategic usability of scientific discoveries.

Note that the ordering of priorities is itself a strategic decision. When the threat is small and waning, one wished to allocate resources to technologies which may not mature for many years; when the threat is large and growing, technologies of more immediate application are needed. These are not scientific decisions.

The technological community has several duties. These will be discussed in more detail in later sections. For the moment, they can be summarized as shown on Chart 10.

The final major source of technological strategy is the nonmilitary conflict expert. The traditional elements of this community, namely, the diplomatic corps, foreign aid experts, propaganda and psychological warfare experts, and economic warfare practitioners, have a self-explanatory role. The important point is that this group cannot be ignored; and perhaps even more important, they cannot operate in isolation. Trade agreements, diplomatic negotiations, and political alliances are extremely important facets of Technological War, and the efforts of those engaged in these aspects of the Protracted Conflict must be coordinated according to a strategy. It cannot be stated too strongly that the Treaty of Moscow and the whole test-ban affair was a great Technological War victory for the U.S.S.R. To a lesser extent, U.S. trade policies have also been Soviet victories in the Technological War, in that they have allowed the Soviets to concentrate their scarce technological talent on mili-

[3] Times change, of course; what was 'far out' in 1969 became vital in 1980. In the chapter "Assured Survival" this book in 1969 advocated strongly focused efforts into 'beam technologies'. That research paid off handsomely after 1983; but note that beam technology is only one of the means for constructing viable missile defense systems.

tary systems in the confident expectation that the West will sell to them the technology and technological products the rest of their economy requires.[4]

This section has been an overview of the creation of technological strategy. In the following sections, we turn to each contributor in detail and trace the development of new weapons systems.

CHART 10: Duties of the Technological Community

- Providing Strategic Analysis with new possibilities.
- Developing specific systems from military requirements.
- Creating technology on demand.
- Creating technology from pure research.
- Discovering new fields of technology.

4.3 The Creation of Military Technology

In this analysis we have divided the creation of technology into three phases but we caution the reader that their linear form is in part illusory. Many of these functions are carried out simultaneously, and it is not necessarily true that all systems will pass through all stages we have shown. However, it will be helpful to trace all steps in the process, keeping in mind that this is not intended to be a recommendation for new delays in decision making. We do not insist that each technological creation go through these steps in succession.

In the discussion that follows we are attempting to show the kind of analysis which should be followed in order to coordinate technology with strategic planning. This is in no way a description of the actual steps taken in present

[4]This situation is essentially unchanged in 1989; the USSR expects *glasnost* and *perestroika* to produce internal changes, but also to induce the West to loosen up restrictions on both strategic goods and credit. While it is important to "give Gorbachev a chance" it is also vital that we don't preserve and increase Soviet military power. In the 1990's Trade policy has become the key front for the Protracted Conflict. [1987]

The decisive moment was when Reagan refused to abandon SDI at Gorbachev's request. This threatened to make obsolete the extremely expensive missile establishment of the USSR; the cost of refurbishing that system to make it viable in an era of strategic defense was unthinkably high for USSR planners. The alternative of using it before it became obsolete was no more attractive due to NATO readiness (although there certainly were advocates of a 'take Europe now' policy within the PolitBuro.)

weapon system design; indeed, as demonstrated in earlier chapters, we argue that at present there is no automatic review of technology to determine its relationship to the overall plan of action in the Technological War. Instead, decisions are made at present on the basis of technological or scientific factors, and usually by scientists.

> Circumstances change: in 1989 this is no longer true. Now decisions are made largely on the basis of cost, with a heavy dose of political pork barreling from the Congress. There is, however, some appreciation of the need for a technological strategy, and to that extent the situation is much better now than in 1969.

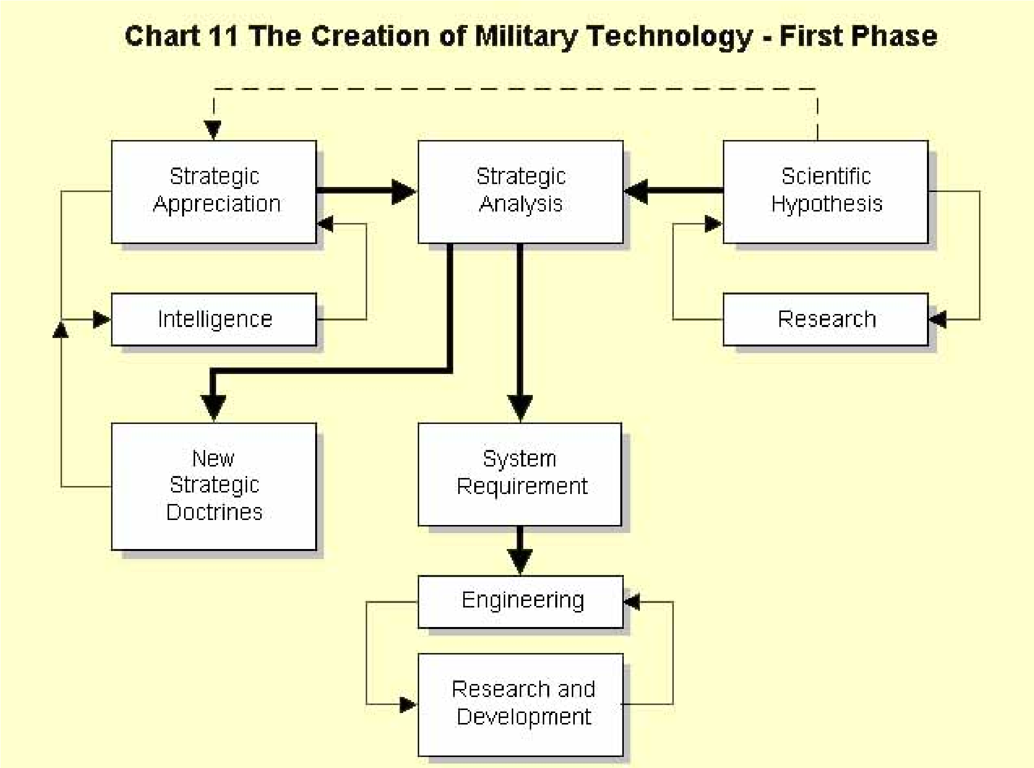
4.4 Phase 1

The first phase of the creation of military technology is shown on Chart 11. It begins with a strategic appreciation. This was once part of the intelligence process. In the 1960's and 70's the intelligence community was largely confined to the provision of data and descriptions of foreign technology to policy makers. The policy makers were generally civilians with little experience in the conduct of war, and rely on staff assistants for advice. The reorganization of the services divorced the top military staffs from direct participation in the operation of the services themselves, which are organized into commands and function as nearly self-contained structures under the direct orders of the Secretary of Defense. During the McNamara era the Plans and Doctrines departments of the various military service headquarters were thus required to compete for the attention of the civilian policy makers who alone have the authority to implement changes in the organization and structure of military forces.

For much of the 60's and 70's there was thus no organization in the United States whose mission was to prepare a strategic appreciation. This serious defect in our national policy machinery, but was not likely to be observed by the average civilian official because strategic appreciation had nearly become a lost art; and one does not feel the need for something he has never seen or known about.

Prior to the McNamara Era, the JCS had the responsibility for strategic assessment, but that role was eliminated by the civilian 'Whiz kids' he brought into the Pentagon. The role is being restored under the Goldwater Act.

All military technology should begin with strategic appreciation. Unlike an intelligence report, an appreciation takes into account our own resources



and weaknesses, enemy objectives and intentions, our own goals and policies, and alternatives available to us. It provides an estimate of the situation, and a prediction of the outcome of the engagement if existing trends continue.

As are all military assessments and decisions, strategic appreciation is an art. It is more than what an economist or physicist would call an analysis or evaluation. Strategic appreciation requires a feel for events and trends which can be gained only from historical knowledge and experience of the proper kind; and that experience must include living in an environment in which one is constantly aware of the opposition of an intelligent enemy. Business and scientific expertise are not enough; almost every skilled generator of strategic appreciation is a military officer of long service, although not every senior officer is capable of an appreciation of the situation in the Technological War. One excellent example of an officer who possessed the talents required for this work was General Bernard Schriever, whose work in generating Project Forecast and Project 75 has been noted throughout this book.[5]

[5]The era of computational plenty has had many beneficial effects, but it has one major drawback: if not careful, one can easily exaggerate the accuracy of computer predictions. The output of a computer analysis is really no better than the understanding of the

The strategic appreciation provides the strategist with an estimate of the probable outcome of present trends, and allows him to form judgments about the future requirements and capabilities for military technology. It thus forms the first element of strategic analysis, but by itself it is insufficient. The second element comes from the scientific and engineering communities in the form of possible or probable developments in the world of technology.

It is important to note that scientists and engineers will in general produce fundamentally different kinds of inputs. Scientists' reports will generally be given as scientific hypotheses, and insight and experience on the part of the strategist are required to see the implications in terms of new weapons systems capabilities.

Engineering reports are generally more concerned with short term problems, costs, and schedules. The technologies they advocate will have less scientific uncertainty – you can be fairly sure they can build what they say they can – but will also tend to be less imaginative if more immediately practical. Determining wheter to invest resources in science or in engineering development is one of the key decisions of the technological war. For example: the scientific work of Arthur Kantrowitz at the Avco/Everett Research Center, was crucial to the development of the continuous wave laser. Kantrowitz was dismissed as a dreamer by many in the aerospace community, who claimed in 1960 that lasers would never be practical military weapons because they could never be made more than 5

Technology will have two distinct impacts on military systems: it will identify new uses for our own systems and suggest new capabilities that would be desirable for the force; it will also postulate potentially new enemy capabilities against our force, generating new requirements for ourselves and changing the predicted outcome of future battles.

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programmer who built the analytical model; and since even today's computers can't understand history and economics and leadership personalities, they output of a computer simulation isn't likely to be an accurate prediction of world events. As an example, a popular computer game called "Balance of Power" is often used in university classes on foreign relations, and has been used in the Foreign Service schools. This game ignores economics and trade, and is largely "won" if the U.S. player pursues a policy of appeasement vis-à-vis the 'implacable' Soviet Union. Nothing the U.S. player can do will make fundamental changes within the structure of the Soviet player's empire. Balance of Power is an amusing game, but it is a pernicious instructor in real-politik. [1989]

We note that had the US followed the precepts of that game—which was based on the principles then taught by the Department of State—the Seventy Years War or Cold War would still continue. [1997]

4.5 MIRV: An Historical Example

Note to Second Edition: After extensive debate, the United States under Nixon decided to deploy MIRV, Multiple Independently Retargetable Reentry Vehicles. This was a key event in the Technological War. In 1969 when the following was written, that decision had not been made, and there were strong advocates against MIRV deployment: that it should either be left as a pure R&D effort, or abandoned altogether.

Fortunately the U.S. continued MIRV development and actual deployment. If we had not done so the consequences would have been extremely serious.

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As an example, the implications of MIRV have an impact on both offensive and defensive systems. If MIRV is installed only in offensive weapons, this technological development can allow the utter destruction of a second strike force before it is launched, without the attacker having to deploy any new missiles. An aggressor could thus construct a full first-strike capability in his territory without doing anything observable by satellites or radar. As no intelligence organization in the world can guarantee that a potential aggressor is not altering the warheads of its existing force to take advantage of MIRV technology, MIRV poses a distinct new threat to U.S. missiles, and thus to the survival of the nation.

MIRV also has the effect of multiplying the capability of the surviving boosters in a second-strike force, by allowing each surviving missile to destroy more than one enemy target. It could, therefore, aid the defense as well as the offense. The actual changes in the strategic equation are dependent on additional factors, in particular the improvements of the yield-to-weight ratio of nuclear weapons (lighter weapons with a bigger bang allow installation of more MIRVs in a given booster), and improvements in accuracy (the more accurate the MIRV, the better chance that the second-strike force will be destroyed completely). In contrast to MIRV, extremely high accuracy of intercontinental missiles chiefly aids the offense: that is, great accuracy is not needed to destroy a city, but accuracy improvements allow the first strike to eliminate a greater proportion of the defender before he can launch a counter blow.

> A current example would be the debate over strategic defenses. SDI forces both sides to stretch their technological resources to the limit. This is clearly advantageous to the U.S. because we have more technological resources: SDI deployment at the very least forces the USSR to spend its resources refurbishing its Strategic Offensive Forces rather than adding new capability to the SOF. They probably cannot afford to do this, which forces the Soviet leadership to decide whether a large and expensive SOF is needed at all. (1987) It is now clear that the above analysis was correct. (1997)

The strategic analyst must understand the implications of new technology, and the uses to which they may be put in both the Technological War and the Protracted Conflict. His analysis must extend beyond such obvious areas as improvements in missile guidance and accuracy to more subtle developments based on new scientific principles. He must also be ready to exploit fallout benefits, such as small computers.

The strategic analyst also uses the strategic appreciation to guide research efforts. From military requirements for underseas warfare capabilities, the technological community may be encouraged to do research in oceanology, particle propagation in dense media, measurement of cosmic ray backscattering, or examination of surface phenomena. Research budgets will to a great extent be controlled by the priorities for new technology set by the strategic appreciation.

However, it bears repeating: only a fool would so trust his own judgments as to cut off lines of research sponsored by competent scientists who believe themselves on the threshold of new principles or new fields of scientific endeavor. Research programs must always hedge against improper judgment or faulty analysis, but they must not be allowed simply to proliferate according to the specialties of the scientists who happen to be employed.

In fine, a technological "center of gravity" must be chosen, and research priorities allocated around it, so that most of the programs contribute to, or are designed to make use of, the advances in the chosen field of emphasis. Research in unrelated fields is good insurance, and should be carried out; but no one spends the major part of his budget on insurance to the detriment of his own plans.

The strategic appreciation and the technological state of the art are then analyzed in the light of the requirements of the other members of the Technological War community. Restraints imposed by political authority and diplomatic necessity must be considered, while, equally importantly, the effects of those restraints on the Technological War must be made clear to policy makers. There are times when diplomatic policies can be overcome only through enormous technological effort, such as in the case of the Test Ban; in these instances, policy makers should at least be made aware of the problems involved in the policy so that they will know their true costs to national security as well as their benefits.

When the restraints have been set and the requirements for the force understood, a technological strategy can be generated. It must plan for maximum strategic surprise, and incorporate planning for technological pursuit. It must plan for real options as well as paper options – that is, for systems that can be built and deployed as well as those that are only theoretical possibilities dependent upon the success of high-risk research and development. The strategic plan must provide for flexible systems which can incorporate new technological developments expected in the near future, and for defense against possible enemy capability improvements.

This analysis will generate a set of military system requirements. These will be brief descriptions such as "a general-purpose offense-defense missile system capable of using many elements in common for both missions. The offense system should have intercontinental range, and the defense system should be capable of interceptions in either the upper atmosphere or mid-course flight at ranges of at least 800 miles from the interceptor launch site." It is, in other words, a strategic system concept. In a real world case, the performance requirements would be defined more rigorously but not in detail. The strategic analyst is concerned with establishing a requirement, not with the actual design of technology.

> We understand that the requirements process is more complex than this. The requirements game is also used as a primary way to suppress promising lines of research and development.

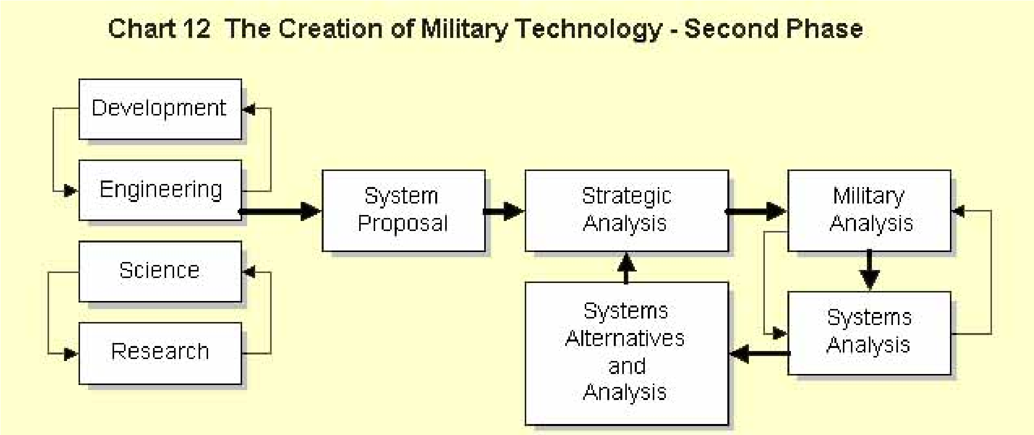
The system design description is turned over to the engineers and technologists for implementation. Some performance features can be implemented with off-the-shelf hardware. Others require new developments in technology. Research will be required to provide a system design. This, however, is directed research to solve specific problems and provide specific technology building blocks to achieve the desired system performance. The engineering design team will also generate a series of estimates of system performance traded off against time and money; that is, an estimate of how long and what cost will be required to achieve each of several different levels of performance. Often this will be accompanied by proposals for alternative approaches to solve the technical problems. These estimates are returned to the technological strategist for decisions.

The decision as to which of several competing technical approaches should be used, or whether to spend the time and effort to achieve a particular level of performance instead of using cheaper methods to build systems of less value, will be one of the most important decisions in the life of the weapon system. Such decisions should be made with due regard to strategic necessities, not merely their scientific elegance. For example, a strategist may require an operational system within a certain period to assure national survival; the possibility that a greatly superior system will be available at a later date may be interesting, but it is irrelevant. He may also be able to restructure his existing forces to provide a stop-gap defense which will carry him over to the period in which the more advanced system will be available, or even decide to abandon the system altogether in favor of a different method of achieving security. The point is, those are strategic decisions, in which technologists and scientists participate only as generators of information, not as part of the policy-making process.

Decisions at this stage must often be referred to political authorities at the highest level. When this is done, the strategic analyst must be able to provide them not only with an understanding of the cost-performance tradeoffs but also an appreciation of the strategic necessity of various performance levels and an estimate of the magnitude of future demands for resources.

In any event, such crucial decisions should be made at a level where there is likely to be an understanding of problems of national security, not, as was the case in the McNamara era, by low-level civilian scientists who have never been faced with real military decisions. The economist in the Pentagon who wants everything reduced to a set of numerical values so that he can pick the minimax strategy has already confessed his ignorance of strategic realities, which cannot be given in numerical form.

In 1989 the decision maker is likely to be a Member of Congress, or, even more likely, a Congressional Staffer, whose expertise is more likely to be in political than strategic analysis. Micro-management and pork barreling by Congress has replaced the systems analysis by Whiz Kids in the Pentagon.



4.6 Phase 2

The decision as to system performance expectations and the technical approach to be employed begins the second phase of system development (see Chart 12). The systems engineers will work with the scientific community, seeking technological developments that may be useful to the system design and requesting assistance in research programs. Eventually, a systems proposal is generated.

At this time, the specific system appears in a recognizable form. It is no longer simply a requirement for a particular mission but a hardware concept, employing radars and interceptor vehicles, warheads and guidance systems, ICBM stages and nosecones, bases and operating personnel. It is for the first time something that can be discussed by the general public, the Congress, and the average civilian official.

Note that, while this stage is usually the beginning in our present method of creating military technology, it is in fact quite late in the process. Systems proposals are expensive in terms of money and technological resources, and should not be generated merely to satisfy curiosity or because they can now be designed. They should conform to a recognizable need identified by strategic analysis.

The concept must then be examined by the military professionals who will use the system. However, if the first phase has been carried out properly, the new system will come as no surprise to the military process. We show military analysis as a separate step because it is at this stage that the system should receive a thoroughgoing review by field commanders to be sure it conforms with such realities as missions, existing installations, manpower availability, operation with other weapons, maintainability, etc. In addition, the impact of the system on force doctrines must be ascertained, and either the system adjusted to the doctrine, or the doctrines changed in time for adjustment to the system. Proper military analysis at this stage prevents the strategist from surprising his own troops – which has happened more than once in the past – and thus allows time to develop new employment doctrines in keeping with new capabilities.

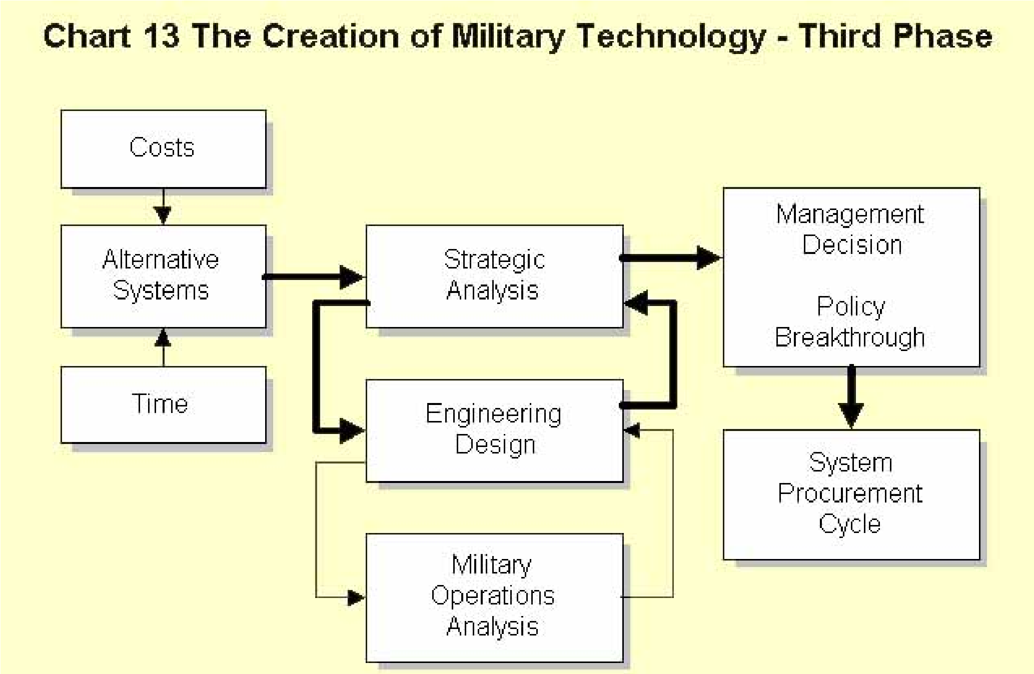
This review may once again force a modification of the system design, and require that the system be submitted again to engineering and development, then back to the military analyst. Because of the delays inherent in this kind of process, it is obvious that the strategic analyst should be familiar with the operation of the forces, not merely be an armchair theorist, so that the first phase will identify and correct the major operational limits imposed on a new system design.

The second phase will thus evolve a system proposal that stands up. The first phase has ensured that it will be strategically useful. Military analysis ensures that it is militarily sound and will conform to the best technological data we have available. It is at this point, and not really earlier, that the systems analyst is useful. He performs tradeoff studies on performance, mission, and cost, to generate a series of alternative systems design possibilities and to compare this systems proposal with other possible ways of completing the mission. He hopes to show the effect of adopting one or another of a family of systems. Eventually a series of proposed alternative systems, not all of which have any assurance of being deployable, and an analysis of cost-performance tradeoffs are returned to the strategic analyst.

4.7 Phase 3

The strategic analyst must now exercise his own analytical judgment in consultation with the engineering and military operations experts (see Chart 13). He cannot base it simply on numerical analysis and statistics, but must take account of strategic principles and real uncertainties. Using his strategic knowledge he will reach a decision. He will select the system that offers the best strategic possibilities, including the capability to achieve surprise and pursuit, etc. There has been a policy breakthrough.

If the proper analyses have been carried out, and in particular if the first phase has been given the attention it deserves, the decision should not take long to make and will not be difficult to defend before strategically alert critics. Many project decisions can be made by relating them to the overall strategy of conduct of the Technological War. Others may require revision in the national strategy. The main point is that once a definite policy and strat-



egy is accepted at the highest levels, project decisions concerning weapons systems will not be impossible for lower level commanders and can safely be entrusted to them. It is only when the top generals do not themselves know what they or their civilian superiors want done that the colonels and majors must submit even the smallest decisions to the top staff.

The system design then goes into the procurement cycle. This function is the best understood of all phases of technological development, and it is the least difficult (although the most expensive) step in the creation of military technology. In the past, procurement managers have been hampered in their work by an excess of management from the top, but to some extent this has been solved by placing a public relations expert in ostensible charge of the program, leaving the real manager (now second in command in the table of organization) to get on with the job while the "Director" uses up his time and that of his superiors in endless briefings. This strategem is more successful than might naively be assumed.

Because the procurement cycle is the best understood and most discussed of the phases of military technology, we will not discuss it here. For a brief discussion of the problems and work of the program manager, the reader is referred to a well known article by then Colonel Lawrence Skantze of the United States Air Force. The opening paragraphs are particularly worthwhile.[6]

> Alas, since the above was written, there has been considerable change in the procurement process; due to micro management by Congress and a proliferation of regulations, procurement has become much more expensive, and takes a very great deal longer, than in 1969. Reform of the procurement process is somewhat beyond the scope of this book; but we do note that it is a major problem for the Technological War.

During the past ten years, the evolution of research and development (R&D) in the Department of Defense might be characterized by two significant achievements:

The development, test, and acquisition of a substantial number of highly sophisticated, expensive weapon systems.

The development of an equally substantial number of R&D management systems, techniques, and tools.

Since the latter is a direct outcome of the former, one might assume that the errors these tools and techniques were designed to overcome have been eliminated. In the real world of R&D management, however, this is not always the case. Such tools as System Engineering, Configuration Management, Scheduling, Cost Programming and Control, etc., are most worthwhile. But the craftsman's skill determines the true effectiveness of the tool. Tools have been oversold to the extent that professional R&D management-course curricula and most trade-journal articles create the impression that R&D management is a science. The implication is that applying all of these tools as doctrinaire formula assures successful program management. This is simply not so. Program management remains more an art than a science, and anyone who believes differently should take a second look.

4.8 Leadership in Technological Warfare

The general decision path for leadership in Technological Warfare is shown on Chart 14. At present the U.S. defense decision process is not organized as shown on this chart, which represents our judgment of what would constitute a proper organizational structure for the creation of technological strategy and weapons systems.

[6] Colonel Lawrence A. Skantze, U.S.A.F., "The Art of the Program Manager," Air Force-Space Digest, LII, 11 (November 1969), p. 78.

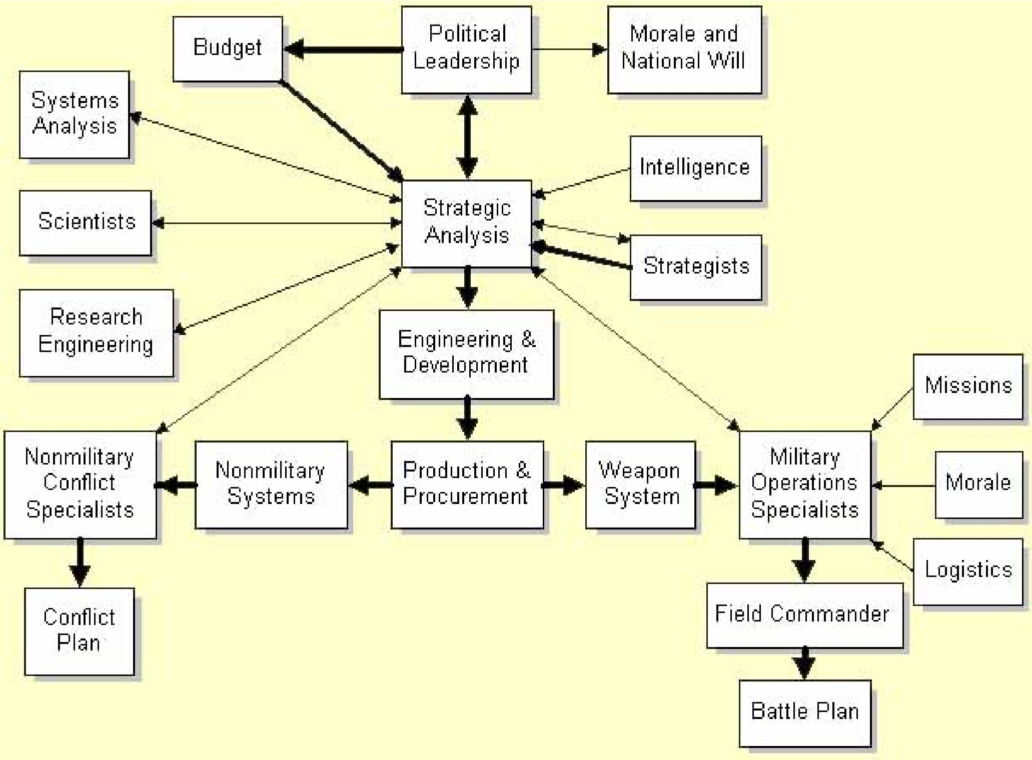


Chart 14 The Development of Technical Strategy and Strategic Weapons

4.9 Political Decision Makers

The task of the political decision maker – the civilian control of the military we hear so much about – is to set policy and see that the grand strategy of the United States is carried out, not to function as general officers in mufti and interfere with the proper operation of the services. Civilian control of the military is important; and it is basically guaranteed in the section of the Constitution which makes the President the Commander-in-Chief of the armed services, as well as in those specifying the functions of the Congress and forbidding appropriations for the Army for more than two years. It is not civilian control to place untrained political appointees at every level of the services and require military professionals to submit all decisions to them before implementation. Such a system of political commissars was tried by the USSR with such disastrous results that we are unable to understand why the United States should institute something along those lines in our military development and procurement commands; yet that is precisely what has been done.

Secretary McNamara's "whiz kids" believed themselves competent to make almost every military decision, and to do so while also holding the privilege of disassociating themselves from the resulting disasters they had produced. Civilian management of the Vietnam War should be sufficient example for anyone, but if more examples are needed the TFX and C5A debacles are also illuminating. In 1968-69 we witnessed a shortage of military fliers caused by the civilian decision to close the schools for pilots, the lack of iron bombs in Vietnam despite the recommendations of the services, and the provision of our combat troops with more than enough turkey on Thanksgiving but not enough helicopter gun ships. Civilian control of the military is a Constitutional requirement; civilian command of the military arts is not.

The chief role of the political leader is to frame basic national goals and policies. These include such factors as whether the nation will be a stabilizer or a disturber; aggressive or defensive; isolationist or interventionist. It is also to be hoped (although from previous performance not expected) that the basic national goals will at least be consistent with each other. The President as head of the National Security Council, with consultation with the Congress as representative of the people, is the only proper level at which such broad and basic decisions can be made; and it is vital that these fundamental goals be set, for without them the strategist is helpless.

Political decisions of this kind cannot, of course, be made independently of the strategist and the technologist. Until the political authorities know what alternatives are open they cannot decide between them; the principle is that a strategy or policy should not be adopted unless it is based on real capabilities. There is no point in considering a strategy of rollback if the means for implementing it are not available and cannot be made available; and there is no point in adopting a strategy of containment if Communism cannot in fact be contained. You cannot opt for Fortress America if defense cannot be built, and you cannot be a world policeman without an effective police force. The statesman must be made aware of the options actually and potentially available and the costs and consequences of each.

There must also be hedges against a changed strategic environment. Even if national authority is convinced that the rulers of the USSR have mellowed, simple prudence requires that there be some insurance against renewed radicalism in Soviet leadership. After all, not even the highest authorities in the USSR can be absolutely sure who will be in control in years to come, or even what the structure of government will be. There must be preplanned alternatives in the event of technological surprise, whether the surprise comes from our own laboratories or in the form of enemy weapons. The one generalization that can be made with certainty about our scientific era is that it will remain uncertain; that the rapid stream of technology will bring new weapons we did not predict. A prudent national strategy will realize this elementary fact and retain sufficient flexibility to allow adjustments.

Another important but recently neglected duty of the political authorities is leadership in solidifying national morale. The political leader must understand the doctrine of Just War and be able to transmit it to the nation. Where sacrifices are called for, the statesman must make the population understand their purpose and necessity. Precisely because we are faced with a dictatorial enemy who does not need to consult his subjects before making strategic decisions, the leaders of the West must continually make clear to the people exactly what is at stake. If freedom is to survive the Technological War, this task is at least as important as the civilian control of our own military.

4.10 Budget

The budgetary process is inseparable from the political machinery of government; the concept of scientific management of the disbursement of billions of dollars extracted from the taxpayers is a myth. Indeed, the control of governmental finances is one of the most important of political decisions, and some theorists have gone so far as to say that it is the essence of politics.

In financial decisions as well as in others, the political authorities must be guided by sound strategic advice, and the strategist should have access to fiscal officials in order to determine priorities. However, strategy does not consist merely of giving the strategist all he asks for, and certainly we do not argue that the defense of the United States requires that the services be given a blank check. Civilian expenditures are obviously relevant. Then, too, military budgets are no longer sensible, and indeed are deliberately inflated. This is not because duplicity is inherent in the military services but because it has become traditional to inflate budget requests so that political officers can take credit for cutting them to trim off the fat.

The problem with this negotiatory method of arriving at budgets is that the political authorities are aware that the budget is inflated. They then seek to make cuts below the sum the military would have requested had they been presenting an honest budget. In many cases they are perfectly justified in doing so, but how can anyone be sure? Service chiefs are generally not aware of their real requirements because their own subordinates have often inflated their requests, anticipating a general trim at the chief of staff and service secretary level. The upshot is that no one is really sure which programs are vital to national security and which are not.

This kind of problem will continue in our republic, and we are hardly foolish enough to believe that we have a solution to it. So long as democratic politics exist, various stratagems must be employed by its servants. We do point out, however, that it is much easier to solve budgetary problems as part of an overall strategy than to control hundreds and thousands of individual programs; and furthermore, that there will be less need for centralized control of the myriad programs that make up defense research, development, and procurement if there is a strategy. Games and debates will continue as always, but if top-level decision makers first decide on strategic centers of gravity they will find that many of the details that plague them today will take care of themselves.

4.11 Intelligence

The intelligence function is one of the most important in the Technological War. Since this is a work on technological strategy, not on intelligence, we do not provide a lengthy discussion of the details of this vital function.

The intelligence community provides inputs to the strategic analyst as well as to political decision makers. It is of vital importance that this intelligence be reliable; indeed, it is often better to be less complete, but more reliable, than to indulge in theories. In particular, the intelligence community cannot be certain about enemy intentions, which are subject to rapid changes. The strategist must work mostly with capabilities and technological trends, and he must have a flexible general understanding of who the opponent is and will be, what the range of his intentions might be, and what he probably will not do. And he must have detailed knowledge of the opponent's operational doctrine.

Intelligence cannot ensure against technological surprise, although the United States has certainly been surprised by enemy actions that were easily predictable. Technological surprise in particular can bring about near-disasters, not the least of which is brought about by psychological effects on the population: people either despair or demand overreaction in a particular field that causes improper utilization of resources.

4.12 Strategists

As General Beaufre has pointed out, the strategist must not limit himself to what is possible; he must find ways to do what is necessary. Wishing for a technological capability will not necessarily give us one, but the history of technological development, particularly of weapons, leads us to believe that identification of a technological requirement increases the likelihood of fulfilling it.

In any research program, there will be alternatives. There is usually more than one way to reach a technological goal, and several competing principles may be involved.

Choices have to be made, and it seems to us far more reasonable to make them on the basis of strategic necessity than simple technological elegance. Cooperation between strategists, technologists, and politicians will solve almost any problem, given the resources of the United States; hostility between these groups precludes the solution even of simple problems.

Strategists are almost never found in universities, or indeed in civilian life. These rare birds will generally have had a long career of working with military officers and military problems. Most strategists are, of course, military officers of reasonably high rank and long service. The converse is not true; many high ranking officers of long service have no conception of strategy – this is not intended as a criticism. The vast majority of military assignments involve the implementation of a strategic plan rather than its generation. Leadership of men, technical proficiency, courage, stamina, and careful attention to detail are all required of the successful field officer; yet nearly all these qualities may be lacking in a good strategist.

The strategist is, above all, an intellectual, but he is an intellectual of a different order from the scientist and engineer, or the average university professor. The strategist, unlike the scientist, deals with a world of secrecy, incomplete information, and real uncertainties which cannot be measured by statistical procedures. He lives in a world of intelligent opponents who seek to thwart him at every turn. He is concerned with the generation of plans which will be carried out by others, and he makes use of principles rather than scientific laws.

Strategists may in fact be unable to carry out their own plans. Many great strategists have lacked the vital qualities of leadership required of great military captains. Some have suffered from severe personality defects which prevented them from convincing anyone of the soundness of their plans. Consequently, strategists are not necessarily carried to the top of the military services unless they have been diligently sought and carefully chaperoned during their careers.

The U.S. armed services are not organized to locate and promote strategists, and originality in strategy has never been plentiful during out history. American military history shows rather the reverse: in all our wars, we have generally started with poor strategists in command and had to muddle through until we found strategic competence – e.g., Lincoln's difficulties in locating a general who could take advantage of the peculiar strengths and weaknesses of the Union Army.

Consequently, we will not generate a strategy of technology simply by giving technological autonomy to the services, particularly as they are presently organized. Our problems are much more difficult than that; in fact, the misconception that the usual military chief of staff is a strategist may be responsible for many of our present difficulties. In the past, civilian authorities have tended to defer to the military whenever they desired support for national security; the discovery that infallibility had not been conferred with the third star initiated a train of consequences that ended with the fallacious policies of McNamara, who regarded the military as incapable of making proper decisions.

The fact of the matter is that the U.S. armed services are commanded by men of great skill and competence, but this is not the same as saying that they are strategists. There are numerous strategists and potential strategists in the military services, but they are not usually found in positions of command. We do not advocate that command of the forces be given to strategists; as we have pointed out, good strategists are not always good leaders. But certain high-level positions must be filled by strategic minds.

What we must do is encourage strategic thought, particularly among younger officers, and ensure promotion for officers who show genuine strategic talents. This nation has always been fearful of a general staff, falsely identifying this useful military instrument with Prussia and Nazi Germany and supposing it to be incompatible with democratic institutions. When the structure of a general staff corps is explained, not one American in a thousand recognizes what it is; yet he no longer fears it when he does understand it. There may be good reasons for rejecting the general staff concept, but we venture to suggest that it be rejected for something better than a pipe dream such as that which was brought to an end by the historic event at Kitty Hawk.

In fact, the general staff corps concept is this: at an early stage in their careers, certain young officers are selected as potential strategists, intelligence experts, and staff officers. Management of their careers is then given to the general staff; they are posted to staff assignments and schools where they study war, strategy, tactics, military doctrine, and history. School assignments are alternated with service in the field and with such special arms as artillery, infantry, and armor. They remain in the general staff corps until they are thought to be unsuitable for it, whereupon they can either be transferred to one of the line services or retired.

During their careers in the corps, the selected officers alternate between appointments to general staff headquarters and its specialized branches –

such as logistics, and attache duties – and appointments in the field, where they serve as chiefs of staff to the field commanders of successively larger units. Thus, commanders learn to command and staff officers learn the functions of staff work. Commanders and staff officers each have their own paths of promotion, and are not in competition with each other until they come to the highest positions. Even there, competition may be kept to a minimum because staff officers often make good commanders above the corps level.

This, in brief, is the general staff corps system. It produces officers who have considerable knowledge of strategy; it requires them to be familiar with the operations of the military services and the tactics of the field forces; and it encourages them to think in intellectual rather than command terms. The system has been proved to be effective, although it is subject to improvements.

Whether it be through the general staff concept or some other, we must find ways of selecting, training, promoting, and rewarding strategic talent and placing it in positions where it would be able to formulate successful strategy. Without strategists we will have no strategy. Yet it is strategy that is our greatest need in the Technological War.

4.13 Military Operations Specialists

The military operations specialist is a uniformed service officer, as is the strategist. However, whereas there are few strategists in the higher ranks of the military, tacticians and men experienced in leadership of troops are found there. No restructuring of the military services is required to bring them to the higher ranks. On the other hand, as we will discuss below, the systematic study of tactics is sadly neglected in U.S. military education.

Although there are a few civilian strategists, there are almost no civilian military operations specialists. [Now there are too many.] Academic students of tactics generally lack experience in leading troops and actually employing military equipment. The officers assigned to strategic planning must be selected for their leadership ability and field ingenuity. In particular, they must be able to get along with men they dislike, particularly with scientists and technologists, and to defend their point of view in intelligent debate. Although these qualities are not as rare as strategic talent, they are not exactly common in the military. The problem is compounded by the lack of academic training of military officers, so that the twin qualities of leadership ability and theoretical understanding are more rare than they ought to be.

Since the military arts and military education are not within the scope of this book we note the following in passing, for the student of the art of war.

First, the relationship between tactics and strategy is complex; the failure of the British to understand the tactical value of the tank led to failure to provide strategy for armored employment in World War I and thus prolonged that conflict. Second, civilian operations analysts have in the past been highly successful as advisors in restructuring tactics and battle plans, and have often been heeded because of the faults in military education.

Good tactics can sometimes compensate for poor strategy. On the other hand, the finest military forces in the world can be destroyed when their leaders employ them with poor strategies or no strategy at all. In military combat, neither tactics nor strategy can be ignored.

We cannot neglect the training of men who will employ the weapons of the Technological war in actual combat; however, in the Technological War the pressing need is for strategy and strategic thought.

4.14 Scientists

It is tempting to allow the scientist to dominate the field of strategic analysis and the management of the Technological War. He is the chief weapon in the war, and without him nothing could be accomplished. However, to give the scientist control of the process is an error of grave consequence. The qualities that make a good scientist are not those that produce a good engineer, let alone a strategic analyst. The scientist understands technology; indeed, he creates technology. However, he is often a specialist who is quite helpless outside of his own field. In general, he must be a specialist to make a reputation as a scientist, and without that reputation he will never achieve a position of management.

There is a major difference in mental attitude between a scientist and a strategist. The scientist must deal with facts and scientific laws. By contrast, the strategist must deal with futures which cannot possibly be factual because the events have not occurred. The scientist deals with repetitive events and laws of nature; the strategist is virtually always confronted by a unique situation in which the opponent will try to do the unexpected. The strategist must always make decisions based on inadequate data; scientists must not jump to conclusions. The strategist's primary skill is to be able to reason like the opponent and stay ahead of him, while the primary skill of the scientist is to produce and package knowledge.

Just as men can be divided into athletes and nonathletes, they can be divided into scientists and nonscientists. But if a man is an athlete, he is not necessarily a good athlete; if he is a good one, he may only be good at baseball or boxing. Scientists, too, have very pronounced qualitative differences.

There are broad distinctions between creative scientists, scientists who work best as assistants and experimenters, and scientific administrators. Many a scientific reputation rests upon one particular discovery. Other reputations are derived from a long series of creative contributions. When we are talking about scientists it is quite important to keep these distinctions in mind.

But this is not the end of the story. The history of science is replete with examples of scientists who were grievously wrong. Scientists have believed firmly in weird theories and have instituted veritable inquisitions against nonbelievers. Scientists often refuse to accept evidence, and they sometimes go to rather comical lengths to defend their own theories.

There is no such thing as a fully rational scientist. There are only men who have scientific training, and this scientific training has not eliminated their emotions, hopes, and other human features as indeed it should not. The trouble is, however, that scientists are often inclined to transfer to themselves as individuals the objectivity of the scientific approach and to consider themselves to be far more objective than they are. They tend to identify their brain with a computer and become emotional if the security of an established theory is threatened.

So far as their contributions are concerned, scientists can be seen as falling into three categories. One group is made up of those who are good at anticipating the scientific future and visualizing new possibilities and opportunities. In sharp contrast are those who are opposed to the future, who in essence want to stop technological advance and, if possible, bury technological innovations so that no one ever finds them again. In a middle group are those who would like to return to the past but realize this cannot be done; they also view the future with concern, would like to slow down technological progress, and frequently raise either genuine or spurious doubts about the feasibility of new ideas.

It must be realized that technological innovations usually call for new approaches. While some of these approaches may be practical, nevertheless none can be proved until much experimentation has been carried out. If doubts are raised about the feasibility of an approach, investigation can be prevented, misdirected, or financed on such a low level that five years later it can be claimed that "this approach has proved disappointing."

Scientists of the middle group, resigned but resistant about the future, have sometimes had a strong influence on U.S. technological activity. This has frequently proved unfortunate. Some of the scientists who have been most influential in American security programs have not quite grasped the fact that today the stream of technological progress flows fast and wide. Some have believed that floating with the current and even occasionally swimming upstream would be the right type of action. Some have had the notion that it is possible to get out of the current and watch the spectacle from the river bank. In some areas, notably in nuclear physics, scientists advising on U.S. weapons have argued that everything worth discovering has already been discovered. The effect such attitudes tend to have on technological progress is obvious.

By contrast, scientists who are future oriented – who understand the need to swim faster than the current and who are able to propose technologies and new ideas – although they may also sit in the councils of government, often have had less influence than might be desirable. And, scientists of the remaining category, who want to bury new technology, have seemed to grow more influential with time, especially at the highest levels.

Responsibility for our deficiencies in technological strategy must rest ultimately with the military. They have the continuing responsibility for our security, but they have been slow in understanding the need for technological strategies and in adapting to this innovation in conflict.

There is no obvious solution to this dilemma, which is essentially that all humans are fallible. The military have placed increasing emphasis on scientific education of qualified officers, but since these officers also must fulfill the professional obligations of the services they cannot possibly become scientists. There is little evidence that scientists, including those who make a profession of advising the Pentagon, ever school themselves systematically in the history of war, military technology, and current strategic and tactical problems. Thus, we have had two groups talking to one other on the basis of different backgrounds, different problems, and even different languages. It should surprise no one that there is no meeting of the minds. The problem may not be entirely soluble but it certainly can be alleviated – for example, by introducing pertinent courses on military problems in the various institutes of technology and universities and by offering such courses in service schools to scientists who want to qualify as military advisors. Our military services have been laggard in teaching military history, yet in the Continental general staffs the teaching of military history was often regarded as a major staff function, and members of the history department participated in military planning. Our services could easily perform this function, and might add a staff section on the history of military technology, members of which would participate in technological planning. There cannot be any panaceas in this field but it is inadmissible that year in and year out obvious fallacies are allowed to influence strategic planning. It should be possible to eliminate recurrent error from what is supposed to be a rational and objective administrative procedure.

4.15 Engineering and Development

The usual engineer is fundamentally different from the scientist, and is given less deference and respect. However, he is far more likely that the scientist to become the president of a large technological company, and is more likely to be useful for strategic analysis. The engineer is oriented toward the use of technology rather than its creation. He is also skilled in taking basic concepts and turning them into workable devices. He is indispensable to the war of technology, but is usually not a proper choice for its overall management because of his limited familiarity with strategy and his frequent inability to comprehend the importance of nonmaterial factors.

Napoleon said, "In war, the morale is to the materiel as three is to one." In the modern age, organizational leadership is to morale, and morale is to the materiel, as six is to three is to one. It is precisely the hardheaded preoccupation with the physical factors that makes the engineer successful that often disqualifies him from successful management of the Technological War.

4.16 Procurement and Production

The production specialist is usually an engineer. His function is highly important, as he must take the designs and concepts from the engineering and development cycles and turn them into actual hardware. In the United States, the production specialist is usually found outside the government process. Unless he closely works with engineering at all stages of weapons design, production is often delayed. In a pure war of attrition with static technology, the production specialist is often the proper manager of the entire effort; for technological warfare, he is usually an improper choice.

4.17 Nonmilitary Warfare

The expert in nonmilitary warfare is the strategist of nonmilitary operations. He may be a scientist, although he often is not. His advice is of great importance to the strategic analysis function, since he must discover and describe the alternatives to military action for achieving the goals set by political authority. He is also important in the exploitation of new technology and the proper design of research programs, educational processes, etc.

There are functions within the nonmilitary warfare specialty, many of which are themselves specialties. Examples range from the inventor of a plow capable of turning jungle into arable farms, thus truly allowing his nation to give land to the landless, to the early space-spectacular enthusiasts, psychological warfare experts, economists and trade strategists, etc.

The nonmilitary warfare expert may or may not manage the nonmilitary systems produced through the strategic analysis process. The important factor in his role, and one which is usually forgotten is that the expert on nonviolence must fit his inputs into a strategy. If his efforts are independent of those of the military they may be ineffective or even counterproductive. Few nations can afford several independent or contradictory commitments of force in the Technological War, any more than armies can afford independent and uncoordinated efforts by divided forces.

4.18 Systems Analysis

The systems analysis function is analyzing tradeoffs between technological possibilities, budgetary constraints, and system effectiveness requirements and presenting the analysis to the decision maker with a series of possible choices or options. He is generally incapable of distinguishing a real option from a theoretical one, although he may attempt to obtain a statement of probability of success of a particular technological innovation from its designer. Because most inventors are fond of their brainchildren they assign high probabilities to their own systems and low probabilities to those of others. The life of the systems analyst is thus not an easy one.

However, the systems analyst must not, as he often does, make the mistake of thinking himself either a strategist or a political decision maker. He can do this consciously or unconsciously. There is sufficient ambiguity in prediction of technological success, costs, schedules, risks, etc., that the analyst is always capable of removing any given system from serious consideration, provided that he wants to do so (and he may want to because of his political assumptions or his own strategic assessments). He may favor one system over another simply by his choice of assumptions about the environment in which the system will operate.

Thus, the strategic analyst must not rely entirely on the systems analysis process to make his decisions. Systems analysis can show why a decision has been made, by making explicit the analytical assumptions involved – although it has lately failed to provide this service – but it cannot substitute for proper judgment until such time as all the variables, including the enemy's objectives and intentions, are quantifiable.

4.19 Strategic Analysis

The strategic analysis function is the most important component of the design process. It is the final decision in the weapons system process, and thus belongs to the civilian officer responsible to the political decision maker. This was in the past the Director of Defense Research and Engineering or even the Secretary of Defense.

The strategic analyst must trade off the demands of the several services. He must implement the basic policies set by the top political decision maker, and do so within the constraints of the budget. He must allocate research and development money and resources among competing scientists, each of whom is honestly convinced that his project will save the country – or possibly the world. He must constantly keep in mind the limits of systems analysis and not allow the mechanical computer processes employed by systems analysis to substitute for the final decision making power. He must understand that there are real uncertainties in this world in contrast with probabilistic or statistical uncertainties which can at least be quantified. He must understand that since an intelligent enemy opposes him, probabilities may not apply at all. Game theory cannot always guide him, for some real world games can be played but once. He must constantly strive to be the surpriser and not the surprised.

In doing all this, he must understand the possible futures the technologists dream up. He must balance off the hardheaded attitude of the engineer, who prefers to work with known technologies to produce something he knows will work, against the more visionary glimpses of the future by the scientist, particularly if the scientist foresees a technology that will make obsolete or useless the system the engineer "knows will work." He must also understand production limitations.

Finally, but most important, the strategic analyst must understand strategy. He must be able to communicate effectively with the strategists and military operations specialists, who will sometimes be in conflict with each other. Beyond strategy, he must understand war. If war is too important to be left to the generals, the strategic analyst in an era of technological warfare is the man beyond the general. His decisions will decide the character of the next war.

Modern war is often won by men who are retired or dead at the time the war is fought. The visible commander must fight with the resources bequeathed to him by others; yet the decision by the strategic analyst, made years before, may have decided the outcome of the war beyond recovery by the most brilliant operational strategist. The strategic analyst can never win the war. Improper operational employment of his designs and systems can waste all his efforts. But he can lose the war. If he has provided future generals with the wrong tools, all their brilliance may be insufficient to prevent defeat.

Thus, this role is almost beyond human talents; yet it must be performed. To some extent, it must be decentralized, so that hedges against wrong decisions can be made. So long as the function is perfectly centralized, even the decision as to what hedges to make is in the hands of one man and perhaps his staff. It is a responsibility that none but a saint or a fool could exercise, and that a saint probably would not want.

Yet there must be a strategic analyst, and he must make final decisions. To some extent, decentralization will protect him, but not entirely. Worse, he must recommend courses of action to his political masters that may result in the unpopularity of the present government because of the cost yet will be vital to the survival of the nation under the successors of the present regime. Indeed, in order for a future regime to survive, it may be necessary for the present one to make decisions that will be so unpopular as to force it out of office.

It is not possible to specify the qualifications of the strategic analyst in any detail, but some stand out. He must have courage; that is, moral courage, the courage to make decisions that may be adverse to his career. He must be willing to give unpopular advice. He must have the courage to say "no," emphatically, to many of the countless men and organizations that demand his precious resources. He must not confuse courage with pigheadedness, however. He must also have the courage to understand that he may be wrong, and to make the appropriate investment of resources in a hedge against this contingency.

He must understand strategy and war, although he need not be a strategist himself. In our judgment, if he is an expert, he should be an expert in strategy rather than technology or science; but specialization in this function is not wanted, and could be disastrous. The strategic analyst must always remember, however, that he is the analyst and decision maker for a strategy – a strategy of technology which could mean the difference to the nation of survival or doom, freedom or slavery. In some senses he is more important that the president, because his decisions will dictate the choices of future presidents. If he fails to make at least some correct decisions, the future president may be helpless.

He must understand technology, although he need not (and often should not) be a technologist. In particular, he must know what the technologists are talking about. He must be a man of vision, yet have a streak of the hard realist within him. He must be a judge of men, capable of knowing which of the scientists are probably advocating research that will pay off and which are merely indulging in fantasies. More, he must be able to judge the engineers and decide which ones are giving him correct advice on what can be done now and which ones simply do not understand the situation.

There are few men with these qualities. Strategic analysis is not a specialty taught in our schools. It is not often learned in business, and it is decidedly not an ability picked up along the road to a Ph.D. degree in economics.

The comforting thought is that if the United States does not have many men with these qualities, the enemy probably does not either. On the other hand, this does not mean that the United States can afford to abandon the search for the proper men, or so structure the organization of technical management that the strategic analysis function is simply not fulfilled.

There is, in fact, no evidence that there are more geniuses in the U.S.S.R. than there are in the United States – rather, the evidence points to the contrary. Yet, the governmental system of the Soviet Union has ensured that strategy is the foremost business of the top echelon, that this top echelon is preoccupied with strategic rather than administrative questions, and that virtually all the participants in the strategic decision-making process have been trained in strategy and tactics. These men have acquired considerable experience in strategic operations, and are counted among the world's foremost experts in strategic planning. Strategy has been the lifelong profession of the Soviet leaders, while in the United States, strategic decision makers are only strategists pro tem and must depend upon on-the-job training. Our American marvels are obligated to make major decisions from their first day in office, before they even know the current American and Soviet battle orders. If Gulliver were to travel to the United States, he probably would report that we are handling security as though we believe that doctors of divinity make good surgeons. Americans pride themselves on their skill in organizing, yet this skill has yet to be applied to security, which is the foremost business of any nation.

Chapter 5

Surprise

It never troubles the wolf how many the sheep be.
–Virgil

Surprise has long been a key aspect of war. The history of surprise has been analyzed from the point of view of the surpriser and the surprised, defender and attacker. Many kinds of surprise have been identified: strategic, tactical, operational, and technological.

One inherent element is warning. Warning results from a combination of intelligence and reason; lack of information about the nature and course of events and lack of time in which to take action after a threat is perceived contribute to the devastating effect of surprise.

Surprise in modern war is vastly different from surprise in the past. At the operational level the ballistic missile with intercontinental range and time of flight in minutes; orbiting bombs of the kind developed by the Soviet Union with times of re-entry measured in minutes; space-based sensors which can detect and report events in seconds; and lasers which have almost instantaneous kill over vast distances all have changed and will continue to change the very nature of surprise in war.

Ballistic missiles and space systems have had a dramatic influence on both tactical and strategic surprise. Combinations of sea-based and land-based intermediate and long range ballistic missiles can be used to confuse sensors and overwhelm the data processing systems of the surprised. Conversely, the data from sensors, especially space based sensors, can be correlated to give much more accurate information of events in real time, and thus provide warning of the tactics being employed by the surpriser.

The responses available include launching many missiles simultaneously to saturate the sensors and prevent accurate intelligence on the number of missiles launched, and maneuvering the re-entry vehicles to deceive the surprised as to the targets being attacked.

Space based systems are essential to prevent strategic surprise. They can report events over a prolonged period so that slow and rapid indicators of changes in normal patterns or operations can be interpreted as opening moves in potentially threatening operations. They provide global coverage but also can be directed to cover specific locations anywhere on the surface, in the oceans, in the atmosphere, and in space.

The surpriser must plan to deceive such space based systems (possibly by destroying them) as well as prevent being surprised himself. These systems are especially important in an era of arms control, because they are generally the only reliable way to verify the opponent's compliance.

Prevention of surprise in the modern era demands access to space; anything which prevents access to space enhances the possibility of surprise.

Technological surprise is in principle much harder to achieve than operational surprise because of the long lead time from concept to discovery through development to eventual military application. However, the accelerating rate of change in electronics makes it possible to retrofit the guidance and data processing elements of existing systems and thus achieve much higher-than-expected performance, as for example in accuracy, and thus contribute to surprise. A more subtle form of advance can also lead to surprise. Passive defense measures, such as hardness, deception, and mobility, which are difficult to detect in the R&D phase can reduce the effectiveness of the attacker.

Unfortunately, defensive surprise, while possibly decisive, is not much use in deterrence of war.

AFTERTHOUGHT FOR THE DAY

Surprise, when it happens to a government, is likely to be a complicated, diffuse, bureaucratic thing. It includes neglect of responsibility, but also responsibility so poorly defined or so ambiguously delegated that action gets lost. It includes gaps in intelligence, but also intelligence that, like a string of pearls too precious to wear, is too sensitive to give to those who need it. It includes the alarm that fails to work but also the alarm that has gone off so often it has been disconnected . . . It includes the contingencies which occur to no one, but also those that everyone assumes that somebody else has taken care of.

–Julian Critchey, *Warning and Response*, 1978

5.1 The Sneak Attack

The popular view of surprise in modern war is identified with a sneak attack, that is, operational surprise. Our experience at Pearl Harbor makes it easy to understand this belief, while the widely-known characteristics of the intercontinental ballistic missile permit us to grasp readily the nature of a future surprise ICBM attack. The missile is the ideal weapon for a rapid sneak attack, not just against one base like Pearl Harbor but against entire countries and continents.

Of the characteristics that make the missile suitable for a sneak attack, the most important is speed. The total flight time of an intercontinental ballistic missile from the USSR to the United States is about 30 minutes. Space-based systems could increase the warning of an attack almost to the total missile flight time; but even if we are given this much warning, the intercontinental ballistic missile has changed the dimension of surprise and has given the aggressor a most potent tool.

Without access to space the United States may well find itself blinded at crucial moments.

Even with warning the US can do little other than launch the force in a classic "use them or lose them" scenario. Lack of adequate defense forces the defending power to a doctrine of launch on warning.[1]

> The alternative is to accept the damage and try to ride out the attack, then retaliate. This may have been a feasible option in the 60's, but by 1975 the Soviet Union had achieved ICBM accuracies of a few hundreds of feet. No passive basing system can protect missiles against nuclear weapons delivered at those accuracies.

A massive intercontinental ballistic missile attack launched by an aggressor is an ever-present danger. Such an attack would come as the culmination of a series of measures, operations, and techniques, orchestrated to achieve

[1]It has always been exceedingly difficult to get arms control advocates to understand this elementary principle: if the retaliatory weapons don't survive, there can be no retaliation; and if the aggressor knows there won't be a retaliation, then deterrence is thin to non-existent. Strategic defenses are stabilizing, not destabilizing, because they are dangerous only to the aggressor.

Strategic defenses make strategic offense weapons obsolete. No one in his right mind believes that strategic defenses can form an 'impenetrable shield' against a modern technological power like the USSR; thus they are not an incentive to a first strike. This point has been made repeatedly in our advocacy of a policy of "Assured Survival" as opposed to the official US Policy of "Assured Destruction", and appears to be taking hold in some part of the armed services, but not in the State Department.

maximum psychological effect on the surprised. The aggressor would have undertaken specialized campaigns in the various elements of conflict – political, psychological, economic, military and, above all, technological.

Once the time is ripe, the attack comes suddenly and catches the defender asleep. But despite the present concentration on the sneak attack, surprise is not the exclusive province of the aggressor. Defenders have used surprise to great effect in the past and should strive to do so in the future. The future security of the United States requires that our strategy include measures to achieve surprise, as well as those to prevent it. The main surprise to aim for is that we won't be surprised.

Before we examine the broader aspects of surprise, let us point up the fundamental aspects of the sneak attack. First, surprise is tactical. Second, this form of surprise is used by the aggressor, not the defender. Third, it will be achieved only with the most advanced weapons. Fourth, prevention of surprise requires use of the most advanced technical means.

5.2 Strategic Surprise

There are also surprises on the strategic level. For illustrative examples, let us look at two of the ways in which the USSR has actually achieved strategic surprise in the decades since World War II: the opening of the space age, and nuclear testing during the test moratorium. As a result, the Soviets obtained a lead over us in space that has only partially been overcome by our massive and expensive NASA spectaculars. They lead in many military phases of space, whereas we are ahead in nonmilitary uses; in near-earth operations their lead may be as much as three years.

> The above was written in 1969. Since that time the U.S. has allowed the Soviets to take a commanding lead in near-Earth space technology. The Soviet Mir space station is fully operational, while the US does not intend even to attempt a space station prior to 1992. As we write this in 1988 the Space Station faces increased Congressional resistance, and its funding is in doubt.
>
> In addition, the Soviets developed and deployed an operational satellite destroyer, which was, because of political opposition, not countered with a US anti-satellite weapon. The US satellite interceptor program was deliberately abandoned, although its feasibility had long been demonstrated. The arguments against development of the US anti-satellite weapon were largely based on the arms control theory that we need space assets more than the Soviets; therefore it would be better if

neither side had anti-satellite weapons. If we don't build ours, we can hope the Soviets won't build more of theirs.

Few now recall when both the US and the Soviet Union engaged in unrestricted nuclear tests. The US was induced to observe a "gentleman's agreement", that is, an informal ban on nuclear testing. Then, suddenly, the Soviets began a massive series of above-ground tests that included the detonation of the largest hydrogen weapon ever exploded; and followed that with the offer of the Treaty of Moscow banning above-ground tests. The result was that the Soviets gathered a great deal of experimental data denied to the West.

The moratorium allowed the Soviets to determine critical effects of nuclear explosions in space. Because we honored the test ban, we let much of our testing capability atrophy, and now the Treaty of Moscow prevents us from finding out just how far behind we are in the application of nuclear weapons in space. The impact of these surprises cannot be calculated with precision but the Soviets gained a considerable time advantage in offensive orbital weaponry and ballistic missile defenses. Note that preparing for strategic surprise must continue over a period of several years.

These two surprises occurred in the technical phase of the Technological War, not in the military phase. They were achieved by an orchestrated strategy that employed several forms of conflict, including intelligence operations, propaganda and psychological warfare, political and diplomatic maneuverings, and a concentrated technical effort. While the goal of the Soviets has been to develop advanced weapon systems, such weapons were not employed militarily in these two surprises; however, military technology was developed, and diplomacy and treaties closed off our access to the means of catching up or at least made it difficult.

The best way to counter surprise is to deploy the most advanced technology possible and continue to modernize the strategic forces. This is not to imply that the technical effort must be devoted exclusively or even oriented primarily to countering potential technical surprise; but as we have insisted, surprise must be made a key element of any technological strategy. Since technology has given a new dimension to surprise in the strategic equation, technology is needed to support our own or prevent enemy surprise in all forms of conflict.

The misconception that surprise aids only the aggressor – a misconception that stems from thinking of surprise only as a 'sneak attack' – is especially harmful in the Technological War. In his classic work on surprise, General Erfuth[2] has shown that there are two parties to the operation, the surpriser

[2]General Waldemar Erfurth, Surprise, S. T. Possony and Daniel Vilfroy, translators.

and the surprised – this is not the same as saying the attacker and the defender. The defender also can employ the technique of surprise, and perhaps more effectively than the attacker.

Furthermore, there is a widespread misunderstanding that surprise refers exclusively to the initiation of war. Some writers consider surprise to be just a more elegant term than sneak attack. To other writers, surprise is tantamount to technological surprise. This is far too restrictive an understanding of surprise and its role in modern war.

5.3 Tactical Surprise

Tactical surprise is essentially surprise in combat. It is used to prevent the enemy from bringing adequate forces into operation in time to counter those used against him. The weapons of the surpriser are used to bypass or neutralize those of the surprised. Without surprise, the attacker would be required to use massive superiority to crush his opponent. The difference is like that between judo and a bare-knuckle fight.

Tactical surprise usually does not lead to the nullification of all of the opponent's armament, but if it is well-conceived and backed by technological improvements and adequate forces tactical surprise can go a long way toward eliminating enemy weapons as a relevant factor. Given the complexity of modern systems, the surprised opponent is faced with considerable delay before he can readjust his tactics; in a fast-moving war such readjustment may not be feasible.

Under modern circumstances time and technology as well as combat procedures are needed to gain tactical surprise. Technology can produce new types of weapons, new weapon effects, improved weapon effects, improvements in delivery systems, combinations of weapon systems, better active defense, and so on. Examples ranging from the "War of the Iron Ramrod" of Frederic the Great to the devastating effect of Lee's rifle pits at Cold Harbor show that technology and its proper tactical use may achieve surprise. With superior armaments or doctrines, and with troops trained in their use, the entire armament of the opponent can be nullified.

While this is the ultimate goal of tactical surprise, it is usually difficult to achieve. This is so because the possibilities of complete technical surprise are limited. Because of time required to develop a new weapon system, opportunities are increased for technical warning and for counterefforts, either technical or operational. Furthermore, excessive secrecy or failure to deploy weapons can result in surprising one's own troops, with disastrous results – as

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Harrisburg: Military Service Publishing Co (Stackpole) 1943.

happened with the use of the mitrailleuse by the French in 1871. On the other hand, tactical surprise can be accomplished by a minor weapon improvement that from a technological point of view may be marginal but which today or tomorrow may facilitate victory in battle by creating a decisive advantage.

5.4 Strategic Surprise through Operational Surprise

Surprise can result from operations of the forces available, as well as from technological innovation. To achieve surprise of this type, the commander operates in a way unexpected by his adversary; in the ideal situation the enemy is unable to devise countermeasures in time. The attacker hits the defender where and when he does not expect to be hit.[3] Or, conversely, the defender reacts by hitting with weapons or with performances the attacker did not anticipate and against which he cannot protect himself properly; the defender counterattacks when and where he is not expected.

The number of operational variations is truly infinite, and the details of such operations usually can be planned and prepared with a high degree of secrecy. These variations are possible because of the multiplicity of weapons, the great spectrum of their performance, and the vast number of operational options.

Opportunities to use operational techniques to achieve surprise arise from various combinations of the performance of the carriers of destructive agents and the effects of those destructive agents when they are transported to the target – from the possibilities of multiple routes and methods of attack – from the variety of environments – and from countless other factors and their combinations. In addition, there are the skills of tactics, the principal one of which is to use a military force in a surprising manner. The use of expedients, saturation, and other techniques that cause uncertainty create further possibilities for operational surprise.

[3]One clear example of this kind of surprise was the Fall of France in 1940. Not only did the Germans attack in a place thought totally unsuitable for armor, but they used their armor in unexpected ways, driving deep into the French interior without waiting for the infantry to catch up. They also used their aircraft as long range artillery to neutralize the French artillery which had been placed so as to be out of range of German artillery but able to bombard any attempted river crossing. Once the river was crossed, the French artillery could be engaged by German infantry and light armor.German armor then penetrated deep into the French interior. The result was the the Germans operated inside the French decision cycle: by the time French headquarters had considered the situation and issued orders, their information about the front was obsolete.

5.5 Technology and Surprise

We repeat, surprise is not confined to active combat. Even though hostilities are not occurring now, the battle for tactical advantage and the effort to achieve surprise goes on incessantly. Laboratory is pitted against laboratory to find new advances such as radar techniques for looking over the horizon and for distinguishing between warheads and decoys. The laboratories struggle to compress data so that information, particularly details on attack, can be instantaneously transmitted and presented to decision makers. They search for new concepts that can find expression in hardware and tactics.

In addition, there is the broad area of strategic deception in matters of science. This includes deception about the general state of excellence, the level of progress in a given aspect of science, and the application of science to specific weapon and component development. It seems that behind the Iron Curtain there is a second curtain that conceals the nature of Soviet science.

To conduct this deception, the Soviets release scientific articles and withhold others, thus creating a false impression of their successes, failures, and interests. Another method is to send scientists to international meetings, where they either spread misinformation or are evaluated by their counterparts as not being knowledgeable or as being geniuses. Such evaluations may lead to all kinds of false deductions.

For example, during the test-ban debates we saw arguments that the Soviets did not know anything about decoupling techniques to conduct nuclear tests underground in secrecy. Also, we were told by Soviet leaders that the day of the heavy bomber had passed – which did not deceive us. On the other hand, we were quite surprised when the Soviets sent a man into space, although they had been forewarning us; and their recent exploits in space, including the Mir space station, and the "Red Shuttle" took many of our decision makers by surprise.

5.6 Stratagems to Achieve Surprise

Scientific deception can have a great impact on research and development lead time. The United States has devoted a great deal of effort to reducing the time required to translate a scientific theory, discovery or invention into a practical weapon system. In spite of much study we have not reduced the time interval to less than five years. (Since that was written the procurement time has grown from five years to ten and more.) To develop and produce a weapon in even this lengthy time costs billions of dollars, and the long lead times reduce the prospects of achieving surprise.

Scientific deception aims at keeping the enemy's lead time as long as possible. In this way a significant military advantage may result. This advantage may be crucial at the tactical and operational levels where it could have a direct impact on a strategic decision such as overt aggression.

The ultimate goal is to gain a strategic advantage by acquiring a major new family of weapons while concealing from the enemy that it is being developed. The appearance of a brand new weapon often is termed a breakthrough. When a nation makes a breakthrough of this type, as we did with the atom bomb, the British with radar, the Soviets in space, an entirely new arena for military operations is opened up. If the breakthrough leads to a military advantage that the enemy cannot counter in time, such as domination of the air, space, or deep water, the breakthrough may be decisive.
Strategic surprises can be accomplished in many ways. A few examples are:

- The choice of a strategic concept;
- The selection of weapon systems and their combination;
- The quantitative and qualitative strength of the battle forces;
- The size of the reserves and their degree of invulnerability;
- The choice of the time and manipulation of the circumstances including deception;
- The exploitation of geography such as bases, areas of access, and approach routes;
- The formation of alliances, including secret prewar alliances of the utilization of allied territory to launch an attack from an entirely unexpected direction;
- The proper choice of a center of gravity of the operation; and
- The mounting of diversions, so that the opponent divides his forces.

The major problem is developing techniques to achieve technological surprise. If we assume that the enemy intelligence service watches the development of a weapon system from its early scientific inception to its use by operational forces, deceptive moves we make at any step in the process contribute to the ultimate surprise. For example, in the scientific field we can misinform and disinform to fool the opponent. Scientific misinformation would not be propagated in the form of false formulas which would not survive the first test, but it can be created by cryptic hints about programs and alleged results. Disinformation makes the enemy doubt the accuracy of his findings.

In addition there is secrecy. A classic method of achieving a technological surprise is secretly using foreign know-how. Another widely used method has been making an unobserved modification in a technologically inferior weapon system to give it a massive improvement in performance.

In the period of weapon development, surprise can be achieved through hiding and concealment, by pretended inadvertent showing of weapons and weapon components, by phony orders placed abroad for spares or scarce materials, and through a whole host of such stratagems that are not complex but must be planned into the production cycle.

One of the most effective methods is to start the development of several competing weapons, select one, and then give a great deal of publicity to the weapons that have been rejected and will not go into production. This was used by the Soviets when they exhibited the TU-31, equivalent to our B-36; the TU-31 did not go to production. In addition, rejected test models can be exhibited in operations in such a way that the enemy will be sure to see them and draw erroneous conclusions, while tests of the chosen models are concealed. If this is impossible, erroneous information can be fed into the technical intelligence stream and various red herrings can be used. In brief, the true testing operation can be enveloped in a lot of phony operations.

Another is to develop a weapon system to meet a specific operational requirement, then adapt it for a different operational employment. The Soviet MiG-25 is an example. Developed to counter threats never deployed, the original design was never taken past the prototype stage; it is now used for reconnaissance.

Similar tricks are available to hide production. The weapon system perhaps cannot be hidden, but there are many methods to make it difficult to obtain accurate performance data. As time goes on, several modifications that change the over-all characteristic of the weapon system can be concealed.

Errors contributing to surprise can be induced about the state of training and the precise deployment. In ground war, the effective concealment of a center of gravity is half the battle won. Generally, it is not correct to assume that military forces act consistently. Some nations tend to bluff; the German pre-World War I general staff operated on the principle that one should be considerably stronger than one appears to be. With respect to technological strategy, it is much better to create simultaneously impressions of greater, as well as lesser, capabilities.

5.7 The Basic Purpose of Surprise

The purpose of such maneuvers is to generate uncertainty in the mind of the opponent. Surprise may result from technology, but the actual surprise is not in the weapon system; it is in the mind of the commander and staff that surprise really takes place. Military commanders, not weapons systems, are surprised.

It's probably worth repeating that: Surprise is an event that takes place in the mind of an enemy commander.

The devastating effect of surprise in the past has been caused by the fact that particular commanders and staff have for years conditioned their thinking according to firm expectations of enemy behavior and have carried out all their calculations within that framework. Suddenly, the basic assumptions are proved false by an unfolding operation. The result is a paralysis of thinking which often makes it impossible to carry out even those adaptations which could be accomplished within the time available.

There are a number of rationalizations that facilitate the surprise. For example, the assumption is frequently made that the enemy wouldn't do what we don't do – "Why should he do that?" Another widespread notion is that the enemy would not do what he apparently is doing because, according to his opponent's calculations of the cost-effectiveness of a weapon system, there are cheaper and better ways to achieve the desired result. There are also such common beliefs as that the enemy would not pursue a certain course of action because he would duplicate a strength he already possesses, because he could not afford the expenditures involved, or because he would not be so dastardly.

By contrast, sometimes the enemy makes a spectacular demonstration or diversion for no other reason than to create attention and misdirect the estimator's interest. Then, after losing years in trying to figure out what the military significance of the stunt really was, the estimator arrives at the wrong conclusions.

In a discussion of surprise in a very broad sense, it is often overlooked that surprise about many smaller items has occasionally been truly decisive. If it is true that a major weapon system cannot be hidden, it also remains true that specific performance data can be manipulated in such a way that the enemy makes small errors. These errors may be within the margins usually allowed by statisticians, let us say 5%. In actuality, speed differentials of 10 or 20, let alone 50, miles per hour may spell the difference between victory and defeat in combat. Similarly, such small differentials in, let us say, a radar performance, reliability of communications, or accuracy of missiles can be of the greatest significance.

In missile warfare, the reliability of the birds is crucial. If reliability is 10% higher or lower than estimated, the enemy's strike capability is quite different from what it has been calculated to be. In addition, this reliability must be figured in the time dimension. Reliability can be very high if there are hours to get ready for the launch. If there are only 30 minutes, and if the force must be launched as the attack commences, the figure would change substantially.

When Minuteman II was deployed the reliability of its guidance and control system was about one-sixth of requirement. It took three years to overcome the difficulty, but then performance exceeded specifications. If the Soviets had attacked during this period, we would have been in a fine mess. Since the mishap was widely rumored, the Soviets probably knew about it – fortunately, the U.S.S.R. lacked adequate strength.

5.8 Historical Examples

In 1937, the Germans won an air race in a spectacular manner by stripping down their Messerschmitts while the other nations entered fully-equipped fighters. Presumably the staffs understood this particular trick, but the public, the reporters, and the political decision makers were fooled. This, of course, is an example of combined technological and psychological strategy.

The most intriguing aspect of the history of aerospace war and the role of the surprise is that very professional staffs have been deceived about the most basic elements of this new type of war. At times this has been self-deception; at other times they were deceived through deliberate campaigns.

There was once the notion that the airplane was not really a militarily useful weapon. When this notion was dispelled – it took years – it was believed that the airplane would serve its purposes best by direct support of the ground battle. Consequently, the range of the aircraft was considered to be of no importance and it was thought that the range should rather be short. Later there was a great deal of doubt about the proper targets for strategic bombardment. The effectiveness of strategic air war was a matter of considerable dispute, largely because the interrelationships between industry, battle strength, and time factors involved were not understood. Furthermore, some air warriors overlooked the recuperation factor.

Similarly, during World War II there was a debate about whether the air weapon should be used for only one purpose – against industrial targets. After World War II, similar arguments raged with respect to nuclear weapons, jet aircraft, long-range bombardment versus forward bases (the question was ill-conceived as an either-or proposition), and, of course, space and air bombardment in Vietnam. Few debaters ever look at the whole range of arguments, and non sequiturs usually abound because emotions become involved in the arguments.

Another frequent source of error is that the versatility of the weapon system is underrated. The aircraft obviously is an excellent purveyor of firepower. But often ignored are its uses for demonstration, reconnaissance, the transport of goods and troops, command posts, and damage assessment and its possible employment in big as well as small wars. Some people who know such capabilities only too well, but for political reasons don't want new equipment, put up smoke-screen arguments against it.

The Strategic Defense Initiatives debates are similar. By an odd coincidence, all those who oppose SDI think it will not work. We do not recall one scientist of note who would like to see it deployed but believes it is just too expensive, or too difficult. The result is that what appears to be a technological debate is in fact a political one; but the fact remains that strategic defense offers one of the most decisive opportunities for strategic surprise in all history.

5.9 Breakthroughs

The many facets of developing, acquiring, and operating advanced weapons systems illustrate the need to consider surprise as one of the key elements of technological strategy. Technological warfare includes the anticipated breakthrough, but the breakthrough need not be a surprise.

In fact, it could well be tactical to announce a happy breakthrough that for a while cannot be countered by the enemy. His inability may come from one of two sources – technological inferiority or inferiority in the decision-making process. Naturally, the combination of these two deficiencies would increase the lead of the opposing power. In the end, unless he is defeated, the opponent would catch up with the new technique. The strategic impact of the breakthrough is a function of the duration of the one-sided advantage.

While surprise has its advantages as far as modernization of the force in being is concerned, the breakthrough has the potential of pushing the state of military art into an entirely new field that may lead to clear dominance. This is the role space warfare will play in the future. At present after three decades of space efforts we face an unprecedented situation: a clear military superiority in space potentially can ensure denial of creating a countercapability. There may be a significant novel feature, namely, that even without war such denial could be long-term.

The ability to deny an enemy access to space is essentially the ability to deny him world power status. You cannot be a global power without access to space.

5.10 Exploitation of Surprise

Initiation of war usually is the object of a great deal of surprise planning. Prior to the initiation of war, the planning of the opponent can be rendered ineffective by such techniques as misinformation (the propagation of misleading and false knowledge) and disinformation (the propagation of news designed to induce the enemy to disbelieve existing truthful and reliable information and buy false new information instead). The aggressor can use the time-honored techniques of single and double deception[4] to cloak the steps leading to his attack and induce the opponent to misread his intentions.

To meet deceptions of this sort, the strategic planner by necessity must plan against a war that might come regardless of the probability that it will not. This planning must be based on the enemy's capabilities to strike rather than on his professed intentions. The fact too often ignored is that intentions can change very rapidly, and that implementation of the new intention might require a shorter lead time than improvisation of defense against an attack that was not expected.

Under conditions of nuclear war, the importance of deception techniques is growing ever more rapidly. Arms Control negotiations must necessarily be a part of an aggressive strategy under modern conditions; the aggressor must use deception techniques to bring about disarmament arrangements which reduce the size of hostile forces in being and thus greatly simplify his planning. For example, the reasonableness the Soviets seemingly displayed in the initial SALT talks may denote (a) a turn toward peace, (b) a maneuver to delay U.S. reaction to the missile build-up in the U.S.S.R., and (c) an attempt to gain a safe rear and increase supplies for a Soviet attack on China.

The above was written in 1969. As we look back now we see that the second premise was correct, with the result that the Soviets gained a clear advantage in ICBM numbers and performance, and in military exploitation

[4]Double deception is best explained by the story of the two Jews who met on a train in Russia. Aaron asked Moses, "Where are you going?" Moses answered "To Pinsk." Aaron replied, "You say you are going to Pinsk so that I will believe you are actually going to Misnk, but I happen to know you really are going to Pinsk. So why do you lie?" In military parlance, if A plans an operation he would not try to hide his plan, but would make sure that B assumes this particular plan is being advertised because it will not be implemented. The German deception plan of 1941 that preceded the attack on the Soviet Union was planned as a single deception but actually worked as a double deception.

of space. (The Soviet Union ha a number of 100-kilowatt powered satellite radars in orbit; the US has yet to put up a 10 KW radar.)

Surprise can be achieved through disarmament and arms control arrangements and the use of propaganda and diplomacy, on one hand, and through counterintelligence, introduction of misleading intelligence, and infiltration into intelligence and policy-making staffs, on the other. As an example, before they had completed operational tests of their antimissile system, the Soviets refused to discuss an atmospheric test ban; afterward they rushed to agree before we tested our weapons concept. Other surprise techniques which may be applied could involve the holding of deceptive maneuvers, the building of dummy forces and targets to divert firepower, the employment of electronic equipments that would not be used in war, and electronic deception on a broad scale.

One important technique of surprise of which American writers seem to remain unaware, is provocation[5] This word in English usage denotes the provoking of an opponent into a rash act, but in the Communist dictionary it also means entrapment and instigation of a fight between third parties. Many wars have been started by provocations deliberately engineered by the aggressor; the purpose has frequently been to shift the onus of aggression from the aggressor to the defender.[6]

Other purposes may be to force the defender to make some sort of premature move and thus expose his strategy, or to get him embroiled in a struggle on another front so that he would disperse his forces and lose control. Such an effect could be achieved, for example, by forcing the defender into a limited war in a peripheral theater and gradually cause him to invest ever-greater military strength from his forces in being into this limited operation. Thus, he would expose his main base to effective attack. If he can be induced to use obsolete equipment in the diversionary war, the victim may never develop the kind of weapons that will be used in the decisive combat.

So-called preemptive strikes also may play a great role in surprise. The attacker could proceed by a combination of double deception and provocation to make open preparation for attack and to evacuate his cities. Then by other surprise techniques he could divert the defender's fire to false targets and achieve military superiority. Certainly moves of this sort are extremely risky, because the defender has surprise options of his own and may see through the deception. The risk can be reduced through a first-rate intelligence system, a superb early warning system such as would be provided by deploying even

[5] The Six-Day War in the Middle East has made the concept better known.

[6] As the Russians say, "If I attack you and you don't defend, there will be no war; if I attack you and you defend yourself, there will be war and you caused it."

the most elementary Strategic Defense System, and good penetration of the opponent's military apparatus and inner decision-making cycle.

Strategic planning aims at the exploitation of weaknesses and vulnerabilities, just as the wrestler tries to apply holds that force his opponent to submit. But the strategist has one advantage over the wrestler: he can contribute to the creation of vulnerabilities in the opposing force.

Creating vulnerabilities is an area where the problems of force and budgetary levels become highly significant. They can be created by an opponent who uses political means to achieve surprise. With low budgets there will always be a great tendency to cut corners, and that means that many of the support systems needed to operate weapon systems effectively will be eliminated or reduced to insufficient numbers. Very often it becomes a question of whether it is more advisable to buy firepower and delivery weapons than to harden the missiles or acquire such items as warning systems. Sometimes the choice is between offensive and defensive weapon systems.

If the aggressor can, through the employment of political means, manipulate budgetary and force levels of intended victims in a downward direction, the effectiveness of the opposing forces will be greatly reduced. Fundamentally, with a low budget it is very difficult to maintain alternative weapon systems simultaneously, and even more difficult to maintain forces based on different technologies. It is extremely difficult to provide them with good warning and protective features, to acquire suitable shelters for population and industry, and to bring new systems into being. Consequently, low defense budgets and low force levels aid the attacker in his strategic planning by reducing the complexities of his operations. Political operations in both the economic and diplomatic fields may be used to reinforce the natural tendency of the defender to save money on defense. These operations will have as their twin goals the reduction of strategic complexities through the lowering of the defender's budgets and the achievement of a state of relaxation in the victim. Then, when the attack comes, on the victim's allies and/or on his homeland, he will be unable to believe it has happened and be unprepared to defend himself. In this case, the last phase of the battle may not be a sneak attack at all; the defender may know it is coming and be unable to do anything about it.

To repeat: surprise techniques are available to both the attacker and the defender. Because we are firmly committed to a defensive strategy it is vital that we prevent surprise. We must understand also that capabilities for surprise exist for us and we must emphasize such capabilities.

These come directly from the basis for surprise: uncertainty. Although the attacker has freedom in choosing his surprise moves, the defender can do a great deal to increase the uncertainty in the mind of the attacker.

If the attacker has no uncertainty about the enemy, it is child's play to plan operations that can be decisive. If instead he experiences a great deal of uncertainty, even the planning of surprise operations becomes extremely difficult.

For example, a major purpose of strategic defense is to create uncertainties. If the defender does not have this capability the attacker will be certain that he has a completely free ride. If the defender has active missile defenses and the attacker is in doubt about whether its effectiveness lies between 50 and 90 percent, the attacker's strategic plan is greatly complicated. Suppose he assumes it is 50 percent, but it is actually 90 percent effective. Then he will fail in attack. Suppose he assumes it is 90 percent but it is actually 50 percent. In this instance he may not attack at all. Suppose his experts argue about whether it is 60 or 85 percent. In this case, the decision makers' will may be weakened. By manipulating the attacker's understanding of this situation, the defender may achieve considerable advantages.

The interplay between achieving and preventing surprise is one of the decisive elements of modern war. Speed appears to give the attacker greatly enhanced possibilities of surprise, but the defender is not without his options as well. The key to being the surpriser or the surprised is initiative, which in turn is based upon planning.

5.11 Conclusion

In guarding against technical surprise, it is important to keep its effects in the proper perspective. Technical advances generally and technical surprise in particular are steps to more decisive measures. Technology makes possible tactical, strategic, and timing surprise, and also provides systems for preventing surprise. It contributes to strategic deception, or prevents it. Surprise and deception are most vital when they contribute to or maximize the effectiveness of modern weapons. If our technological advantages are not exploited, while those of the U.S.S.R. are, we will inevitably lose the Technological War. Put differently: we must not be surprised about the fact that this is a Technological War and we must never be deceived about our relative technological standing.

Success in an operational approach based on deception and surprise depends on total orchestration of the types of conflict, not on the effectiveness of each element. Partial successes attained and exploited in many areas will offset the failures that will occur in others. The net result is that overall success is rendered more likely.

If the defender understands this particular aspect of the problem, he can devise many actions through which aggressive stratagems are neutralized. He can maintain force levels, both quantitative and qualitative, that preclude a successful attack. The defender must move constantly during the period of so-called peace, to keep abreast of technical and strategic developments. He must initiate actions to which the attacker must react, using resources that would otherwise be employed against the defender, and must initiate these actions in time to prevent the aggressor from achieving a significant advantage. Success in this game will mean that aggression by nuclear weapons would be unthinkable, simply because the aggressor would remain confined to an incalculable but low probability of success.

The really important point is that war has not become unthinkable simply because weapons of mass destruction have been invented. The prevention of war is just as much a strategic undertaking as preparation for aggression. If the strategy of prevention is effective, the aggressor will be blocked. If, on the other hand, it consists merely of dependence on passive deterrence and on weak retaliation, the strategy of prevention is doomed to failure.

For the Communists, surprise is vital to successful aggression. For our part, through the application of a rehumanized strategy surprise can be our path to the initiatives and maneuvers that suppress aggression.

The only thing that is worse than being taken entirely be surprise is to be taken by surprise after repeated warnings that one is going to be taken by surprise. The former is shocking. The latter is devastating.

Chapter 6

Assured Survival

6.1 Introduction

This chapter was originally written in 1969. We had intended extensive revisions; after all, much has happened since then: the U.S. began the Sprint Anti-Ballistic Missile (ABM) System; signed and ratified the ABM treaty which restricted the U.S. and U.S.S.R. to a single system defending one strategic offensive installation; abandoned our ABM systems entirely; and, under Reagan, began the research and development program known as Strategic Defense Initiative or SDI.

When we examined the chapter, we were surprised to discover that little beyond cosmetic revision was needed.

Our original analysis missed the importance of intercepting ballistic missile boosters in the post-boost phase when orbiting defense systems can attack the primary booster vehicle before it deploys its Multiple Independently Targetable Re-entry Vehicles (MIRV). This is an additional period of vulnerability which gives defense great leverage. Otherwise, the chapter stands up very well indeed.

In the first edition of this book we argued that the US ought to abandon the strategy of Assured Destruction (since renamed Mutual Assured Destruction, or MAD) in favor of a strategy of Assured Survival. We presented that argument in a series of briefings beginning in 1968 and continuing until 1983. The analysis remains valid. [1984]

6.2 Assured Destruction

Former Secretary of Defense McNamara based the strategic survival of the United States on a policy of Assured Destruction.[1] This was defined as the capability to assure the destruction of some specified fraction of the population and industry of the potential enemy after the U.S. Strategic Offensive Forces (SOF) had absorbed the best possible attack the enemy could launch.

To this end, the U.S. Strategic Offensive Force (SOF) was designed to be survivable, although little was done to make it flexible. Polaris missiles and nuclear submarines were built. A force of 1,000 Minuteman missiles was deployed, although a larger force was deemed necessary by the Air Force. The Minuteman silos were hardened as best they could be, which did not make them invulnerable, and the Minuteman command structure was given redundancy. The bomber force, thought to be vulnerable to the enemy first strike, was allowed to become obsolete and decline in numbers. The bombers were not replaced by newer types until the 1980's, although systems were designed much earlier. In 1970, Congress approved research and development of a long-range supersonic bomber, the B-1, but it did not appear in inventory until the late 1980's because the program was halted during the Carter Administration. McNamara had intended, consistent with his strategic doctrine, that the strategic bomber would vanish forever from both U.S. and Soviet arsenals.[2]

Missiles of that era which were slow to react and believed not to be survivable were eliminated from the inventory. Overseas-based missiles were withdrawn, chiefly because of explicit or implicit executive agreements made during the Cuban incident of 1962. The capability of the U.S. high command to fight a nuclear war was regarded as far less important than the capability to achieve assured destruction of the aggressor.

McNamara began his reign by denouncing the "spasm war," the sole purpose of which was destruction of the enemy society, and said he was replacing the spasm war plan with a policy of flexible response;[3]

[1] This was subsequently expanded to Mutual Assured Destruction, or MAD; what the late Herman Kahn called "a suicide pact" in his seminal work On Thermonuclear War.

[2] One of the most far reaching decisions made by McNamara was canceling the highly successful X Programs in the name of arms control. This action was consistent with the theory of arms control: the X projects were a continual source of new military technology. New military technology is precisely what arms controllers don't want.

[3] The story is told that in the first days of McNamara's tenure as Secretary of Defense, he invited the Commander in Chief of the Strategic Air Command (SAC) to explain the US strategic war plan (known as the Single Integrated Operational Plan or SIOP). After the review, McNamara said in horror "General, that's not a war plan! All you have is a kind of horrible spasm."

however, by the time he left office the entire strategic offensive force was geared to Assured Destruction and therefore to a spasm reaction. By forsaking flexible systems such as manned bombers, mobile ballistic missiles, and on-board guidance systems for ease of retargeting, the United States had technologically locked itself into a situation in which the only flexibility of the response would be "how much is left of our force, and what can we launch?"

Much of even this limited flexibility was illusory. The enemy's reserves and refire capabilities made our surviving missile force vulnerable to renewed attack unless it was launched quickly after the initial strike. Because of our lack of adequate air defenses, the enemy could destroy our unlaunched missile force with manned aircraft (even aircraft as inappropriate as refueled medium-range bombers). Without counterforce capabilities to destroy the Soviet strike forces, the United States had no choice but the spasm reaction to any enemy attempt to eliminate our strategic systems. We could not seek to reduce or destroy his ability to make war on us, because we had chosen not to construct forces capable of flexible operations. We had, almost completely, predetermined our strategy for years to come.

Thus, the United States had no alternative but Assured Destruction. If we failed to deter an enemy attack, the President would be left with only one option for retaliation: An attack on Soviet urban industrial targets. In the parlance of the time, this was known as a pure countervalue attack. We could fight no other kind of war. With our land-based systems dependent upon early launch to assure that they could be launched at all; with no flexible retargeting capability for this force; with no reconnaissance capability to allow us to know which enemy sites were empty and which were being prepared for refire; and with the Polaris force having insufficient accuracy for anything other than a countervalue strike, flexible response took on a note of irony.

6.3 Soviet Strategic Doctrine

In contrast to the United States, it would appear that the U.S.S.R. adopted a policy of Assured Survival. That is, the Soviets installed substantial defenses and counterforce weapons to limit damage from U.S. retaliation. While such counterforce capabilities are consistent with development of an "out of the blue" first strike capability, they also allow the Soviets more flexibility in responding to escalating tensions. Under some post-strike conditions the U.S. might be self-deterred from retaliating at all.

Whether they have been successful in this policy may be questionable, but the point is that they chose a reasonable strategy while our professed strategy led to deployment decisions that forced us into a posture that was the opposite of what we intended.

Presumably the Soviets have been unable to guarantee that U.S. retaliation will not bring destruction above the deterrent level. On the other hand, since the United States has conceded the initiative of striking first, the Soviets do not need to be overly concerned about the U.S. policy of Assured Destruction: the level of destruction is essentially a function of the level of success in the first strike. The lack of U.S. active defenses augmented the chances that such success might be considerable, and made it unnecessary to use any large part of the Soviet strategic budget for development of penetration systems.[4]They could and did concentrate on large payload capacity, accuracy improvement, and sheer numbers of offensive weapons, hoping to exploit their numbers and large payloads more fully when multiple reentry vehicle technology was adequately developed. The rest of their budget could go to testing and development of strategic defense, to which they traditionally have allocated huge resources.

6.4 Requirements of Assured Survival

The United States has never developed an actual policy of Assured Survival. The Safeguard defensive system, abandoned after the ABM treaty, was intended to protect the SOF, not our people. Although President Reagan clearly intended the Strategic Defense Initiative as a means of protecting the American people, our strategies and doctrines are still based on a policy of Assured Destruction, and to the extent that there is bi-partisan support for SDI it is largely built around the protection of our SOF.

Defense of the strategic retaliatory force is, of course, better than no defense at all; but the moral objections to Mutual Assured Destruction are unchanged by deployment of weapons intended solely to protect missile fields.

In any event, the requirements for Mutual Assured Destruction are no less dynamic than those for Assured Survival. Deterrence through MAD is not automatic. In 1970 we pointed out at least one way that deterrence could fail through nuclear blackmail.

US strategic nuclear forces are offensive only. Suppose, then, a Soviet attack directed solely against our strategic force, with the intent of reducing the assured destruction that our damaged force, further reduced by Soviet defenses, would be able to accomplish. The result might well be that the

[4]This is presumably one reason for Soviet opposition to the Reagan SDI studies.

President would question whether the surviving force would be sufficient to destroy the enemy's war-making capability.

The Soviets could then point out that the launch of our surviving force would be suicide for unprotected U.S. cities. The Soviet commanders would, of course, have held back hardened and mobile forces sufficient to destroy many American cities, using their soft-based and reloadable ICBM installations in the initial strike. Our president would be faced with a most difficult moral choice. He could either launch the SOF against Soviet industry and population centers or surrender. Doubtless, the surrender terms would be made easy to accept – initially. Whatever happened to the United States, Europe would have no choice but surrender.

Because the United States concedes the first strike to the Soviet Union, Assured Survival is a policy more expensive for us than for the enemy. We must have an Assured Destruction capability as a part of Assured Survival; but we must also have active defenses and forces capable of defeating the enemy in nuclear aerospace battle.[5] The most pressing military problem of the free world is to provide active defense against the strategic striking power of any would-be aggressor. Active defense is also the most technically difficult of the current military problems. It becomes no easier with time; the longer defense technology is held back, the more difficult the problem becomes because offensive power is growing. Yet strategic analysis indicates that a strategy of Assured Survival will be far more valuable to the free world than one of Assured Destruction.

There are two basic methods to provide Assured Survival. The first, construction of a force sufficient to destroy the enemy striking force in a preventive attack, is not feasible for an open society; if it were constructed it could not be launched by Western statesmen without severe provocation. Even a preemptive strike appears to be very difficult. The problem, it should be noted, is not symmetrical. A secretive society without scruples about aggression can achieve a decisive first strike capability far more readily than an open and peaceful government.

U.S. SOF systems are openly deployed after years of debate in Congress. Their nature, numbers, and locations can be known with considerable confidence. By contrast the U.S.S.R. can build and deploy weapons whose very existence is only speculation in the West.

Furthermore, U.S. concession of the first strike to the other side allows

[5]It is very important to understand that the alternatives to strategic defense are grim: one must either adopt a policy of launch on early warning, or watch deterrence fail as the enemy realizes he can overcome the retaliatory force with a properly planned first strike. Launch on early warning is dangerous and destabilizing policy, and even that can be defeated with a well planned pin-down strike.

the Soviets to employ large missiles launched from soft pads. Thus to say the United States may be unable, given the present state of weapons technology and sociological factors, to achieve a full counterforce capability is not the same as saying that the Soviets cannot achieve it.

Note that in the above analysis we say nothing of intentions. As we write this the Gorbachev regime appears to be interested in reduction of strategic forces and the achievement of nuclear stability. We would be more convinced of this if the Soviet Union did not continue to maintain four separate missile production lines running at full capacity to produce ICBM's; but even if we assume that the current Soviet leadership sincerely desires peace and detente, it may not be desirable to bet the survival of the United States on the stability of the Gorbachev regime.

The second method of achieving Assured Survival is through active defense, coupled with sufficient counterforce capability to threaten the enemy's residual or holdback forces. Active defense also serves to prevent destruction or extensive damage to the United States by a third power. In fact, an adequate program of active defense will ensure that, whatever our capability against the U.S.S.R., the American people will not be hostage to anyone else. There are at present no other powers capable of overcoming the defenses we could construct with present technology, and by the time others achieved penetration capability the United States could easily update the system to accommodate new technology. There are other benefits to active defense. They include the "fallout" benefit of assured adn economical access to space; and control of accidental or catalytic nuclear war, which we will discuss below. Nevertheless, the primary value of defense is its contribution to a policy of Assured Survival.

6.5 The Case Against Active Defense

> The following analysis was written in 1970, long before the SDI debates. We see no reason to change it.

There are two primary arguments against active defense, each in turn divided into two schools. The two broad classes of arguments against defense are theoretical and technical-economic.

The basic theoretical argument against defenses is that they might work. By so doing, they reduce the casualties that would be incurred in a nuclear war, and thus make that war more "rational" or possible. If decision makers know their national survival is assured, or believe this to be the case, the argument goes, they will be more reckless in making nuclear threats, and sooner or later the war will begin. According to this theory, the American and Soviet populations are hostage to each other, and ought to be. Through this massive exchange of hostages, we ensure peace.

The second theoretical argument against defense, often made by the same people who support the first argument above, is that the system will not work. Instead, all the defense systems will do is force each nation to construct strategic offensive forces that can penetrate the enemy defenses. This, they say, will "trigger another round in the arms race," resulting in great increases in SOF on both sides. The defenses will then be useless and vast sums of money, which should be put to work by other agencies of the government, will have been wasted. Most adherents of this view have a number of projects they believe the government should support with resources that might otherwise have gone toward a policy of Assured Survival.

The primary technical-economic arguments against defense are, first, that it cannot work, or that we simply cannot afford a system that will work. Complete defense is not possible at any price, and partial defense is prohibitively expensive. A second school contends that this argument is probably true, but that even if it were not, we would be better off using the money to construct new Strategic Offensive Forces, on the basis that the aggressor will be more easily deterred by the prospect of more complete destruction of his homeland than by the possibility that his attack will not be successful.

There are variations on those themes, including some unlikely combinations of them, but they all reduce to one or more of the basic points.

6.6 Discussion

The first and last of the above contentions reduce to the argument for deterrence as opposed to defense: Assured Destruction against Assured Survival. They are vulnerable to the same objection as is the deterrence thesis itself, namely, that an opponent with a rationality that differs from your own may not accept your logic; a stupid one may not understand your rationale; a very clever one may devise a method of neutralizing your force, either through a first strike, defense, or a combination of the two with psychological means; and a timid, frightened, or simply humanitarian president might prefer surrender to the deliberate killing of millions of nonbelligerent enemy nationals. The deterrence thesis of a balance of terror runs counter to Christian ethics and the doctrine of Just War, although, if there is nothing else to depend upon, preservation of the peace through Assured Destruction is in our judgment preferable to surrender or war, even on purely humanitarian grounds.

Furthermore, by abandoning defense on entirely theoretical grounds we fail to take advantage of inevitable breakthroughs in defense technology. It is becoming more and more conceivable, for example, that some form of ray or energy beam might be devised which could destroy all incoming warheads, whether delivered by aircraft, short-range submarine-launched missiles, spacecraft, or ICBM. This possibility, long considered remote, has become more than a theoretical possibility in the past 10 years.[6] But if we do not have the radars and computers to detect and track incoming enemy missiles, perfection of laser kill mechanisms will do us little good.

We cannot stress often enough that technology has a habit of being richer than even the most imaginative planners predict. Technological breakthroughs in missile defense are inevitable, and we must be in a position to take advantage of them. It is obvious that the unilateral achievement of good defense, or offense-defense combinations, by the U.S.S.R. would hardly have a stabilizing effect on international politics. We doubt that the free world would become safer through such an event. If we want to survive, we cannot concede the initiative in active defense to the enemy. Defense technology is at the moment in the lower left-hand quadrant of the technology S-curve. We see no reason why it should not continue to a breakthrough.

In March of 1983, on the advice of a council that included the authors of this book and General Daniel O. Graham, President Reagan challenged the U.S. scientific community to demonstrate and develop strategic defense technology. Within two years a number of such weapons were examined, and many found to be feasible. Some are listed in Chart 11.

CHART 11: Potential Strategic Defense Systems

Kinetic energy weapons

- Space-based
- Non nuclear
- "Smart Rocks"
- Railguns

[6] There have been many scientific breakthroughs since this was written in 1969. These have led to dramatic developments in laser technology, used for detecting, tracking, and killing enemy missiles; development of tiny computers for on-board guidance of kinetic energy weapons; technology for construction of both ground and space-based mirrors for directing beamed energy; etc.

Terminal defense systems

- Lasers
- Nuclear-powered
- Chemically or electrically-powered
- Single-shot
- Continuous

Laser Basing systems

- Space-based lasers
- Ground-based lasers with orbital mirrors
- Popup mirrors

The second argument, although theoretical in form, is in fact technological and economic, and reduces to a special case of the third argument. If a defense could be achieved that could not be countered by the offense, the argument against such defense on technical grounds vanishes. If this defense were obtainable at any reasonable price, the nation would be faced with the alternatives of continuing to live with the balance of terror or making the necessary sacrifices to end it through Assured Survival.

In the real world, of course, it is highly unlikely that a leakproof defense will ever be found. This does not mean that no defense is preferable to a partial defense. In any rational view, survival of some of the nation is preferable to complete extermination. We hope that those who fear that nuclear war will result in the extinction of all life on the planet would be the first to agree.

Moreover, partial defense systems greatly complicate the aggressor's war plan. A 25

In 1970 there were legitimate questions about the technical feasibility of strategic defenses. This is no longer true in 1988. While there can and should be debate about the degree of effectiveness that can be obtained, and which mix of systems is optimum given the strategic threat, there is little scientific doubt about the ability of the U.S., using 1988 technology, to build and deploy ICBM defenses sufficient to intercept 50% or more of the enemy's offensive strike. We may expect considerably higher intercept effectiveness with future technology. We stand at the very threshold of a rising S-curve.

The arms race argument is perhaps one of the most spectacular; it is also the most overworked. According to this view, all that defense would accomplish would be to raise the levels of strategic offensive forces in the inventories of both the United States and U.S.S.R., encumber each with defense systems that could not cope with the new offensive weapons, and waste a great deal of money all around. In addition, it is usually said that these mutual increases in SOF levels are themselves dangerous because they make nuclear war more probable.

The latter statement is most certainly not correct. As the mutual inventories of SOF increase, the destructiveness of nuclear war also increases, so that it becomes less and less rational to initiate nuclear hostilities for any but the most compelling reasons. Even the most dedicated advocates of the MAD strategy must admit that in general, the higher the force levels, the more stable what Albert Wohlstetter called "the delicate balance of terror."

In addition, even a minimum defense system will be able to cope with small, unsophisticated attacks such as might be launched by enemy officers against orders, insane local political leaders, or small nations hoping to trigger (or catalyze or provoke) a war between the superpowers.[7] Thus, the chances of nuclear war, initiated for whatever reason, are reduced by this new round in the arms race, even if the race works as predicted.

More important, the prediction is almost certainly wrong. It is far more likely that as each side develops defense technology, the defense systems will become more, not less, useful. Offensive systems to cope with the new defenses will become more and more expensive, so that fewer of them can be built. The price of the Technological War will increase rapidly. The first result of this price increase will be to force all minor powers out of the strategic picture. They may continue to be threats to each other, but after the first round of offense-defense deployment, the minor powers will never again be a threat to the superpowers. The Nth country problem vanishes, and in the highly unlikely event that detente is ever achieved, this achievement will be meaningful. There will be no pressures from allies to complicate the agreements made by the superpowers.

Still more important is the effect on the U.S.S.R. of a dramatic rise in the price of the Technological War. Soviet resources available for expansion and weapons are really quite limited compared to those of the United States. Even without U.S. mobilization, we are able to spend substantially more on defenses than our opponents–as indeed we must so long as the ob-

[7]The "madman with a missile" scenario was first discussed by Herman Kahn. For a time after 1970 it was not taken seriously, but the rise of Khadafi and the Ayotolah Khomeni have given it a renewed attention. We now have the requirement for Northern/Southern Hemisphere deterrence. Defense against ballistic missiles will be necessary even if glasnost and perestroika are entirely successful.

jectives of the United States and the U.S.S.R. are asymmetrical. Stabilizer powers always require larger forces than disturber powers because they have abandoned the initiative in military action; they must not also abandon the technological initiative, or else they no longer have the capability of stabilizing.

Soviet resources consumed in the Technological War of offensive against defensive strategic systems will not be available for other aspects of the Protracted Conflict. They would not be available, for example, to subsidize Soviet allies in the Middle East. They would not be available to subsidize Communists in Asia. Soviet naval strength would suffer. The threat to Europe would be eased. The consequence of a real escalation in the nuclear arms race, in which the weapons may be destined to sit unused, anyway, is to reduce Soviet resources for investment in the sphere where armed conflicts are fought. If the costs of the strategic arms race of defense and offense are really not high enough to accomplish that result, then they have been exaggerated, and the argument against defense weapons fails. If they are that high, the result will be well worth the expenditure. The cost of the war in Vietnam greatly exceeded the cost of a proper defensive system. The United States enjoys economic superiority over the U.S.S.R., and proper exploitation of this priceless advantage can result in real gains for the free world.

Indeed, given the professed intent of the Gorbachev administration to rationalize the Soviet economy, the result of a strategic defensive arms race might well be Soviet abandonment of the nuclear arms race in general. The Soviet Union, with it's economy in shambles, its minority races growing and disaffected, and the ruling Russians themselves becoming disillusioned, can hardly afford to repeat the past investments in strategic weapons. A shift to strategic defense would force them to choose between genuine economic improvements and refurbished missiles. Since they don't need the missiles, what they do will make their intent clear to the world.

The above paragraph was written in 1985 for a special pre-publication of this chapter. As the Berlin Wall comes down and the winds of change sweep over Europe and Asia it is clear that the threat of SDI was as economically effective as we had predicted it would be.

Finally, there is no good reason to suppose that if the United States fails to install defensive systems, the U.S.S.R. will not continue to increase the SOF. The evidence is to the contrary. Soviet SOF deployment has been dependent on U.S.S.R. technology and resources, not U.S. armament levels. [This remains true in 1989; Soviet missile production has not yet halted.] When the United States ceased to deploy ICBM systems for several years in the McNamara era, the Soviets redoubled their efforts to add to the SOF inventory and gain ascendancy. Since they continue to add to the SOF whether we install defenses or not, we would prefer that they be forced to divert some part of this budget to penetration aids and increased sophistication of their devices, rather than that they simply accumulate more and more missiles that could be used either to exterminate the last survivors or to launch highly sophisticated and effective attacks against our SOF. With very large numbers in inventory, a Soviet pin-down attack becomes far more than a theoretical possibility.

> In fact, since we wrote the above paragraph in 1970, the Soviet Union did precisely as we predicted. They greatly increased their Strategic Offensive Forces, then invested in SS-20's to threaten Europe.

In our judgment, the arguments against strategic defense are basically those used against any attempt to win the Technological War. They stem from an incorrect view of Soviet motives, or an incorrect appreciation of the decisiveness of the technological theater of combat, or an incorrect understanding of the S-curve of technology. They stem from wishful thinking about the advantages of using the money that would be spent on the Technological War to eradicate poverty, or crime, or disease, or whatever other cause is favored at the time. We share the reluctance to spend money on unnecessary weapons. We have no desire to waste the resources of the American people on defense and weapons simply for their own sake. However, we recognize the grim reality of the times. The silent and decisive Technological War will be won or lost by weapons, not wishful thinking; and in time of war, especially in the early nuclear age, a nation must choose survival as the primary goal.

6.7 The Case for a New Strategy

The benefits of a strategy of Assured Survival are presented in outline form on Chart 15. Most of these have already been discussed elsewhere, and demonstrate how strategic analysis should influence technological decisions.

By protecting national leadership against nuclear attack, a defensive capability gives political leaders time to assess the nature and purpose of the enemy action and decide on appropriate responses. Without this assurance of survival of the highest authorities, the United States has no choice but to delegate launch authority to the surviving commanders or launch on warning of attack. Because survival of a general staff cannot be assured, the attack must follow a preplanned pattern, which means in effect that it must be directed against targets chosen well in advance of the conflict. This makes conduct of the war dependent on our intelligence capabilities.

We do not argue against such preprogramming, and in fact recommend it; but we would prefer to have the option of a careful post-attack assessment, and a rational response to enemy action. This can only be gained if an authority with the means of countermanding and modifying the preplanned strike can survive; and the only way to assure such survival is through active defenses.

CHART 15: The Benefits of Assured Survival

- Ensure Survival of National Leadership
- Allow political control of the war
- Increase time for decision on retaliation
- Increase effectiveness and Flexibility of U.S.Second Strike
- Increase cost and complexity of enemy first strike.
- Increase credibility of U.S. guarantees to allies.
- Decrease likelihood of thermonuclear holocaust
- Retaliation need not be launched on warning.
- Intercept and negate small attack.
- Control accidental war.
- Control catalytic war.
- Advance defense technology to breakthrough; brings defense and offense to better balance.
- Minimize civilian losses.
- Environment and natural resources.
- Prevent genocidal strategies.

Active defenses will preserve more flexible means for carrying out a counter attack. By protecting our strategic offensive forces, we will have more of them, and have more options. This surviving war-fighting capability may be sufficient to disarm the enemy, thus avoiding the necessity for mutual extermination.

Active defenses may prevent the first strike from coming at all. If a technological breakthrough allows the enemy a capability of destroying our undefended missile force, it does not follow that this new technology will also be sufficient to allow him to overcome those weapons if they are defended. There has been considerable discussion of electromagnetic pulse (EMP) resulting from nuclear explosions in space. Without discussion of the technical merits of the arguments, it is obvious that if there were such an exotic kill mechanism that could disable our missiles in their silos, the carrier of the weapon with this mechanism still would have to be delivered on target. A defense capability would keep the carrier at a distance, require a much heavier attack, and disrupt the aggressor's attack pattern.

When the enemy must counter active as well as passive defenses such as hardening and dispersal, he must devote major resources to the effort. This diversion is beneficial, provided only that we have not wasted resources we might have used against him. But since the United States holds a defensive grand strategy and is a stabilizer rather than a disturber power, active defense is very much in keeping with our overall strategic posture; at the same time it requires the enemy to devote resources that might have been used to destroy us to the penetration or destruction of our defense network. At any given time, resources have a constant magnitude and are not expendable at will.

Another dramatic effect of Assured Survival is on our allies. The United States may be willing to place the U.S. at risk to prevent the takeover of France or Germany, but it would be more comforting to allies to know that, if we had to launch a counterattack against the U.S.S.R., we did so with strong expectations of survival. It would make it a lot easier for allies to believe we would in fact launch the strike. More important, it would be a lot easier for the Soviets to believe it.

Finally, by making possible a counterforce type of war, with interception of small or uncoordinated attacks against us before they destroyed much of the nation, Assured Survival through active defense would make less likely the thermonuclear holocaust that paralyzes so many of our intellectuals with fear. Accidental and catalytic war as well as war caused by third parties would no longer be total. National authority would be able to assess the effects of the enemy attack, which, if the defenses were effective at all, would have caused no great harm to our cities. It would be possible to determine whether a flight of missiles directed at us were the first wave of an attack, a pin-down maneuver intended to create a local environment through which we could not launch our missile force, or an unauthorized act. We could tailor our response accordingly.

In addition to active defense, we also require counterforce weapons. Assured Survival cannot be entrusted entirely to defense, because deterrence cannot be achieved except through offensive threats. So far as it goes, the idea is valid that the enemy will be deterred if we have an assured capability of inflicting enormous damage on his society. But if our strategic objective is to ensure that we do not suffer mass destruction, and will not have to kill millions of his noncombatants, we must be able to fight a war through to a successful conclusion. Pure defense is obviously no strategy at all; we need counterforce weapons as well.

The Soviets have grasped this essential point and unlike us have been deploying new systems; since the 1970's they have developed, made operational, and deployed 5 new ICBM's, some with nuclear payloads of up to 25 megatons as a single warhead, others equipped with multiple reentry vehicles to strike many targets with the same missile. Many of these systems have a reload/refire capability. Others can he held as a strategic reserve to use against our cities. We must have a capability of destroying that reserve force before it can be launched against us.

In summary, given acceptance of a strategy of assured survival, we must consider active defense and strategic counterforce weapons as the means for achieving that posture.

6.8 The Technology of Active Defense

The following brief and admittedly incomplete discussion of the technology of active defense is presented to put the problem in focus and to illustrate the nature of technological warfare. Active defense is one of the most complex and difficult problems posed to the planners of the Technological War. For precisely this reason, it could be one of the most decisive engagements in that silent and apparently peaceful war.

6.9 The Nature of the Threat

We can define the defensive problem more concretely by examining the many kinds of weapons that could be used against the free world. The list of weapons is formidable.

The threat of air power is still poised against the free world. This includes tactical fighters and bombers; long-range subsonic bombers; and supersonic bombers. These aircraft carry a variety of nuclear and nonnuclear gravity munitions and guided air-to-ground missiles. The Soviet air force is a formidable threat, only minutes away from NATO countries and Alaska, but still hours away from the continental United States.

Surface-based missiles have considerable variations in range. The Soviets began their program with the development of short-range and medium-range land-based and submarine-based missiles. The total force could carry a considerable weight of attack against Europe and Asia. The submarines also pose a direct threat against the Continental United States. One scenario, the so-called decapitation attack, has the war begin with sub-launched missiles aimed at Washington and other national command centers. These would arrive with a maximum of 12 minutes of warning, and, given uncertainties in detection and decision making by our warning system operators, probably considerably less effective time.

The intercontinental ballistic missiles pose the most direct and formidable threat against the United States. They can reach any part of the country. They carry large nuclear warheads. Furthermore, the ICBMs in existence today are accurate fourth-generation systems, with more capability to come. In 1964 the best estimates of Soviet capabilities predicted they would achieve 600 foot accuracies at intercontinental ranges by 1975. Technology has advanced considerably since that time. It is safe to assume accuracies of no more than 300 feet.

Global ranges have been achieved with FOBS (Fractional Orbit Bombardment Systems) and conceivably could be augmented by fully orbital systems, including those with highly eccentric and very high orbits. The Soviet missiles carry large payloads, and can accommodate decoys, multiple warheads, maneuvering warheads, and target seekers.

The missiles have paved the way for threats from space. Although this is forbidden by treaty, bombs of great size can be put into orbit. Khrushchev claimed these could be 100-megaton area weapons. Numbers of them could be orbited simultaneously so that at least one would be over the United States or Western Europe at all times. Warning of attack would be measured in minutes. There is some speculation that offensive systems will not be limited to nuclear weapons. New laboratory devices could result in exotic weapons, such as energy beams, that could be used for operations in orbit. While such concepts are years away from reality, it is important to realize that the state of offensive power is dynamic and that defensive power can and must be even more dynamic.

Hence, the aggressor has extreme flexibility in tactics. He could use a mass launch of his many systems, varying the time of impact of his weapons. He could use varying times of launch and strive for near-simultaneous impact. He could attack in waves, depending on which targets he thinks he must eliminate to attain overall success. For example, he could attack warning, reconnaissance, and defense systems on the assumption that he would sacrifice giving warning in order to ensure penetration of defenses. He could use feints and threats on the assumption that he could wear down our alert force and thus facilitate his later strike; or he could try to maximize surprise in all its forms.

6.10 Defense Problems

The extreme complexity of possible attacks greatly complicates the defense effort. It is therefore not surprising that many theorists have thrown up their hands in despair, and turned to a doctrine of offensive a outrance as the sole possible answer. They contend that against these highly sophisticated and complex attack mixtures the only tactic is one of deterrence through a threat of a counterattack directed, not at the enemy's weapons, but at his value system.

The defense picture is easier to comprehend if we break it into parts and examine each of them. Additional analytic divisions are possible, but for our illustrative purposes we divide the problem into the following categories:

- ICBMs and Space
- Sea-launched Systems
- Aircraft

The first category, ICBMs and Space, is the most complex. Underseas warfare technology also is difficult, with few promising approaches, but for the submarine to deliver its weapons, either ballistic missiles or air-breathing cruise missiles, it must launch them through the aerospace. If these can be intercepted, the threat of the submarine is largely negated. The development of space based synthetic aperture radar has heralded a new breakthrough in capabilities to detect submerged missile subs.

In any event, we will examine the ICBM defense problem. We will not discuss undersea warfare and air defense, not because they are uninteresting but for the sake of brevity.

6.11 The ABM Problem

The Nature of the Attack. ICBM weapons go through four reasonably distinct phases on their way to target. They are the Boost Phase, Post-Boost Phase, Midcourse, and Re-entry (or Terminal) as shown in Figure 2. Each phase has certain characteristics.

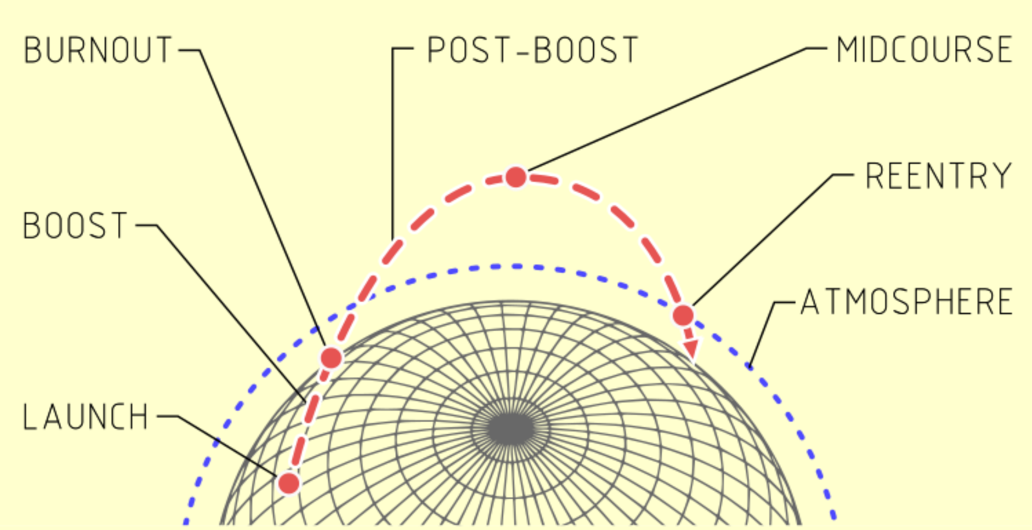


FIGURE 2: PHASES OF ICBM FLIGHT

6.11.1 Boost Phase

The boost phase lasts from the time of launch until the rocket engines are shut down (burnout). The phase is characterized by relatively slow flight, necessity for exact guidance, infra-red and perhaps other radiation, and high vulnerability. Given an interceptor vehicle with the proper homing equipment in the vicinity of the missile, boost phase interception is theoretically the simplest method of active defense.

6.11.2 Post-Boost

After the Boost Phase, the Post Boost Vehicle, or Bus, continues on a ballistic trajectory until it reaches the point in space at which it deploys its MIRV (Multiple Independent Reentry Vehicles) and/or decoys. For single-warhead ICBM's without decoys this phase is not distinguished from Mid-course.

6.11.3 Midcourse

The midcourse phase lasts from burnout to reentry of the warhead into the atmosphere. A purely ballistic missile during this phase is passive; it is cold, gives off no radiation, and most of the time moves at tremendous speed. It could reach a height of 700 miles or more. Some ICBM systems are designed to make use of midcourse correction, a maneuver in which the course of the missile is determined, its impact point predicted, and some kind of power applied to the vehicle to move the impact point closer to the target. If midcourse corrections are applied, the missile must radiate, and will be easier to detect and track.

Multiple independently targeted re-entry vehicles will also radiate during some part of midcourse flight, as the warheads are deployed from the bus.

Geography dictates that the midcourse phase for missiles directed at the United States from the USSR must pass over large uninhabited areas such as the Arctic icecap, or Antarctica. This is a theoretically desirable location for interception, as damage caused either by the interceptor warhead or by premature detonation of the missile warhead will be negligible. At the same time, interception in this region of flight is more difficult, as decoys of small weight cannot be distinguished from the bomb-carrying reentry vehicle or vehicles.

6.11.4 Reentry or Terminal Phase

In the days of the Safeguard system the Re-entry, Terminal, or "end game" phase, in which the incoming warhead must pass through some or all of the atmosphere before it reaches its target, received a great deal of attention. By reentry time, the reentry vehicle (RV) has long since separated from its powered booster and is flying a more or less predictable path, although the shape of the RV, plus sophisticated techniques for moving its center of gravity, allow limited maneuvering capability for evasion of defenses or accurate target-seeking.

The RV leaves a detectable ionized wake in the atmosphere. It is small but vulnerable, particularly in its initial stages where limited distortion of its shape or damage to its heat shield will destroy it completely. This phase takes place over the United States, and thus requires that the interceptor vehicle use a non-nuclear weapon, or a very clean warhead of limited yield to avoid damage to the population below

6.12 Interception Possibilities

Boost Phase and Pin-down. The most intriguing intercept possibility is some form of destruction during the boost phase of the enemy missile. This was once studied as Project BAMBI (Boost Anti-Missile Ballistic Interception), but the results (1959) were discouraging. Since that time, more promising approaches have been developed, but unfortunately they are more available to the enemy than to the United States.

The tactic that appears to have the largest prospect of success is a pin-down attack. In this attack, warheads fired from the defender's homeland or from space are detonated in the atmosphere over enemy missile bases. As the boost phase of an ICBM lasts several minutes, and the missile is quite vulnerable during that time because its guidance system is active and it is undergoing acceleration, any nuclear detonation nearby will render it useless if it takes place during the first few minutes of launching. The missile is no longer in its protected silo, and it is moving slowly through the atmosphere. Blast can push it off course; electromagnetic pulse can negate its guidance commands; hard radiation can destroy its guidance computer; or heat can even detonate its unburned fuel. A multimegaton warhead detonated within several miles of an ICBM in boost phase can destroy the missile.

To employ a pin-down tactic, then, it is necessary that a string of nuclear warheads be timed to arrive and explode at two to five minute intervals over each missile farm. This pin-down attack continues until other weapons arrive to destroy the missiles in their silos; none will rise through the pin-down detonations. Successful pin-down attacks require many warheads, but not an excessive number; for example, the entire Minuteman force of the United States might be pinned down with about 100 warheads per hour. Given multiple warheads, this could require as few as 20 enemy missiles per hour, surely not an impossible number.

The advantage of this technique goes mostly to the surprise attacker, who may begin his strike with a much smaller level of effort. He does not have to destroy the entire enemy missile force in his first attack wave; he merely pins them down until other weapons, including both ICBM's and manned bombers, arrive to finish the job. Only a few warheads are seen by the defender's early-warning system if pin-down tactics are employed; by the time the victim realizes what has happened, it is too late to launch his missile force.

Pindown attacks can be launched in a variety of ways. The most plausible strategy calls for the initial strikes to come from submarine-launched missiles, followed by ICBM's. However, if the original pin-down detonations come not from ICBM but from apparently peaceful satellites, there may be no warning at all before the force is trapped. Unless the defender has space weapons and manned bombers already in flight, he will not be able to employ pin-down tactics of his own because his force cannot get through. He has been denied access to space.

An alternate technique for boost-phase interception requires that space interceptors be constantly over the enemy territory. Keeping a sufficient number of interceptors continuously ready for action and over the enemy territory is costly, although not impossible. Advances in technology – lasers, neutral particle beams, non-nuclear ”smart” weapons – make it possible to attack missiles as they rise. This will be discussed in more detail in the update sections below.

On the other hand, a smaller number of space-based interceptors employing pin-down tactics can be highly useful. Moreover, even a few boost-phase interceptors with large yield weapons in random orbits severely complicates the enemy’s first-strike planning. He must plan to make this launch when there is no interceptor over his country (assuming that he knows what is and what is not an interceptor.) If he sends his attack out in waves, a single explosion in their midst can destroy a very large part of his force. The satellite-based, boost-phase interceptor can be useful to the attacker and it is also a possibly valuable component of the defensive arsenal. It can be coupled with manned, defended satellites that control the interceptors.[8] Manned space components can be useful in any phase of interception.

[By 1980 it was clear that space-based components of a defense system could accomplish boost-phase interceptions using laser kill mechanisms (space battle stations) or through kinetic kill (”smart rocks” or ”brilliant pebbles”). The American Physical Society and IBM Fellow Richard Garwin chose to ‘analyze’ this possibility by ignoring the space-based elements, and acting as if the interceptor had to be launched from the continental United States. They then claimed that the proponents of SDI were so stupid as to believe that the intercept mechanisms could exceed the speed of light. When it was pointed out that they analyzed a system no one had ever proposed, they continued with their derisive reports. Fortunately they were ignored by the President although not by most of the intellectual establishment of the United States.]

Post-Boost Phase. The missile in Post-Boost phase is vulnerable to attack from orbiting weapons, whether directed energy or non-nuclear, because in order to deploy decoys or MIRV it must perform thrusting operations, and thus will be visible to space-based sensors.

Midcourse. Theoretically, midcourse interceptors would best be based in the geographical area in which interception is to take place. That is, they should be based in the Arctic, probably on mobile platforms that could be either airborne or seaborne. Radars and other components of midcourse interception can be based in space or on land or at sea.

The midcourse interception problem is complicated by the fact that detection of the ICBM is hardest in this phase of flight. Its altitude is very great, and it is or can be cold and nonradiating. It may be accompanied by

[8] Such satellites are, of course, vulnerable to attack. However, their destruction would provide unambiguous warning of immanent attack.

decoys, and it leaves no wake. However, the problem of intercepting large clouds of incoming warheads is not insuperable. Our ability to intercept this type of attack would complicate the attacker's war plan: not only must he invest in decoys at the expense of warheads, but he cannot be certain how much of his attacking force will get through. The fact that midcourse interception can be made difficult or impossible does not mean that it has been made so. Whether this kind of intercept capability is a prudent investment for the free world is a technical and economic question; but it should be noted that a relatively small capability will still greatly complicate the attacker's planning problems and decrease his confidence.

If we remember that the purpose of defense capability is Assured Survival, and that this is best achieved if the attack never comes off at all, the midcourse interception problem assumes more manageable dimensions. We are not greatly interested in a capability for midcourse interception of a few small warheads or decoys. These can be destroyed by area and point defenses based in the United States, near the potential targets. What is desired is a capability for complicating the attacker's battle plan, and for diminishing or destroying clouds of salvoed weapons launched at us. Thus, not only can anti-missiles with relatively large but standard or improved warheads be employed but also the tactic of "threat-tube sterilization" is applicable.

This technique is based on the fact that an ICBM leaving a known location for a known destination can fly only one path, predictable in advance. It must travel through a "threat tube" in space. Properly designed weapons that vector their effects along a single direction rather than in a spherical burst can be used to destroy everything in the threat tube.[9]The presence of decoys becomes irrelevant. Such directional weapons are highly expensive (because they must be boosted into space), and would hardly be employed against single warheads, but as a system to be used against a heavy attack they show promise.[10]

Midcourse interception becomes a matter of area defense in the latter portions of ICBM flight. A long-range, interceptor designed to defend against enemy RVs over a wide range and area can be used in midcourse interception as well as in the terminal phase or end-game. It can also be used to deliver threat-tube sterilization devices. Thus, although the best theoretical midcourse interceptors should be based in the geographical area of intercept (to cut down time of flight before intercept, allow larger payloads, etc.), it is not absolutely necessary that they be based there. Area defenses in Alaska

[9]One approach to vectored energy weapons is to employ debris, steel slugs, or other physical objects – a sort of atomic grapeshot. Another is to focus radiant energy.

[10]As access to space becomes cheaper, such weapons become more feasible. Ultimately such defenses would be in orbit.

and Greenland would, or course, be useful for both missions.

If it is technically feasible, an area defense system using airborne or sea-based platforms with sensors and weapons would be valuable. Problems of location, guidance, communications, and payload complicate the matter, but the mobility of such systems would allow them to be used in defense of allies. A capability for forward deployment to provide allies with not only deterrent protection but active defense would be of immense value.

Space-based defense systems, which might make use of vectored effect weapons or, in years to come, energy beams, including laser weapons, could also be useful in defense of allies.

> The feasibility and important of space based defense systems has dramatically changed since the above was written in 1969. The SDI program has identified a number of ways that such systems can be employed. In 1969 we advocated designing space exploration programs to determine the feasibility of space-based defensive systems; now, in 1989, it is clear that they are vital for a strategy of Assured Survival.

Reentry. Terminal interception of the incoming RV after it has entered the atmosphere is the most-discussed type of ABM system, and has been adequately summarized in many publications. We confine the discussion below to a few observations.

End-game or atmospheric interception can be roughly divided into two types: area and point. Area defenses employ relatively long-range interceptors which can be used over a broad geographical area. Because of their time of flight, they must make interception at relatively high altitudes.

Point defenses, in contrast, can defend only specific targets. The point-defense concept, however, has two advantages. It may make use of somewhat smaller interceptors (although the tremendous accelerations required because of their short time of flight make their design and construction very complex); and, because interception takes place at lower altitudes, low-weight decoys have been stripped away from the warhead by the atmosphere and target identification is more or less assured. It is not worthwhile for the enemy to employ high-weight decoys, because the cost of their delivery is sufficiently high that it would be preferable simply to add another warhead.

> Although the U.S. abandoned the SPRINT and other point defense missiles developed in the late 60's, a number of new point defense systems were developed in the 1970-1988 period. These include high velocity/high fire volume guns. There is little doubt of the feasibility of point defense of hard targets such as missile silos. We do not know of adequate point de-

fenses for soft targets such as cities, which must be defended by weapons that intercept at longer ranges.

Discussion. This general and non-technical description of some of the problems of active ICBM defense is intended to serve as a background for the recommendations we make below. Our purpose is to show strategic considerations, and how they affect technological decisions and the management of the Technological War.

The offense-defense duel is summarized on Chart 16.

CHART 16: Interception Concept				
Technical Problem	**Pin-down**	**Boost Phase**	**Midcourse**	**Reentry**
Detection	–	Simple	Very Difficult	Feasible
Acquistion	–	Simple	Difficult	Feasible
Tracking	–	Simple	Very Difficult	Feasible Fast action required
Decoy Discrimination	–	Problem nonexistent	Very Difficult to impossible	Feasible to Simple
Interceptor Launch	Routine ICBM	Highly difficult interceptor must be in target area	Routine	Very fast response required; feasible but difficult
Timing & Guidance	Routine	Routine; present state of art	Feasible	Feasible but difficult
Vulnerability of Target	Highly vulnerable	Highly vulnerable	Less vulnerable Large yeild weapon employable Directed effect for sterilization employable	Atmopsphere attenuates weapon effect

6.13 Passive Defense

All active defense programs must be coupled with passive defense or shelters. The usual objections to shelters are expense and their so-called provocative nature. Although limitations of space prevent detailed analysis of these arguments, we will briefly discuss each.

To deal with the second objection first, shelters are no more provocative than any other defense measures, and less so than offensive weapons. Providing a capability for protecting the U.S. civilian population can provoke only those who intend to kill American citizens. We have not found the well-known Soviet civil defense programs provocative.[11]

With regard to cost, no one imagines that even partial shelters will be cheap; yet, with minor modifications or new construction, many shelter spaces can be created at very low cost. Urban renewal and Interstate highway construction offer excellent opportunities. Bridge abutments, overpasses, etc., provide heavy concrete and earth-filled structures that could be made with hollow spaces to provide shelter. Basements of new office buildings supported by public money can also be used. Shelters are costly if they are constructed as shelters; but if they are included in new construction the additional costs are small.

> Since this was written, the Interstate Highway System, which was originally intended to incorporate shelter spaces in the overpasses and bridge abutments, has been completed without making any contribution to civil defense. We can only hope that those who chose to strip the nation of the means for assuring the survival of at least part of the population were correct.

Assured Survival will not require a massive expenditure for shelters. It will require intelligent analysis of existing structures and future construction to provide passive defense to protect the population. Combined with active defense, intelligent shelter identification and construction can greatly reduce the possibility of "assured destruction" of the United States.

6.14 Laser Weapon Systems

> We have left much of this section as written in 1969. This is not merely braggadocio to show off the correctness of our predictions. The point is that those predictions were a result of the principles developed in this book. If laser technology had not proven to be the right path, something else would have; but in 1969 lasers and beam technologies in general

[11] As of 1988, the Soviet Union continues to require every citizen to undertake some thirty hours of instruction in civil defense, and maintains a system of fallout shelters. It is said that the Soviet population doesn't take this training seriously.

appeared to be a good bet because of their momentum, and because if they did pay off, they would pay off big.

There are many indications that laser technology is on the threshold of a major breakthrough. The laser offers such outstanding potential advantages for missile defenses that it cannot be ignored; it may be the defensive answer to the preponderance of offensive power generated by the ICBM. Lasers already seem to be the proper defense of ships against missiles such as the Soviet-constructed Styx with which the Egyptians sank the Israeli destroyer Elat. Some strategists even foresee the end of the ICBM as a modern weapon. They say the laser has sufficient potential to eliminate the ICBM threat and usher in a new era when defense has the preponderant advantage, rather than offense. This may be far-fetched, but it is something to think about.

We have left the above as it was originally written in 1969. Now, in 1988, it is clear that several varieties of lasers have great potential for defense against the ICBM.

The laser is a kind of energy beam; it projects a tightly-focused beam of high-energy coherent photons with power sufficient to melt holes in aircraft, missile booster, and possibly reentry vehicles. The range at which it can do this is at present (1969) rather short; but this is a function of the focusing of the beam, and research now indicates that it may be possible to extend this range to enormous distances. Specialized short-range Army lasers have already punched fist-sized holes in armor plate at ranges of several hundred yards.

The primary advantage of the laser for missile defense is that it acts almost instantaneously; the killing power travels at the speed of light, 186,000 miles per second, and consequently the capability to locate an incoming RV is sufficient to aim the weapon; the enemy vehicle need not be tracked for long distances. As the laser is a multi-shot weapon, decoy discrimination becomes less important; there is time to shoot down many incoming objects. Unlike an atomic ABM warhead, the laser kill mechanism does not contaminate the detection environment; the laser leaves no ionized cloud behind to blind its own radars.

Thus, laser defense systems offer enormous potential. Tracking enemy reentry vehicles is simplified; multiple installations become possible; there is little chance of running out of ammunition, as is possible when defenders must use interceptor vehicles. Shipboard installations become a distinct possibility, thus giving mobility to the defense and making a surprise attack on defensive installations much more difficult.

The present state of laser technology is, of course, highly classified. However, it is obvious that many of the early technological difficulties such as low efficiency and impossible power requirements have been overcome. We can expect continued advances in this field, and the Department of Defense is investing in laser technology. A Congressional appropriation committee member has questioned the value of research into "something that is away in the distance, 5 or 6 or 10 years," demonstrating again the problem of a nation without a strategy for the Technological War; but despite this there is great enthusiasm for laser technology in the military services. If the Congressman's estimate is correct, we could have an entirely new concept in weapons within a decade.[12]

Planning for Assured Survival, therefore, should include provision for making use of the laser, and for compatibility of laser guns with future defense installations. Laser weapons will still require heavy investment in radars and other ICBM detection and location equipment.

> The authors can remember when many scientists were certain that lasers could never be used as weapons, because they could never be made more than one or two percent efficient. This mistaken underestimate of technical potential delayed for years the development of strategies for using the laser.
>
> Since 1983 the SDI program has invested heavily in laser research. We now have the possibility of such weapons as Excalibur, a nuclear-pumped space laser weapon capable of destroying dozens of targets with one blast; large lasers on the ground with mirrors lofted into orbit at the critical time; ground based laser beams of great (terawatt) power, which are deliberately defocussed on the ground so that the atmosphere serves as a lens to refocus them; and even more exotic systems.

6.15 What Kind of Defense?

> Like the section in laser technology, the analysis below was done in 1969. It is included here to demonstrate what could have been done at that time with technology available then.

[12] There have been many scientific breakthroughs since this was written in 1969. These have led to dramatic developments in laser technology, used for detecting, tracking, and killing enemy missiles; development of tiny computers for on-board guidance of kinetic energy weapons; technology for construction of both ground and space-based mirrors for directing beamed energy; etc.

At present, the U.S. strategic force structure is essentially responsive to the Soviets. Our penetration aids are designed to counter what we believe their defensive forces to be, and have required hasty redesigning each time Soviet performance improved. Fractional Orbital Bombardment or Fully Orbital Bombardment Systems (FOBS) have required another hurried examination of our strategic defense concepts. Every U.S.S.R. deployment causes a fundamental reevaluation of our force structure.

It would be preferable to seize the initiative in the Technological War by designing and deploying dual-purpose systems capable of both offense and defense. This is technically feasible, and can save a surprising amount of money as well as force the enemy to spend resources providing for contingencies.

A dual-purpose system deploys missiles, aerospace ground equipment, basing, and logistics, all of which can be used to support both area defenses and strategic offensive weapons. Of course, the same missile cannot be used simultaneously for defensive and offensive missions. It is necessary to choose which mission the particular missile will perform, and before the mission can be changed modification would be required. However, the silo in which it is based, the maintenance crew that services it, the aerospace ground equipment that launches it, possibly the crew that controls it, and the logistics net that supports it are largely identical for both missions. It is quite probable that the same flight article can be used for both missions, with some modification of the warhead or warheads, arming and fusing, and probably the nosecone reentry vehicle. It is likely that different guidance systems as well will be required for the two missions, but there is no theoretical reason why a general-purpose guidance system could not be developed if it is required. Microminiaturization makes on-board guidance computers feasible.

In addition to missile bases, the dual-purpose system would require radars to acquire and track incoming enemy warheads. These, however, may be used also to control other defensive systems, such as point defenses near cities, missile bases, and the radars themselves. Radars and computers are highly-expensive elements of a strategic defensive system, but the savings achieved by dual-purpose forces would be substantial. These components would be compatible with use of lasers for actual kill of incoming ICBMs, if laser technology develops as expected.

The advantages are more far-reaching when we consider the effect of these systems on the enemy. he cannot know which missiles in a given complex are defensive and which are offensive. He must prepare to penetrate defenses; yet, if he achieves sufficient capability, probably at great cost, there may be no defenses at all, all the birds having been converted to offensive purposes. On the other hand, if he develops defensive systems of his own, we would be capable of restructuring our force to achieve an optimal balance between defense and offense, while if he abandons defensive systems we could divert a larger part of the general-purpose forces to defensive missions without compromising our Assured Destruction capability. Dual-purpose forces allow us to engage in technological pursuit at low cost compared to enemy expenses, and to take the initiative in the Technological War.

Given dual-purpose forces, we can select the type of defense system that offers the greatest prospect for technological success and also creates the largest problem for the enemy. Proper strategic analysis must consider not only technology and feasibility but also the entire strategic picture. To some extent, technology can be created on demand. More important, less technical effectiveness may be preferable if the system achieves greater strategic effectiveness. In our judgment, this is the case with active defense systems.

Of the active defense concepts, the one most compatible with the dual-purpose force is the area defense system that intercepts the enemy either in midcourse or at high reentry altitudes. The same defense system can be used for both types of interception. Radars used for tracking and guidance of midcourse interception are also useful for tracking enemy RVs during their midcourse flight, even though they will not be intercepted until reentry or later. The midcourse interception concept is admittedly one that poses severe technical problems, and it may well take years before an operational capability can be achieved. The high-altitude reentry intercept, on the other hand, is as feasible today as is point defense at lower altitudes. By deployment of area defense systems we preserve an option for midcourse interception, threat-tube sterilization, or laser interception at a later time. The enemy, however, must take this into account, and divert resources to counter this threat even though neither the enemy nor we know what the future capability will be. If it turns out that offensive technology for penetration of midcourse defenses is more easily developed than defensive technology, we have forced the enemy to prepare for a problem he will never have to meet, since we are not forced to deploy or use the midcourse system. On the other hand, if we do choose to develop the midcourse interception system, we will have a powerful head start and will realize considerable savings.

It is easy enough to plan a dual-purpose force capability before the technology for defensive systems is fully developed. Actually, we can achieve still more force flexibility, by designing our basing concepts to be capable of launching any one of several possible flight articles, such as: several small ICBMs; one large ICBM; one large area-defense missile; several small point-defense missiles; or one large area-defense missile capable of midcourse interception. The enemy cannot know which of these is in each silo, and, for that matter, we can change the configuration at will. He must prepare for all possible contingencies. We will have seized the technological initiative. When he responds, we can adjust our force to his maximum disadvantage, thus engaging in technological pursuit.

All of these can be real options as opposed to the paper options of the past, in that at least two of the possible birds for the system can be built with present (1970) technology. Thus, even if the research programs for the other possible configurations fail, we have added materially to the force while requiring the enemy to respond to several possible contingencies; if all of them pay off as expected, we will have achieved a real capability for deploying them at satisfactory savings in cost.

Instead, we have in the past preserved paper options. Technology was not carried past the research and development stage and thus made no useful additions to the force. Real options through multipurpose installations can create the military base for a strategy of Assured Survival. The analysis given above is not intended to be definitive or final. It is illustrative of applying the elements of strategic analysis to a contemporary strategic decision. Note also that the options we argue for are intended to prepare the base for deployment of a new generation of systems, such as the laser, that are not expected for some years.

Assured Destruction as a strategy is insufficiently flexible. To stay ahead in the decisive Technological War, the United States must strive for a real option of Assured Survival.

> On March 23, 1983, President Reagan challenged the scientific community to find means to defend the United States against ballistic missile attack, and make the nuclear ballistic missile "impotent and obsolete."

President Reagan's support for SDI came about largely because of the conclusions reached in strategic analyses performed by, among others, Lt. General Daniel O. Graham, US Army, (ret.) and his High Frontier project; the Citizen's Advisory Council on National Space Policy (which includes all three authors of this book); and others. The analysis included examination of the Soviet and US defense budgets.

Immediately after the President delivered his speech, there was first debate, then rising opposition to the program from some parts of the intellectual community. (According to the New York Times poll, over 70% of the American people were enthusiastically in favor of strategic defenses.

Most arguments against SDI are phrased as if they were technical, but in fact they are not. We know of no one who believes that we cannot build missile defenses who does not also believe that we should not build them even if we can. The analyses purporting to prove that strategic defense is impossible have not only been seriously in error, but with all the errors in the same direction, namely against SDI. Some speak glibly of the "simple" countermeasures the Soviets could take; these include shielding their missiles, spinning them, and coating them with mirror surfaces to protect them from laser energy.

Even assuming the technical feasibility of spinning large missiles as they take off – it has never been tested, much less regularly employed as a launch technique – the opponents of SDI have never analyzed what it would cost the Soviet Union to do this for all the missiles in their strategic inventory. Our analysis indicates that it would cost a lot, sufficient to slow down drastically or halt entirely the Soviet acquisition of new strategic offensive weapons for years to come.

Perhaps the bottom line on ICBM intercept effectiveness was said by Professor Gregory Benford of the University of California at Irvine: "Why would it surprise anyone that you can interfere with an ICBM? Especially if you can spend ten million dollars to knock down each one. A delicate thing like an ICBM is just fragile. The trick is to make it work, not keep it from working."

The arguments are different today, but the basic debate remains what it was in 1969: Assured Destruction vs. Assured Survival.

We continue to believe that a strategy of Assured Survival is both desirable and feasible.

6.16 1997

It should be more than obvious that there is a great need for some kind of strategic defense. Hundreds of warheads from the former USSR have vanished. Some are known to have entered the world market. One of those warheads plus an ICBM would constitute a blackmail threat against the United States that would be extremely difficult to counter; and if the threat were directed against an ally, while it might be easier to bluster and promise deadly retaliation, the ally would not find the situation comforting.

It is much better to have a defense that defends; it remains true that it is better to kill missiles rather than retaliate by killing enemies; that it is better to prevent deaths than to avenge them.

Chapter 7

The Nuclear Technology Race

7.1 Foreward

7.1.1 1997

Revised from Kane notes up to the point marked. This chapter is accompanied by another on the subject by Dr. Kane.

Of all the technologies since World War II, the one which epitomizes a strategy of technology is the silent war in developing nuclear technology. The U.S. pursuit and application of this postwar breakthrough is science and development has followed two paths.

In one the U.S. excelled and still excels; in the other the U.S. consistently demonstrated its failure to apply its innovative skills to national strategy. In this chapter we deal with the technology first, then relate it to the issue of strategy.

Throughout the period there are two major themes: fear of nuclear technology, and the development of weapons for deterrence.

The reasons for fearing nuclear technology are obvious. Nuclear weapons have sufficient power to destroy a great part of the Earth's population and wealth in a short time.

It is also well to remember why the U.S. places so much emphasis on nuclear technology for deterrence. In the late 1940's and early 1950's it became clear that the U.S. had no choice but to erect a defensive perimeter to assure its freedom and that of its allies in Europe and Asia. Major studies were conducted to examine two alternatives: dependence on conventional technology (a study that lasted three years), or dependence on nuclear weapons.

The cost tradeoffs clearly favored dependence on the nuclear deterrent. Matching the Soviets in size of forces while depending on a semi-mobilized economy was clearly not acceptable because of both the cost and political factors: the U.S. population was unlikely to endure more years of mobilization.

The U.S. began research, development, and acquisition of nuclear weapons to deter central war and for battlefield deployment to deter war in Europe and Asia. However, though these actions were deemed essential, the rate and timing were episodic, determined more by Soviet initiatives than by deliberate U.S. planned application to a long-term strategy.

Strategy reflects a struggle between decision centers.

The U.S. goal has been to preserve the status quo through a defensive strategy which is based on offensive forces. These forces and the nation itself have been (and in 1989 remain) essentially undefended. Meanwhile the Soviets continually tried to preserve the initiative and freedom of action. Their strategy has two aspects: a dynamic technological effort to try to match the episodic advances of the U.S. and a diplomatic/propaganda effort to constrain and delay U.S. technology by confusing the U.S. decision process, generally by invoking fears of global annihilation.

7.1.2 1988

There have been many advances in nuclear technology since this chapter was written. Given the dynamism of the field it would be surprising if there had not been.

In 1969 our analysis of nuclear technology focussed on lost opportunities. We did not have a broad strategy for exploiting all the potential applications of nuclear technology.

We did, however, have a nuclear strategy. It has been in operation since somewhat before the first edition, and continues to this day. The strategy is very narrow; but very, very successful. The objective has been continuously to improve our weapons in spite of all constraints. The weapon technology goes hand in hand with the inertial guidance technology. As accuracy has gotten better and better, yield has gone down, and weapon effects have gone up. Furthermore, our weapons are longer-lived, have become more reliable, and have been very economical in the use of critical nuclear material.

As we have decreased yield without giving up military (and even improving) military effectiveness we have reduced the amount of critical material in each weapon. Thus, we are able to "mine" obsolete weapons for their nuclear material and re-use it for newer, more efficient designs.

That strategy, narrow as it is, can only be called an unqualified success.

7.2 The Applications Effort

In the fifty years since Nils Bohr announced the splitting of the atom, nuclear technology has grown and matured – and become the most controversial technology in history. As we approach the end of the century, the issue is whether or not nuclear technology will continue to be constrained from its full potential. In the immediate post-war period several landmark studies (as for example the Lexington Report) identified applications to an array of military and civil applications (See Chart 17). Most of them were explored. But at the same time there was a raging discussion of ways to limit those applications or to "put the nuclear genie" back in the bottle. That situation still prevails at the start of the last decade of this century – new applications are being invented; new attempts are being made to prevent them.

The list of military applications explored covers nearly the entire range of propulsion and weapon systems.

In the initial period the focus was on nuclear weapons design and production. Two major designs were pursued: Implosion and insertion. The objectives in weapon design were efficiency and safety. As for efficiency, there were two major objectives: improving the yield to weight ratio and decreasing the amount of critical material used. Safety aspects concentrated on the bombs themselves, including extension of life of the weapons, and maintenance of reliability. During this period also, an entirely new weapon was designed – the hydrogen or "H" bomb.

Principally under the influence of the ICBM program, design shifted from weapon development and production to that of weapon systems. The marriage of a small weapon with a rocket booster led the way to an integrated approach. The first major product was the MIRV'ed ICBM, but others were found in the SLBM, field artillery, and tactical fighter delivered weapons.

Beginning at about the same time, other technologies, principally electronics, began to play a major role in nuclear weapons. The internal guidance system of the Post-Boost Vehicle which carries the MIRV's greatly improved the accuracy of weapon delivery. That technological innovation meant that the yield of the individual weapon could be reduced while still maintaining weapon effectiveness as measured by SSPK (Single-Shot Probability of Kill).[1]

Another important application of electronics came from the political requirement for absolute control of each weapon. The concern was that aircraft-carried weapons could be employed by the aircraft crew on their command. Thus, inadvertent, accidental, or deliberate but unauthorized release could

[1] Accuracy is much more important than yield in increasing the SSPK. For example [[give examples from Rand wheel]]

occur and nuclear war could result. Consequently, Permissive Action Links (PAL's) were designed and installed on nuclear weapons. For ICBM's in their silo's, a "turn-key" system was installed so that no one crew member could launch a missile, because two members would have to "turn their keys" in a prescribed sequence and on receipt of a coded message in order for ICBM launch to occur.

Implementation of the INF will remove the newest, most effective nuclear weapons from the U.S. stockpile. This is a reversal of prior treaties which resulted in or permitted removal of older, less efficient weapons while retaining the most modern ones. One of the effects of the INF is thus to increase the average age of the U.S. nuclear weapons stockpile.

In the decade of the 1990's, nuclear weapon technology will see a new phase – transformation to "wizard" weapons. During the war in Viet Nam advanced guidance technology, notably lasers, was adapted to World War II conventional bombs to make them more effective. Heroic feats of air delivery against selected elements of the power plants in Hanoi with a CEP of 14 feet were achieved with "smart bombs". These early highly accurate guidance systems will be adapted to nuclear weapons to produce in effect zero CEP weapons, meaning that no passive system of silo hardening can assure the survival of second-strike weapons.

Optical guidance, map matching, radar guidance including laser radar are available. The weight of such guidance systems will be measured in ounces, not pounds; their mass will be practically zero also. These application to nuclear weapon design with still greater improvements in yield to weight ratios, will result in new weapon capabilities. Such advances will cascade into small, more effective weapon systems.

Given the advances made in the 1960's in discriminate nuclear weapons, the ultimate will be highly effective performance with controlled energy release from small weapon systems.

On the other hand, nuclear weapon technology can be applied to ballistic missile defense by X-Ray lasers which can have destructive effects at very long distances in space. Whether based in space or on the ground with relay mirrors lasers can achieve such effects nearly instantaneously. Such lasers and other "speed of light" weapons will be possible in the next century if not well before.

But as has been the history of nuclear technology, the development of "wizard" nuclear weapons and "speed of light" weapons will be constrained and perhaps prevented by policy decisions. And those decisions will flow from the continuing fear of the atom, fear which has retarded many potential applications.

A key factor in the evaluation of policy will continue to be the Soviet drive for a total ban on testing. A comprehensive test ban would mean the end of nuclear technology.

Nuclear bombs grew from the 20 kiloton weapon of 1945 to the 60 megaton bomb exploded by the Soviets in 1961 and 1962, when they abrogated the "gentlemen's agreement" not to test nuclear weapons in the Earth's atmosphere. As nuclear technology matured, the explosive power in bombs declined from the multi-megaton range to that of the low kiloton. Such bombs are carried by fighter and bomber aircraft, ballistic missiles (ICBM, SRAM's, and SLBM), and cruise missiles.

Nuclear artillery rounds were developed, deployed and modernized for battlefield operation, particularly as part of the U.S. deterrent to Soviet attack on NATO.

Nuclear air defense weapons were deployed in Europe and the U.S. Nuclear weapons for ballistic missile defense and ASATs were deployed. Nuclear depth charges were designed. Cassaba and Howitzer were designed as nuclear ballistic missile defenses.

In propulsion technology, nuclear powered engines were developed for the Camel long-range bomber; nuclear powered cruise missile as well as SLAM, the nuclear ramjet; NERVA, a nuclear space propulsion system; nuclear reactors for ships, both surface and submarine; nuclear propulsion for spacecraft (SNAP) was used; and nuclear power systems for space stations and lunar bases were designed. A design to propel large satellites and spacecraft by a chain of nuclear explosions (Orion) was developed but never implemented.[2]

The Soviets for their part have developed and orbited many nuclear reactors. Their 100 kw Radar Ocean Surveillance system is the largest power plant put in orbit by anyone. (The largest US system has less than 10 kw of power.)

On the commercial side, nuclear power for the generation of electricity became the mainstay of France and other countries. Nuclear explosions for peaceful purposes such as building canals were actively considered by both the U.S. and U.S.S.R. for a decade and dropped.[3]

All these applications were constrained by fear; fear of accident, pollution and unknown effects, and the overriding dread that the use of even one nuclear weapon (even by accident) would lead to the end of mankind. To allay fears, emphasis was placed on safeguards and constraints. Nuclear weapons on aircraft, for example, were controlled by Permissive Action Links (PAL) so that they could be used only on authority of responsible civilians. Most

[2]ORION could have put a two million pound payload on the Moon in one flight. This is more than sufficient for a complete Lunar Base.

[3]The Soviets seriously considered very large geographical engineering projects such as diversion of north-flowing rivers and the creation of an inland sea.

of the applications for propulsion were dropped because of the impossibility of safe military operations. The nuclear-powered aircraft was to have been flown in remote areas of Utah and a special hangar was built for it even though the program never survived the design stage. A nuclear reactor was flown on a B-36H but it was not used to power the airplane. Of those propulsion applications only the nuclear reactor to power submarines survived and matured.

In like manner, nuclear "plowshares" never became a real program. Nuclear power for generation of electricity survived, albeit controversy surrounded individual plants and caused delays in construction, cancellation of programs, and even abandonment of plants.

Very much related is the issue of disposing of nuclear waste materials. The search for suitable sites has dragged on for years, hindered by concerns for pollution of the water supply and other health hazards.

Nevertheless, invention continues. New ways to focus energy produced by nuclear explosions were developed. One application was postulated for the X-Ray as a source of power to destroy enemy ballistic missiles. Tailored weapon effects for discriminant employment were developed for the "Safeguard" ABM program and battlefield weapons, and the most controversial of the inventions was the "neutron bomb" which could kill enemy forces by enhanced radiation with little collateral damage to structures and the environment.

In parallel with the technical effort was the strategic struggle with the U.S.S.R. which continues to this day.

7.3 The Basic and Continuing Role: Deterring War

Throughout the early decades of the struggle the U.S. developed and maintained adequate power to deter. Soviet advances and diplomatic and political maneuvers did not give them a decisive advantage. The U.S. episodic development, painful as it was politically maintained an adequate posture.

The development of nuclear weapons undoubtedly spared Europe from another frightful war of the dimensions of World War II. Had it not been for the American nuclear monopoly, it is highly unlikely that the USSR would have ceased expansion with East Germany, Czechoslovakia, Poland, Hungary, Rumania, the Baltic Republics, etc., in 1945-1948. The United States retained little conventional ability to stop the Soviets short of the Pyrenees, if there, and except for the threat of nuclear weapons, Europe would have fallen and would have pulled America down. As a French expert puts it, "The disappearance of nuclear deterrence would be a frightful catastrophe, for we should then lose the benefit of the stability created by the atom in our rapidly evolving world. Actually, if the United States and the United Kingdom had not developed the new weapon the Nazis would have done so, and thereby would have won World War II. The chimneys of the extermination camps would still be smoking.

If they are owned by both sides, nuclear weapons create a nearly unique historical situation, one in which the loser of a war may still retain sufficient striking power to badly damage or destroy the winner. This may be negated by defensive systems: but no matter how good the defense, the aggressor cannot rely on them for 100% protection. Some of the enemy's weapons may get through the defenses no matter how badly the enemy has been hurt.

Thus, because of nuclear weapons, deterrence becomes possible and the defensive grand strategy of the United States could be effective and may be ultimately successful. Without such weapons, we would be required to retain ground, sea, and air forces of enormous size to deter Communist aggression and we would have to deploy them overseas. Nuclear weapons create a strategic environment in which deterrence is at least theoretically feasible in terms of being economically bearable and of preventing the use of all-out war to settle a conflict.

However, the enormous power of these weapons creates still another strategic possibility: a decisive military advantage could be gained through victory in the Technological War, i.e. through technological competition without violence.

To some extent, qualitative inferiority can be compensated for by sheer numbers of weapons. It is true that the more deliverable nuclear weapons the defensive side retains in its inventory, the less attractive the situation is for the attacker; but, we must repeat, modern technology is very fluid. Truly revolutionary advances in the field of modern weapons–advances that would upset all existing military relationships–are not only possible but, if one side does nothing while the other actively seeks to exploit new technological potentialities, such upsets are well-nigh inevitable. There is no standing still, and no going back. In a world of conflict and dynamic science, the only rational policy is to pursue the Technological War diligently.

7.4 The Initiative

Nuclear technology also presents a splendid opportunity for seizing the initiative in the conflict. The United States has a defensive grand strategy. By active development of nuclear technology, we can force the U.S.S.R. to invest heavily in weapons to counter our advantages, to defend itself against our new weapons, and in general to use resources in ways that cannot harm us. Most of the advanced theoretical work in nuclear physics takes place in the West. Most of the facilities for active development of useful nuclear engineering devices are in the United States. We require only a rational strategy of nuclear technology–and the will–to take advantage of our superior facilities and resources. If we embarked upon such a course we would do more to cool down the Cold War than by almost any other technique.

7.5 The Shape of Things To Come: The Baruch Plan

The opening round of the struggle came when the U.S. presented the Baruch Plan, under which the U.S. offered to share its nuclear technology with the Soviets. That offer was summarily rejected by Stalin, who declared the U.S. to be the enemy and pushed ahead with his nuclear technology program with emphasis on nuclear weapons. Surprising the U.S. and the world, the Soviets exploited the programs they had started during World War II (aided by espionage of US technologies), to explode their first atomic bomb in 1949.

Within the U.S. a bitter debate arose over whether or not to pursue the next phase of weapon development: the hydrogen bomb. This well-known struggle was settled with the U.S. decision of proceed but the Soviets had the first bomb. The U.S. delay resulted from the gamut of assertions that would be repeated at each subsequent decision point:

1. If we don't, the Soviets won't.
2. Don't trigger a new round in the arms race.
3. Let's negotiate a ban on the new development; better, let's negotiate nuclear disarmament.
4. We're heading for annihilation of life on Earth.

7.6 The Second Ploy: The Test Ban

In 1945, the United States enjoyed absolute superiority in nuclear weapons technology. Twenty-five years later we are not certain that we are ahead in any area of nuclear weapons research, and we know that we are behind in some. Yet, during that time we have invested far more resources in nuclear weapons research and development than the USSR Despite such massive investments, our lack of a strategy and strategic sense has allowed the enemy to close the nuclear gap, and even to create one in his favor.

The first phase of this battle in the Technological War was dominated by our failure to engage in technological pursuit. We did very little to exploit our nuclear monopoly, and nothing to hinder the Soviet's development of weapons of their own. Indeed, through our lend-lease policy we sent important nuclear resources, including enriched uranium, to the USSR, greatly aiding their weapons development. Espionage also played an important role in this phase of the battle and reduced the Soviet lag time substantially. But our deliberate decision not to engage actively in development of new nuclear weapon systems was our crucial failure. Given Soviet industrial resources, all the espionage in the world would not have enabled them to catch up with us if we had been running at only one-half our potential top speed.

The second phase of the battle was the race for the thermonuclear or hydrogen weapon. This story has been told often enough and will not be repeated here, but the key decision was to allow technologists who for political reasons wanted the hydrogen weapon to be impractical to govern the allocation of resources and thereby to starve the H-program. Not surprisingly, men who believed the new weapon to be impossible, who devoted few resources to its development, and who wished it never could be built, were unable to construct the device; yet, as it happened, at least three feasible approaches to hydrogen weapon construction were discovered, none particularly difficult or complex. In this phase, the Soviets almost outstripped us, and did develop a bomb before we did.

7.7 The Test-ban Strategy

An even more decisive phase of the nuclear development battle came in the late 1950's, and illustrates the highly successful orchestration of technological and nontechnical resources into a strategy for the Technological War. The fact that this successful strategy was conceived by us, developed by the U.S.S.R., and employed against the free world should not prevent us from profiting by its example. The test-ban phase of the battle was protracted over several years, and during the entire time the initiative lay with the U.S.S.R. on the one hand, and American demagogues and professional disarmers uber alles on the other.

The first salvo of this battle came with exploitation of the sincere concern of U.S. scientists and conservationists over the possibility of atmospheric contamination due to fallout from tests, coupled with the hope that further developments in nuclear technology would never be made. It was this fear of contamination of the atmosphere that led to the atmospheric and space test bans, and it should be recalled when we examine the consequent course of the battle.

At first the U.S.S.R. and the disarmers skillfully manipulated sentiment for banning nuclear testing, through public statements in favor of a test ban accompanied by impossible conditions for a test-ban treaty. During this time, the U.S.S.R. rapidly conducted tests, then, before analyzing the test data, proposed a gentlemen's agreement or moratorium on testing. The United States concurred at once and testing ceased.

However, while we congratulated ourselves, the Soviets prepared for a new test series which took place, in violation of the moratorium, after the data of the previous tests had been evaluated and planning of the new tests had been adjusted to these findings. Test shot after test shot, all designed to increase knowledge of large-yield weapons and high-altitude explosions, was detonated with monotonous regularity, while the United States raced to respond with a new test series of its own.

In designing our own series, however, we had no real strategy; thus we conducted tests for many different purposes, and completed no series before we were again caught in the test-ban trap. Before that time, however, the Soviets, directed by their own strategic analysis, tested first large-yield weapons, then weapons for defense against ballistic missiles. They launched rockets from their center at Kapustin Yar, near the Volga, and shot them down with interceptors launched from their defense testing complex at Sary Sagan, near Lake Balkhash. They fired ICBMs with nuclear warheads, allowing the weapons to detonate after reentry. They exploded defensive warheads directly under their scientific satellites. Finally, when their preplanned series was complete, they changed their diplomatic position.

Instead of a complete test ban without inspection, they now insisted on a partial test ban to include not only atmospheric tests but also those in space. Note that there is no public health reason to include a space test ban. This was quickly accepted by the United States in the Treaty of Moscow, and we then found ourselves in a new situation. Under the terms of this treaty, the U.S.S.R. was free to conduct underground tests of small weapons in which the United States was in the lead; but the United States could not conduct, either in the atmosphere or in outer space, tests of the really large yield weapons or defensive weapons in which the U.S.S.R. was in the lead. This situation has continued to this day.

Note particularly that the reason for the original cry for the test ban was that tests threatened to contaminate the atmosphere; note also that this cry was raised because of our emotional dislike of nuclear weapons and our desire to ban all tests; the final result was a ban on tests not only in the atmosphere, where health considerations are important and a test ban is desirable, but also in space, where no atmospheric contamination is possible.

Because the Soviets had a strategy for conducting the nuclear development battle of the Technological War, they were able to maneuver us into a position of temporary disadvantage and deliver us a set-back, i.e. they imposed upon us unilateral military handicaps and they demonstrated the psychological manipulability of the United States. The Soviets then turned to technological pursuit, deploying missile defenses making use of technology that we do not have and can get only with difficulty if at all and testing small-yield weapons underground to close that lead which we had held.

7.8 Another Strategic Failure

The neutron weapon could be an important element in the next phase of the struggle. Its significance lies beyond arguments about feasibility; and indeed, the only arguments about funding research in the vital area have been arguments about feasibility. The few strategic points made by opponents of neutron technology have been erroneous.

Most of the discussion has centered around technical difficulties. William Laurence, for example, quoted "scientific opinion" that "it is scientifically unlikely that anybody can perfect an N-bomb for nearly half a century." Sometimes such predictions may be right or false but in this case it was plainly silly; it was inspired by those advisors around Kennedy and McNamara who did not want the weapon in the first place. Their opinion was not, however, based on strategic need, which received no consideration, but on general opposition to nuclear research bolstered by the overkill thesis. In making a funding decision, however, strategic requirements should be the major consideration.

The neutron weapon produces an explosion with blast in the same order of magnitude as that of a large TNT detonation. It develops little heat and negligible long-term radioactivity and fallout. That is, the neutron bomb is a kind of "death-ray" which destroys organic tissue, has great power of penetration, and does little damage to property.

There are obvious military advantages to such a weapon. Even if they cannot be constructed at low cost and air-deliverable weight, neutron weapons could be useful as atomic land mines to impede the advance of hostile field armies. In fact, the use of neutron weapons to halt enemy invasion of U.S. allies is their most obvious application; such weapons are not subject to the same objections as are other tactical nuclear weapons. They create no fallout, and destroy no large areas.

The real importance of the neutron weapon, however, is that it was a new and unprecedented nuclear technique which could lead to a revolution in weapons technology. It is not only what the N-bomb does that counts, it is also that research may ensure technological progress in the nuclear field. This is, to be sure, an intangible factor that is unpalatable to those who fear further progress.

The tactical utility should not be ignored, however. The addition of neutron weapons to the U.S. arsenal could be a major factor in future hostilities by allowing the United States to engage in war with small commitments of men and resources. By preserving its resources for the decisive Technological War, the United States would continue to function in the proper role of the arsenal of democracy.

The usefulness of neutron devices for small wars should be obvious. Enemy troops, not allied real estate, should be the targets of air weapons. One reason we have never been able to use nuclear weapons in small wars is that they leave behind them a swath of destruction and residual contamination, destroying the areas we hope to liberate. Neutron weapons do not suffer from these defects.

In a full, centralized war, the neutron weapon makes possible a new strategy. Concentration of neutron devices on the Kremlin and other known enemy command posts is preferable to blasting entire cities. If we have weapons of this kind we can use them to good psychological advantage. We could inform the peoples of the U.S.S.R., particularly such dissident minorities as Ukrainians, Estonians, Turks, etc., that we are using neutron weapons because we are not at war with the population of the U.S.S.R. but are compelled to eliminate their oppressors, who want to be oppressors of America also. If our strategy were designed to discriminate between friend and foe it would be in the self-interest of many citizens on the other side of the battle line to help us get rid of the real aggressor. With large indiscriminate weapons we will inevitably kill those who would be on our side.

There is an excellent chance that the neutron weapon will greatly improve antiaircraft and antimissile defense systems. The neutron device may be marginal for antiaircraft defense because the blast and fireball of existing nuclear weapons presumably would have a radius of destruction greater than the radius of neutron flux; on the other hand, the neutron weapons will be absolutely clean, and this is a great advantage. In space, radiation is the only long-range effect that can be obtained from any nuclear explosion. Whether neutrons or some other type of radiation such as X-rays (the kill mechanism of the first-generation ABM) are more suitable for the destruction of incoming warheads is unanswerable so long as the neutron device has not been tested.

For that matter, combinations of radiation types may prove to be the best proof against the ICBM designer's skill. In any event, if radiation is the main nuclear agent for ICBM defense and the only practical kill mechanism in space, we can hardly neglect research in this field, particularly in radiation weapons such as the neutron device.

Scientists have opposed the neutron device because many of them are instinctively opposed to advancing nuclear techniques. Some of them have stated their opposition to the neutron weapon honestly in those terms. More frequently, however, it has been alleged that neutron weapons are not important because, one, they could not be built; or two, if built, they could not be produced cheaply or in practical configurations; or three, even if they could be incorporated into weapon systems, they would not add to our existing capabilities or do military jobs better than existing nuclear weapons.

Other scientists have stated that in their judgment the neutron weapon would be useful only for ground combat and have alleged that this development commands only a very low priority. The fact of the matter is that in the past scientists have made very bad strategic and tactical analyses because they often argued on a priori grounds and looked only at fragments or segments of the overall operational requirement.

As a result of this opposition, development of the neutron device has been delayed. This is the old familiar story of the vicious circle: if budget and priorities are established on an assumption that a particular development is not promising or useful, only mediocre results can be expected. Fortunately, science marches on.

We had an instructive experience with the hydrogen weapon, which was delayed because some scientists did not believe in the need for the United States to have this weapon. When, because of dramatic Soviet progress, the decision was made to go ahead on the program with full power, the feasibility of the H-bomb was still very much in doubt. However, once the program really got under way, the necessary solutions were speedily found.

The same happened with neutron weapons. The technical problems were quickly solved. There remain the usual arguments for constraining U.S. nuclear technology.

Fear has been expressed that by pushing neutron technology we will push the Soviets in the same direction and thereby disturb the stability of the strategic balance. This deserves some attention. First, the so-called stability of the strategic balance is an illusion. In time, every system in our strategic inventory will become obsolete. Second, the nature of nuclear weapons makes arms races in this modern era qualitatively different from those of the conventional weapons period. An increase in conventional weapons capability gives a power increased confidence in his ability to win a war without disastrous results. The same is not true of a mutual increase in nuclear capability. We will discuss this more fully in the final chapter, but it is well to keep in mind the conclusion of General Beaufre: "A conventional arms race produces instability, whereas a nuclear arms race produces stability."

Moreover, the U.S.S.R. is inevitably making nuclear progress; but the strategic situations of the Soviet Union and the United States are by no means parallel. We have no intention of invading Communist territory, but we want to prevent the Communist invasion of the free world. Consequently a battlefield weapon that minimizes civilian casualties is to our advantage. Otherwise, friendly populations would be killed not only by the enemy but by their friends.

It is clear that this weapon gives us an advantage that would have only limited utility for the Soviets. The same is true with respect to increased capabilities in ICBM interception: the new technology aids both sides but is more helpful to the side on the strategic defense than to the disturber power.

This strategy dictates that neutron technology should be diligently sought by the United States. If it can be kept as a technological monopoly for the free world, the advantages are obvious. If it is developed by both sides, we still retain an advantage because of strategic asymmetries. It is only if the U.S.S.R. develops neutron technology as its own monopoly that neutron weapons will upset the stability of the arms race.

Hegel's "rule of reason" never rests: the laser is coming into its own and its development is "happening," just as an avalanche, once it is formed, moves forward beyond man's ability to stop it. The laser is a God-sent for the triggering of nuclear weapons and will necessarily be used. It will improve the yield-to-weight ratio, and thereby allow higher reliability and greater accuracy; it will permit more fire power per weight of the delivery instrument, for example in the form of additional MIRVs or, conversely, make possible reduction of the size of delivery missiles and aircraft. Such a development, by the same token, would boost the range of combat aircraft and improve the capability for low-level attack. The interesting point is that the laser trigger not only greatly facilitates the construction of an all-fusion neutron weapon but would also boost the output of fission weapons. Therefore, it can be safely predicted that sooner or later all nuclear weapons will release large neutron fluxes and correspondingly will have reduced blast, heat, and electron radiation effects.

The nature of research is precisely that uncertainty is involved. Consequently, the decision to acquire such devices should be based not on the pessimism or optimism of scientists but on strategic utility. For example, in the field of controlled fusion for electric power, pessimism is very strong and thus far the pessimists have been proved right. Nevertheless, the stakes are so enormous that we are rightly pursuing the program.

7.9 Yield-to-weight Ratio

Another important aspect of the technical race between the United States and the U.S.S.R. has centered around the mass-yield or yield-to-weight ratio. Improvement in the mass-yield ratio made it feasible, first, to develop small nuclear weapons for airplanes other than heavy bombers and, second, to complement the manned airplane with airborne missiles until better mass-yield ratios were developed. The United States saw one point in missile development; the U.S.S.R., meanwhile, concentrated on very large boosters capable of lifting the then-existing H-bombs. The United States waited until smaller bombs were developed. Subsequent improvements permitted us to progress from the single-shot to the multiple-shot missile. Further improvements will facilitate the development of space delivery systems and will enhance the effectiveness of all types of delivery–ground, sea, air, ground-to-air, etc.

To take the measure of much scientific advice, it should be recalled that the advocates of the total ban on nuclear testing argued that for all practical purposes the mass-yield ratio could not be improved much beyond that attained by the United States in 1958! We now know that this assumption was entirely fallacious and that very considerable improvements have been achieved by both the United States and the Soviet Union. All the facts suggest that considerable improvements are foreseeable, both by extrapolation from known techniques and by entirely new designs that incorporate several types of nuclear reactions.

In retrospect, we know that even those scientists who were considered to be optimistic about possible improvements were far too cautious. This has happened over and over in the history of technology, as any reader of science-fiction knows, and does not necessarily mean that the superoptimists are right about the future. It does mean that we cannot assume in advance that we know the practical upper limits to processes like the yield-to-weight ratio that have very high theoretical limits, the development of which is hindered only by engineering considerations. We should never forget that the future remains unpredictable.

One immediate improvement in existing missiles will result from advances in this technology: yield per fixed weight can be increased and multiple reentry vehicles can be installed in the present carrier force, thus effectively increasing the size of the force without adding a single new carrier. Since we will soon have to make dramatic improvements in our force in order to ensure survival, the economic gains that research into mass-yield ratio improvement could bring are worth contemplating.

Improved mass-yield ratios will aid the search for survivable second-strike weapons by allowing the construction of very small missiles that retain respectable yields. This would reduce the cost of our missile force, permit smaller silos, and give us capabilities for installing superhard survivable installations. Alternatively, we can enlarge the number of missiles in the inventory without increasing the budget; and of course Soviet MIRV development must be compensated for, either through MIRV of our own, active defense, proliferation of our missile force, or new, more survivable systems. A combination of the above including manned bombers would be preferable, and by its construction each would aid advancement of the other technologies.

Improvements in yield-to-weight ratios can change the defense picture in other ways. By appropriate design of nuclear weapons, we can change the energy partition; that is, we can alter the proportionate amounts of energy given off as heat, prompt gammas, X-rays, etc. Nuclear research may produce energy partitions that make use of exotic long-range kill mechanisms to be used against enemy missiles in space. However, all these techniques are dependent upon the energy being there in the first place, and that will require better yield-to-weight ratios.

Beyond the military uses of nuclear weapons, there are applications of nuclear energy to plowshare applications, such as digging a new Atlantic-Pacific canal, blasting out harbors, mining, and constructing shelters, underground cities, etc. There is even the possibility of nuclear energy being employed to construct large bases on the moon, where "earth"-moving will be both expensive and necessary. The advantages of using low-cost nuclear techniques for constructing underground habitations are apparent.

In order to try to curtail the application of nuclear technology to weapons, extensive, long-term efforts were devoted to international negotiations, treaties, and agreements. Very much related were efforts to prevent the use of nuclear materials developed for and by commercial reactors for weapons. The International Atomic Energy Agency was established by treaty and located in Vienna, Austria. Technology for inspections and safeguards were developed for the IAEA. Non-proliferation programs were instituted by the U.S., U.K., and U.S.S.R. but with limited effects. France pursued its own path for commercial power and military weapons, developing bombs for aircraft, strategic ballistic missiles and SLBMs.

New nations joined the nuclear club. China followed much the same path as France, but also developed its own ICBMs. India exploded its own nuclear bomb to signal its arrival as a major power. In order to prevent Iraq from developing the "Islamic Bomb" financed by Libya, Israel conducted an air strike on Iraq's nuclear reactor and destroyed it.

Israel was reported to have its own nuclear bombs. Argentina, Brazil, and Pakistan have been assessed to be "on the verge" of developing nuclear weapons. In sum, non-proliferation efforts were never successful when nations decided that it was in their interests to have nuclear weapons, and they acquired the necessary technology to develop them.

The consequence for the U.S. military planner in the 1990's is that Third World countries could use nuclear weapons in wars in their region. For example, the U.S. in the 1980's pressured Pakistan not to develop its own weapon because of the fear of nuclear war between nuclear-armed India and Pakistan. (We should note that the Pakistani have another motivation, namely, to defend themselves from a Soviet invasion through Afghanistan.)

But the major focus on nuclear technology has been on strategic relations between the U.S. and U.S.S.R. The arms control theory is that if tests are banned, weapon development will stop; the arsenals will atrophy; the user will be uncertain as to the health of his nuclear weapons; and consequently they will not be used. There is a somewhat related motivation, namely, when a country believes it has a lead in nuclear weapon technology it wants a treaty to preserve that lead and prevent its adversary from closing the gap.

The history of test ban negotiations covers the entire post-war period. The harmful effects of testing in the atmosphere led to the "gentlemen's agreement" of the 1950's which the Soviets violated in 1961.[4] It was followed by the Treaty of Moscow which did end atmospheric testing by the U.S., U.K., and U.S.S.R. (But not by France and China which were not signatories.) Lengthy efforts followed in the 1970's to limit underground nuclear testing which resulted in a partial ban, limiting such tests to 100 KT. Negotiations continued in the 1980's for a complete test ban which was not achieved.

A very curious situation arose as a result of the meeting of President Reagan and Communist leader Gorbachev at Reykjavik in December 1986. President Reagan proposed that the objective of stopping nuclear weapons testing be achieved another way – to eliminate nuclear weapons entirely. Suddenly many believers in test ban theory found themselves to be "children of the nuclear age" and opposed total elimination of nuclear weapons.

The continuous drive on the part of the Soviets impacted on nuclear technology in two domains. One lay in designing and testing weapons within the partially negotiated constraints, such as limits of 100 KT's of yield. The other lay in the closely related domain of verification. Any limit on testing has the attendant requirement to determine if violations are occurring. That in turn requires verification of compliance with the treaty limits. Obviously,

[4]The massive Soviet testing program of 1961 has been discussed in other chapters. A good work on the subject is Bielenson, The Test Ban Trap.

as the limits were decreased, the difficulty of assessing yield at lower limits increased. Thus, technology, principally the application of seismic measurements, had to be adapted to measuring yield. By the end of the 1980's that application had been very successful, giving confidence in the ability of the U.S. to verify treaty compliance.

Thus of the major lines of nuclear technology, only weapons and commercial production of electrical power survived. The strategy of nuclear weapons technology had a history of its own.

7.10 Nuclear Strategy

> The balance of this chapter was prepared in 1969. In the comparatively few places where it has needed revision, we have inserted parenthetical remarks.

The Soviets have made it clear through their continued test series that they intend to perfect their nuclear weapons and improve their nuclear technology. So have the Maoists, who have made rapid nuclear progress. As of several years ago, the initiative for perfecting nuclear technology, particularly weapons, has been conceded to the U.S.S.R., and U.S. test programs have been designed largely to react to their moves. To the extent that we have had a strategy of nuclear weapons development, it has been to deplore the existence of the weapons, deny the feasibility of more useful weapons, attempt to halt testing through diplomatic means, and design test programs to be used only after the Soviet Union begins testing. There has been no attempt to seize the initiative in nuclear technology or to pursue the advantages we do have, not, of course, for the purpose of aggression and conquest but to preserve peace.

One reason for this curious lack of strategy in this most vital area has been our fear of nuclear weapons as such and our fascination with the holocaust which supposedly will end human life or, at least, civilization as we know it. Now, the authors are well aware that nuclear weapons are dangerous, and that they can be employed to exterminate a large part of the vertebrate life on this planet. However, these weapons will not simply go away if they are ignored; nuclear technology marches on inexorably, as does other technology– in fact, nuclear physics being the characteristic science of the age, nuclear technology moves far more inexorably than other sciences. More important, nuclear weapons have been of great positive benefit to the cause of peace and in the future can perform for peace again, again, and again.

7.11 History of the Nuclear Race

7.11.1 Nuclear Research Requirements

This is not a technical study, and nuclear research remains a highly classified field. Incidentally, although there is good reason for the great secrecy surrounding some of our nuclear technology, some material appears to be classified to prevent the American people from rationally discussing the problem, much as the information that U.S. planes were bombing enemy pack-trains in Laos remained officially secret. The enemy is well aware of certain information about nuclear weapons development, just as he could hardly be unaware of the fact if he were being bombed; it is the American people whose ignorance is maintained by official secrecy.

Because the subject is classified and technical, we do not attempt to detail nuclear research programs that should be funded or to specify the direction of the programs under way. We do wish to point out aspects of nuclear technology requirements that can be learned from elementary strategic analysis. Each of the areas of potential technological breakthrough shown on Chart 17 will generate enormous repercussions in both the military and the civilian technologies dependent upon them; indeed, it can be said that the exploitation of the atom has only begun, and that future nuclear research will make the military and economic environment of 30 years from now as different from the present as 1969 was from 1939.

For example, the development of earthmoving techniques combined with nuclear power plants and seawater conversion will allow construction of cities at any seacoast location without regard to natural features such as harbors. Harbors and canals can be constructed at will, water can be converted without regard to rivers, and complete underground cities with controlled climates can be constructed if there is some necessity for them. Areas with excellent climate but neither harbors nor rivers can become resorts or industrial cities. The population explosion, which is largely a result of too many people in a few sites while most of the earth remains uninhabitable, can be damped out, at least for a few generations. Even pollution of the air and the waters may be reduced through nuclear techniques, despite the fact that modern man lives in hysterical fear of pollution by radioactivity. Pollution, the unwanted child of technology, can be eliminated only through use of the most advanced technology.

In the military field, the revolution will be as great. Warfare in the twenty-first century will differ from today's war as much as warfare in the sixties differs from the German conquests in 1939. We have no choice but vigorously to pursue our nuclear research programs. There is no way to halt nuclear progress; it must not be unilateral progress by our enemies.

7.12 The Impediments to Nuclear Research

Since the crucial importance of nuclear technology is rather obvious, and the U.S. capability in this field so well recognized, those not closely concerned with the Technological War may be surprised to discover that the United States is not far ahead of the U.S.S.R. in several key fields, and may be at a loss to understand why we have not progressed more rapidly than we have. The answer lies in the nature of our scientific decision process, as well as in lack of a technological strategy, lack even of insight into the necessity for such a strategy.

The major problem with nuclear research is that many U.S. decision makers have a strong feeling of guilt about nuclear weapons and an almost neurotic reluctance to learn more about nuclear problems. The reasoning runs as follows: We have enough thermonuclear explosives to kill every man, woman, and child in the world fifty times over; why should we spend money inventing more?

The usual decision maker is not even interested in the answer to this question; he knows in advance that there is no answer.

The problem, however, is far more complicated than he thinks. Although the so-called defense intellectuals strongly suggest that this is so, mere possession of thermonuclear weapons is not enough to deter war; nor will the "just-possessed weapon" win a war if deterrence fails. Any high school biology teacher can manufacture and store in a refrigerator of medium size enough botulism toxin to kill every vertebrate creature on the globe a thousand times over, but he has not thereby stopped war, avoided defeat, or ensured victory. Deterrence weapons must be deliverable after an enemy strike–they must get off the ground, penetrate the enemy defense, and destroy the target. If technology brings forth ways to negate the defender's arsenal before it can be delivered, only one nation will be destroyed in the war.

The self-fulfilling prophecy is another serious problem in technological development. Those who are entrusted with the technical decision about a promising line of research say it cannot be accomplished; the research program therefore gets no money; and, naturally, no invention is ever made. The history of the all-fusion weapon is an excellent illustration of this tendency.

The third problem is unreasonable expectations. The new technology is expected to produce operational weapons with characteristics far beyond anything presently in the inventory, to do so making use of previouslyundiscovered principles, and to accomplish this unfeasible feat cheaply and within four or five years. The nuclear airplane and early space-observation systems were treated this way.

It should be clear that a properly-designed technological strategy will obviate such artificially-created problems. If strategic analysis were to be systematically devoted to discovering technological areas in which surprise could be mounted, research funds should be invested to forestall surprise, through knowledge and anticipation, and to hedge against the possibility that the enemy will forge ahead in a crucial technique. Unfortunately, we usually ignore the problem. It is not enough for the technological strategist to bring his research and development programs into an orchestrated plan, we also need hedges against failure or success of exploratory programs and against surprises.

To illustrate what we mean by strategic analysis applied to nuclear research, we will discuss certain examples below. We do not assert that these are the only critical areas of nuclear research, nor even that they are necessarily the most important. We have tried to choose examples in which an understanding of strategic value does not depend on classified information.

7.13 Conclusion

Our examples demonstrate the importance of strategic analysis in the generation of a technological strategy. Technical skepticism can be important, and of course wasting resources on unprofitable lines of research can be disastrous. However, really vital research should not be neglected in order to achieve some kind of illusory economy. It is never economical to allow the enemy to move ahead in a decisive field in the Technological War, because the defender must then engage in crash programs that are wasteful of resources and consume far more time than would orderly development begun earlier.

When strategic analysis indicates that areas of nuclear research can lead to decisive advantages in the Technological War, and technical opinion is divided about the feasibility or time-schedule of the projected inventions, it is prudent to ensure that the enemy will not gain a decisive lead. Furthermore, if the research comes to nothing, it need not be wasted effort; not only may unexpected but highly important discoveries be made in the research effort, but through the use of misinformation and disinformation the enemy may be induced to invest equal resources in similarly unprofitable programs. A properly-drawn technological strategy will make use of this kind of deception, which has been practiced on us several times.

About the political battle over nuclear research, certain predictions can easily be made. For example, as neutron weapons are potentially of decisive importance, the Soviets will direct a propaganda campaign to hinder our technological advances in this field, holding out the prospect for arms control or even disarmament agreements which somehow are never signed or do not work out according to our expectations. This was the Soviet strategy to obtain the Treaty of Moscow, which is so cunningly worded that it affords them all the advantages. Neutron technology, like nuclear testing, will become the subject of much propaganda; still other attempts will be made to prohibit all nuclear testing, underground or not. No actual treaty will be signed, however, until the Soviets have accumulated all the data they need.

We must not fall victim to this stratagem again. The nuclear technology race is perhaps the key battle of the Technological War. We must seize the initiative, driving the Soviets to react to us rather than our reacting to them. The arguments of the technical skeptics and disarmers will be with us in the future as they have been in the past, and they will be difficult to counter. The primary question, however, is this: will we be first or second in the critical area of nuclear technology? If we are second, we may find that the gap is not closable; the results can be decisive.

7.14 Notes to Chapter 7 by Dr. Francis X. Kane

NUCLEAR TECHNOLOGY TEXT FROM DR. KANE 1 June, 1988 Jerry, after struggling with the chapter, I finally identified its flaw. Steve assumed that a nuclear strategy meant exploiting all the potential applications, and that the Soviets constrained us by their deployment/propaganda efforts.

The fact is that we have and have had a strategy for nuclear technology. It has been very narrow; but very, very successful. The objective has been to continuously improve our weapons in spite of all constraints. The weapon technology goes hand in hand with the inertial guidance technology. As accuracy has gotten better and better, yield has gone down, and weapon effects have gone up. Furthermore, our weapons are longer-lived, have become more reliable, and have been very economical in the use of critical nuclear material.

Furthermore, as we have decreased yield without giving up military (and even improving) military effectiveness [sic] we have reduced the amount of critical material in each weapon. Thus, we are able to "mine" obsolete weapons for their nuclear material and re-use it for newer, more efficient designs.

That strategy can only be called an unqualified success.

7.14.1 Nuclear Technology

In the fifty years since Nils Bohr announced the splitting of the atom nuclear technology has grown and matured – and become the most controversial technology in history. As we approach the end of the century, the issue is whether or not nuclear technology will continue to exist. In the immediate post-war period several landmark studies identified applications to an array of military and civil applications (See Chart 17). Most of them were explored. But at the same time there was a raging discussion of ways to limit those applications or to "put the nuclear genie" back in the bottle. That situation still prevails at the start of the last decade of this century – new applications are being invented; new attempts are being made to prevent them.

The list of military applications explored covers nearly the entire range of propulsion and weapon systems.

Nuclear bombs grew from the 20 kiloton weapon of 1945 to the 60 megaton bomb exploded by the Soviets in 1961 and 1962, when they abrogated the "gentlemen's agreement" not to test nuclear weapons in the Earth's atmosphere. As nuclear technology matured the explosive power in bombs declined from the multi-megaton range to that of the low kiloton. Such bombs are carried by fighter and bomber aircraft, ballistic missiles (both ICBM and SLBM), and cruise missiles.

Nuclear artillery rounds were developed, deployed and modernized for battlefield operation, particularly as part of the U.S. deterrent to Soviet attack on NATO.

Nuclear air defense weapons were deployed in Europe and the U.S. Nuclear weapons for ballistic missile defense and ASATs were deployed. Nuclear depth charges were designed (Casaba Hawlyn[?]) and deployed.

In propulsion technology, nuclear powered engines were developed for long-range bombers (the Camel[? Comet?])' nuclear powered cruise missile; nuclear reactors for ships, both surface and submarine; nuclear propulsion for spacecraft (SNAP) was used; and nuclear power for space stations and lunar bases were designed. A design to propel large satellites by a chain of nuclear explosions (Orion) was developed but never implemented. The Soviets for their part have developed and orbited many nuclear reactors.

On the commercial side, nuclear power for the generation of electricity became the mainstay of France and other countries. Nuclear explosions for peaceful purposes such as building canals were actively considered for a decade and dropped.

All these applications were constrained by fear; fear of accident, pollution and unknown effects, and the overriding dread that the use of even one nuclear weapon would lead to the end of mankind. To allay fears, emphasis was placed on safeguards and constraints. Nuclear weapons on aircraft, for example, were controlled by Permissive Action Links (PAL) so that they could be used only on authority by[?] responsibility civilians. Most of the applications for propulsion were dropped because of the impossibility of safe military operations. The nuclear-powered aircraft was to have been flown in remote areas of Utah and a special hangar was built for it even though the program never survived the design stage. Of those propulsion applications only the nuclear reactor to power submarines survived and matured.

In like manner, nuclear plowshares never became a real program. Nuclear power for generation of electricity survived, albeit controversy surrounded individual plants and caused delays in construction, cancellation of programs[?], and even abandonment of plants.

Very much related was the issue of disposing of nuclear waste materials. The search for suitable sites dragged on for years, hindered by concerns for pollution of the water supply and other health hazards.

Nevertheless, invention continues. New ways to focus energy produced by nuclear explosions were developed. One application was postulated for the X-Ray as a source of power to destroy enemy ballistic missiles. Tailored weapon effects for discriminant[?] employment were developed for the "Safeguard" bird[?] program[?] and battlefield weapons, and the most controversial of the[?] inventions was the "neutron bomb" which could kill enemy forces by enhanced radiation and not produce damage to material.

In order to try to curtail the application of nuclear technology to weapons, extensive, long-term efforts were devoted to international negotiations, treaties, and agreements. Very much related were efforts to prevent the use of nuclear materials developed for and by commercial reactors for weapons. The International Atomic Energy Agency was established by treaty and located in Vienna, Austria. Technology for inspections and safeguards were developed for the IAEA. Non-proliferation programs were instituted by the U.S., U.K., and U.S.S.R. but with limited effects. France pursued its own path for commercial power and military weapons, developing bombs for aircraft, strategic ballistic missiles and SLBMs. China followed much the same path but developed also its own ICBMs. India exploded its own nuclear bomb to signal its arrival as a major power. In order to prevent Iraq from developing the "Islamic Bomb" financed by Libya, Israel conducted an air strike on Iraq's nuclear reactor and destroyed it. However, Israel was reported to have its own nuclear bombs. And Argentina, Brazil, and Pakistan were assessed to be "on the verge" of developing nuclear weapons. In sum, non-proliferation efforts were never successful when nations decided that it was in their interests to have nuclear weapons, and they acquired the necessary technology to develop them.

The consequence for the U.S. military planner in the 1990's[?] was that Third World countries could use nuclear weapons in wars in their region. For example, the U.S. in the 1980's pressured Pakistan not [to?] develop its own weapon because of the fear of nuclear war between nuclear armed India and Pakistan. (We should note that the Pakistani have another motivation, namely, to defend themselves from a Soviet invasion through Afghanistan.)

But the major focus on nuclear technology has been on strategic relations between the U.S. and U.S.S.R. The arms control theory is that if tests are banned, weapon development will stop; the arsenals were[?] atrophy; the user will be uncertain as to the health of his nuclear weapons; and consequently they will not be used. There is a somewhat related motivation, namely, when a country believes it has a lead in nuclear weapon technology it wants a treaty to preserve that lead and prevent its adversary from closing the gap.

The history of test ban negotiations covers the entire post-war period. The harmful effects of testing in the atmosphere led to the "gentlemen's agreement["?] of the 1950's which the Soviets violated in 1961. It was followed by the Nassau Treaty which did end atmospheric testing by the U.S., U.K., and U.S.S.R. (But not by France and China which[?] were not signatories.) Lengthy efforts followed in the 1970's to limit underground nuclear testing which resulted in a partial ban, limiting such tests to 100 KT[?]. Negotiations continued in the 1980's for a complete test ban which was not achieved.

A very curious situation arose as a result of the meeting of President Reagan and Communist leader Gorbachev at Reykjavik in December 1986. President Reagan proposed that[?] objective of stopping nuclear weapons testing be achieved another way – to eliminate nuclear weapons entirely. Then many believers in test ban theory found themselves to be "children of the nuclear age" and opposed total elimination of nuclear weapons.

The continuous drive on the part of the Soviets impacted on[?] nuclear technology in two domains[?]. One lay in designing and testing weapons within the partially negotiated constraints, such as limits of 100 KT's of yield. The other lay in the closely related domain of verification. Any limit on testing has the attendant requirement to determine if violations are occurring. That in turn requires verification of compliance with the treaty limits. Obviously, as the limits were decreased, the difficulty of assessing yield at lower limits increased. Thus, technology, principally the application of seismistic[?] measurement, had to [be?] adapted to measuring yield. By the end of the 1980's, that application had been very successful, giving confidence in the ability of the U.S. to verify treaty compliance.

Thus of the two major lines of nuclear technology: Weapons and other applications, only weapons and commercial production production of electrical power survived. The strategy of nuclear weapons technology had a history of its own.

In the initial period the focus was on nuclear weapons design and production. Two major designs were pursued: Implosion and insertion. The objectives in weapon design were efficiency and safety. As for efficiency, there were two drivers[?] – improving the yield to weight ratio and decreasing the amount of critical material used. Safety aspects concentrated on the bombs themselves, including extension of life of the weapons, and maintenance of reliability. During this period also, an entirely new weapon design – the hydrogen or "H" bomb.

Principally under the influence of the ICBM program, design shifted from weapon development and production to that of weapon systems. The marriage of a small weapon with a rocket booster lead[?] the way to an integrated approach. The first major product was the MIRV'ed ICBM, but others were found in the SLBM, field artillery, and tactical fighter delivered weapons.

Beginning at about the same time, other technologies, principally electronics, began to play a major role in nuclear weapons. The internal guidance system of the Post-Boost Vehicle which carries the MIRV's greatly improved the accuracy of weapon delivery. That technological innovation meant that the yield of the individual weapon could be reduced while still maintaining weapon effectiveness as measured by SSPK (Single-Shot Probability of Kill).

Another important application of electronics came from the political requirement for absolute control of each weapon. The concern was that aircraft-carried weapons could be employed by the aircraft crew on their command. Thus, inadvertent, accidental, or deliberate but unauthorized release could occur and nuclear war could result. Consequently, Permissive Action Link[s?] (PAL's) were designed and installed on nuclear weapons. For ICBM's in their silo's, a "turn-key" system was installed so that no one crew member could launch a missile, because two members would have to "turn their keys" in a prescribed sequence and on receipt of a coded message in order for ICBM launch to occur.

Implementation of the INF will remove the newest, most effective nuclear weapons from the U.S. stockpile. This is a reversal of prior treaties which resulted [in?] or permitted removal of older, less efficient weapons while retaining the most modern ones. One of the effects of the INF is thus to increase the average age of the U.S. nuclear weapons stockpile.

In the decade of the 1990's, nuclear weapon technology will see a new phase – transformation to "wizard" weapons. During the war in Viet Nam advanced guidance technology, notably lasers, was adapted to World War II conventional bombs to make them more effective. Heroic feats of air delivery against selected elements of the power plants in Hanoi with a CEP of 14 feet. Similarly, such guidance systems will be adapted to nuclear weapons to produce in effect zero CEP weapons.

Optical guidance, map matching, radar guidance including laser radar are available. The weight of such guidance systems will be measured in ounces, not pounds; their mass will be practically zero also. These application to nuclear weapon design with still greater improvements in yield to weight ratios, will result in new weapon capabilities. Such advances will cascade into small, more effective weapon systems.

Given the advances made in the 1960's in discriminate nuclear weapons, the ultimate will be highly effective performance with controlled energy release from small weapon systems.

On the other hand, nuclear weapon technology can be applied to ballistic missile defense by X-Ray lasers which can have destructive effects at very long distances in space. Whether based in space or on the ground with relay mirrors they can achieve such effects instantaneously. Such lasers and other "speed of light" weapons will be possible in the next century.

But as has been the history of nuclear technology, the development of "wizard" nuclear weapons and "speed of light" weapons will be constrained and perhaps prevented by policy decisions. And those decisions will flow from the continuing fear of the atom, fear which has retarded many potential applications.

A key factor in the evaluation of policy will continue to be the Soviet drive for a total ban on testing. A comprehensive test ban would mean the end of nuclear technology.

Chapter 8

What Kind of War Is This?

Small wars, like the poor of the bible, are always with us. Since the end of World War II each year has seen an average of 40 small wars occuring around the globe. People have been killing each other with all sorts of technology from primitive weapons such as spears and swords to the most recent innovations such as Soviet Hind helicopters firing guided missiles. Nuclear weapons have not yet been employed, but there is no certainty that they will not be.

Although many years have elapsed since the first use of nuclear weapons in war, there has never been a nuclear war as the term is popularly understood. Of course in one sense we are already engaged in nuclear war, in that the Technological War has an important nuclear dimension; but nuclear weapons have not been used in anger since before the capitulation of the Japanese.

This has not meant the end of conflict. The United States was heavily engaged in Vietnam, so much so that the level of effort was greater than that put forth in all of our wars with the exception of World War II and the Civil War. The Korean War, although limited, was no small affair; in various other places, such as the Bay of Pigs, U.S. prestige has been heavily involved in the outcome of military operations, not all of which have been successful.

One of the most inhuman wars of the decade of the 1980s has been the Soviet attempt at conquest in Afghanistan. Long delayed in the timetable of Soviet expansion to its coveted warm water port, Afghanistan has yet to fall under the Soviet war machine on its way through Pakistan to the Indian ocean. The struggle between nationalist guerrillas using mostly primitive weapons and the world's mightiest military force employing highly advanced technology was a proving ground for Soviet doctrine, operations, leadership and technology. As they face the next step the Soviets have to anticipate a strategic issue – would the invasion of Pakistan result in Pakistan using nuclear weapons to halt the onslaught?

As usual, the Soviets have employed a propaganda campaign to "arouse the world against proliferation of nuclear weapons". The assertion that Pakistan needed nuclear bombs as a counter to its powerful neighbor, India, was discounted. Under no circumstances should Pakistan have nuclear weapons to deter the Soviets in the 1990s from marching toward this decades long desired prize.

The world struggle may ultimately be decided in a major nuclear conflict between the United States and the U.S.S.R. Obviously any decision in such a confrontation would determine the fate of the world; but until that final engagement takes place, if it ever does, there will be numerous dispersed brush-fire, limited, police-action, or small wars, and these can be of enormous strategic significance. The outcomes of small wars can contribute to success in centralized war, facilitate or lead to nuclear aggression, or render nuclear battle unnecessary. They are key events in the Protracted Conflict.

8.1 Classification of Conflicts

In this chapter we define and describe Small Wars, relate them to other wars in what is called the spectrum of warfare, examine some of the major issues, and then deal with options for applying technologies to this aspect of the Technological War. We begin with a definition and description.

8.2 What Are Small Wars?

Small wars are a special form of organized violence to seize and maintain political power. Small wars have been part of human affairs for many thousands of years, but in the 20th century the art, science, strategy, tactics and operations of small wars were highly developed and employed by political ideologues.

The conspiratorial revolutionaries, such as Blanqui, in the late 18th and early 19th centuries, developed the tactics, which are incorporated into small wars. Lenin and the Bolsheviks, building on the conspiratorial revolutionaries, introduced a "scientific" approach and with it a strategy for seizing power. Trotsky's operational plan for the capture of St. Petersburg in 1917 became the model for today's operational planning.

Since the 1920's, the Lenin School in Moscow has been teaching conspiratorial revolution and its many tactics and techniques; strategy for seizing power; tactics, such as propaganda and disinformation; and operational use of violence, such as kidnaping, assassination, demonstrations and terrorism. An innovation in the past two decades has been the use of drug traffic as the source of funds for revolutionaries.

The Lenin School in Moscow is no longer the only school for small wars. North Korea, Cuba, East Germany and Czechoslovakia now have centers for training individuals in strategy, tactics, and operations.

In the 19th century, the century of revolution, there were many opportunities to use violence for attempted seizures of political power: In 1848 in France and Germany; and the Paris Commune of 1870. In the 20th century, we have seen the Russian Revolution of 1905, Lenin, Hitler, Mussolini, Castro and Ortega.

The starting point for the "scientific" study of this form of organized violence was the extensive literature of sociologists such as Weber and Mosca, political economists Pareto, and Sorel.

The strategy of such small wars is based on a theory of the power structure of society and government. The key element is the elite which controls the instruments of power, principally the coercive armed forces, the military services, the constabulary and the police. But it includes also communication, transportation and propaganda.

Thus, the struggle is between decision centers, i.e., the elite on the one hand and the group using violence to seize power on the other.

The issue for a strategy of technology is whether that technology should be applied to specific parts of the spectrum of conflict, or should it provide applications flexible enough for all parts of it. A second issue is whether the technology should be acquired to be the counterpart of that of the enemy at a specific level. In other words, can high technology be applied to low intensity wars, and conversely, can low technology be employed at high levels of conflict.

This is obviously an artificial approach because technology, like war, really cannot be defined as a spectrum.

Two cases, Afghanistan and Pakistan, point out the dimension of the strategic problems of small wars and of the strategy of technology involved. The types of conflicts described as small wars encompass terrorism; assassination; marriages of criminal elements, such as dope smugglers, and subversives; large scale guerrilla actions; insurgences; civil wars; and highly intensive conflicts in which advanced technologies from space reconnaissance (used by the Soviets), were applied to electronic warfare used by Israel and Egypt. In the last war between them the overhanging question was, just as it will be when the Soviets invade Pakistan, will nuclear weapons be used?

The technological problems of the American strategist of technology in dealing with small wars are different from those in other countries. The Israelis for example have a clearly defined defensive mission and they are constantly upgrading the applications of advanced technology to their offensive power. The Soviets employ a wide range of conflicts as part of their global expansion and they equip surrogates with many types of technology depending on the location, geography, and forces engaged. Even when expanding into the American domain they have employed surrogates, such as Castro and Ortega, and have equipped them with the technology appropriate for putting them in power and keeping them there. At the same time they have secured bases near the US heartland from which they can operate their forces equipped with their most advanced technology.

As the defensive power the US has developed military forces, alliances, and bases from which to operate against a constantly expanding range of conflicts. On two occasions when operating at the highest level of conflict with conventional weapons, Korea and Viet Nam, the US approached the domain of a major power, the People's Republic of China. The Chinese invasion of Korea raised the strategic issue of whether or not the US would use nuclear weapons. In that situation, Secretary of State John Foster Dulles invoked the policy of "massive retaliation" as a potential US response. In the Viet Nam case, Senator Barry Goldwater was defeated in his bid for the Presidency in 1964 partly because of fear that he would use nuclear weapons. Thus, the array of demands on the American strategist of technology covers technology in all its forms from the highest to the lowest.

The overriding demands of deterring nuclear war have been the engine of the US strategy of technology since the end of World War II when the USSR chose the US as its enemy. Failures to achieve US objectives in large-scale continental war in Korea and Viet Nam have led to high priority for technology for conventional war in Europe. Deterrence with conventional weapons has gone hand-in-hand with nuclear deterrence.

Success in the dynamic struggle to deter large-scale war has not prevented the continual conflicts which threaten the interests of the US and the security of its allies. One consequence was Congressional intervention in 1986 to mandate that the Department of Defense organize and operate "Special Operations Forces" to cope with terrorism, hostage-taking, subversion, guerrilla action, and insurgencies. The problems are global in extent, from Cuba, Nicaragua, El Salvador, Honduras in our own hemisphere; to Angola, Ethiopia in Africa, to Lebanon and Israel in the Middle East, to Afghanistan and Thailand in Asia; and to the Philippines in the Pacific. Threats to our interests and to our allies can best be countered, Congress decreed, if we organize properly.

This is an old argument. In the 1950s the "spectrum of conflict" had theoretical vogue partially because of doctrinal issues such as levels of conflict; escalation of conflict; nuclear thresholds; nuclear firebreaks. The implications for strategy of technology were explored in Project Forecast I in the 1960s.

Issues such as "are there technologies which apply to the various levels of conflict" were addressed. Or, if the conflict were at a low level, could it be terminated by employing weapons designed for a higher level of conflict. In other words, would escalating the conflict bring it to an end?

For example, should the long range bomber be employed in a low-level conflict, and if so, when? Conversely, should the risks be run that the "barefoots" equipped with advanced air defense missiles could kill a multi-million dollar aircraft designed for nuclear weapons delivery. Similarly, should counterinsurgency forces be equipped with aircraft designed especially for operating from austere bases in remote areas against small units?

The answer then and for years later was that special forces should not be organized for low level conflicts, and the strategy of technology should not include technologies uniquely for such conflicts.

> This constraint does not mean that high tech equipment in the inventory should not be employed in small wars. In the Falklands War of 1982 bothe the British and the Argentines employed available weapons such as the "Exocet" missile and Harrier aircraft which had been developed for other wars.

The rationale was two-fold: 1) Forces and tecchnology for higher level conflicts could be employed, and 2) the budget and the priorities required concentration of resources on the two highest requirements – deterrence of nuclear war, and deterrence of large-scale conventional war in Europe.

The strategy of small wars, like any other strategy, results from the struggle between decision centers. Within the "elite," the group in power, there are at times several groups, coalitions who are trying to displace those who are in control. Thus, within the elite, there is "elite a," "elite b,", "elite c," etc.

Those who are attempting to seize power and who are not part of the elite form a group whose unity of purpose, discipline and control varies from country to country, and time to time. However, what is distinctive is the agreement within the group that the old order, the elite with its several factions, must go.

The observers, victims, targets, and sometimes participants in the struggle are the general population. Their voice, influence and participation in the control of affairs of political, economic and social nature is limited. By and large, the population is neutral in the violent phases of the struggle.

The revolutionaries have many techniques available for "splitting" the elite, and we have been watching them "split" the Congress over U.S. policy in Nicaragua. An indirect approach to the elite is through the population in general. While the group trying to seize power carries on "operations" against the elite and its several factions, and against the general population, its principal target is the instruments of power of the elite, that is, the armed forces, the militia, and the police forces. Most of the members are drawn from the general population, but their loyalty is principally to the ruling "elite." The tactics employed against the instruments of power range from obtaining defection, to assassination, to guerrilla attacks, to large scale military operations. In any seizure of power the role of the military, para-military and police forces is crucial to success or failure.

Finally, the theory and practice of small wars incorporates the intervention of external powers and influence. The most extreme case is that of defeat in war and the imposition of a new controlling elite by the victor. Intervention can also take the form of money, arms, technology, training, and outright, obvious support of the group trying to seize power, such as providing satellite data to them. In the past, such external intervention came from other governments; now it comes also from those who control the international drug traffic.

As we now know the Soviets have come a long way in developing, analyzing, and applying doctrine, strategy, tactics, and operations. Their approach is embodied in Five Laws of War which apply to small wars as well as other forms of war, such as technological war. Their origin lies in the formulation of Lenin of the conditions for seizing power. In today's version, the Five Laws cover Political, Economic, Morale, Technology and Military elements.

The assessment of the laws of war is called the Correlation of Forces. The political element dominates, although until about ten years ago, the military element was primary. There are correlations of political stability, economic power, strength of morale, lead in technology, and related military power. Obviously the status varies from time to time, and the assessment is a dynamic process. But the key point is to exercise control over the dynamic process so as to achieve power. That means planning and organizing.

Assessing the Correlation of Forces is as complex as it is dynamic. The Soviets are not mesmerized by quantitative analysis of status of military forces. True, they employ many models of different levels of conflict, and different sizes of forces. Often, those models are conservative in orientation because the Soviets abhor "adventurism." But quantitative analysis is only a step and often the last step in the process of helping the decision maker. He is a political figure, even the military commander, for he executes policy of the ruling group. He may participate in the decision process itself, but this was not the case under Stalin and even today the military have no vote in the Soviet Defense Council. (The Chief of the General Staff is the Secretary of the Council.)

8.3 Political Correlation of the Forces

The assessment here focuses on the elite in power and its factions. Goals and objectives, strategy, plans (if they exist), and outside political support of the elite are elements of the assessment. The purpose, however, is to understand strengths and weaknesses so as to employ the most effective tactics.

For example, within the elite, a faction may be headed by a dissatisfied close relative of the head of state who may be induced to defect overtly or covertly. In some instances, the church of the predominant religion may be a presumed source of strength for the ruling elite, but individuals in the church hierarchy may also be made allies of the group trying to seize power. The educational system and the media are similar elements of influence and may be causes of weakness which can be exploited.

The array of tactics developed by the Soviets is well documented: information and disinformation, lies, propaganda, slogans, mass appeals, whispering campaigns, and outright graft and corruption are a partial list.

Obviously, a leader of the group attempting to seize power must be highly visible as an alternative to the existing elite. If possible, a charismatic leader has the most effect. He has to be supported by his own organization, his "cadre" which does the planning and executes the operations. In theory, the cadre is to become the new ruling elite.

As will be discussed further, the loyalty of the military or other coercive power to elite is crucial, and it is assessed as the key factor in the Correlation of Military Forces.

The timing of the all-out attack on the ruling elite is central to success or failure of the seizure of power. Thus, the Correlation of Political Forces focuses on the timing of the overthrow. The other four elements are also important, but it is the failure of will of the elite which begins the dissolution of the regime.

8.4 Correlation of Morale

The assessment of morale includes that of support of the members of the elite, but it concerns more generally the support of the general population. The population can be neutral, loyal, indifferent, apathetic or hostile to the state. Usually it is not involved in the power struggle within the elite or between the elite and those attempting to seize power. For the latter, the neutrality or lack of involvement of the general population may be an asset in some instances, but in other, there must be a breakdown of support by the general population. For example, general strikes, work slow-downs or stoppages, riots, provocations of the police or military forces may be organized and executed to give the impression, real or assumed, that the ruling elite are no longer in control. The population becomes demoralized. The ruling elite loses its will to power.

8.5 Correlation of Economic Power

While the "reformers" attempting to seize power usually propose vague and general programs for economic improvement, this factor is also important to assessment of the Correlation of Forces in determining the timing of the assault on the ruling elite. The group attempting to seize power often employs tactics to disrupt and destroy the economy. The strikes and other economic tactics which are elements of the morale factor are also crucial to the economic assessment. Violent actions, such as bombings of transportation and facilities (power plants, pipelines, factories) and assassinations and kidnaping of business and industrial leaders are among the tactics employed to disrupt the economy. Blackmail and extortion are employed to gain financial support for military operations and other elements of the general plan for seizure of control.

When economic paralysis has been caused, the assessment of the correlation of the Economic Factor is obviously in favor of the group attempting to seize power. However, condition short of paralysis may also be an element in the timing of the all-out assault on the elite.

8.6 Correlation of Technological Power

Generally speaking the ruling elite will have technological superiority. Communications, transportation, firepower in the hands of the coercive power provide the ruling elite with an important, if not decisive edge. The spread of technology at an accelerating rate is eliminating that edge. In the international drug traffic the drug cartels have access to the latest communications and transportation. They are becoming more heavily armed than police forces.

Military operations by the group employing violence to seize power are greatly aided by external intervention. Such intervention can be in the form of modern weapons and communications. It can also be in the form of data from intelligence collection or from satellites which are provided directly to forces in the field during the course of operations.

In future interventions advanced technology will be made available. Sensors for detection and tracking of government forces, data fusion and transmission, real-time command and control of guerrillas, subversives or dope-dealers will be employed to defeat government forces.

8.7 Correlation of Military Power

The Military Factor is the key element in assessing the Correlation of Forces and the transfer of political power. As long as the coercive power of the elite remains loyal, has not been defeated militarily, and has the will to defeat the group attempting to seize power, the latter will not be effective.

Indirect attacks on the coercive power, such as seemingly indiscriminate attacks on the general population, causing and leading to riots and assassination of military leaders are tactics to support the direct attacks, the small wars with government forces. Defeat of the latter means success in seizing power form the elite. In Chapter Two, we discussed the current Soviet approach to Protracted Conflict and their use of the Correlation of Forces to assess the strategic, technological, tactical, and operational situations. In planning and conducting small wars, the Soviets employ the same approach. It is not discussed in detail here except as the Correlation of Forces applies to small wars.

Small wars have all the characteristics of other wars. They are subject to the same kind of assessment as nuclear wars with one major difference. They are a complex of interacting elements which make up a state, a government, a nation, a society, or a country. An effective strategy for seizing power is based on the assessment of the individual elements and their integration into one overall assessment. The struggle between the two decision centers is, thus, protracted, very complex and dynamic. The key elements in such struggles will be the individuals in the opposing decision centers – just as they are in all human affairs.

8.8 The Spectrum of Small Wars

1. **INSURRECTION**: Use of force against a government to achieve public purposes that cannot, in the opinion of the insurrectionist, be achieved by pacific methods.

2. **REBELLION**: An uprising intended to effect the territorial autonomy or independence of a region, but not complete overthrow of the central government.

3. **COUP D'ETAT**: A change in government effected by holders of governmental power in defiance of the state's legal constitution.

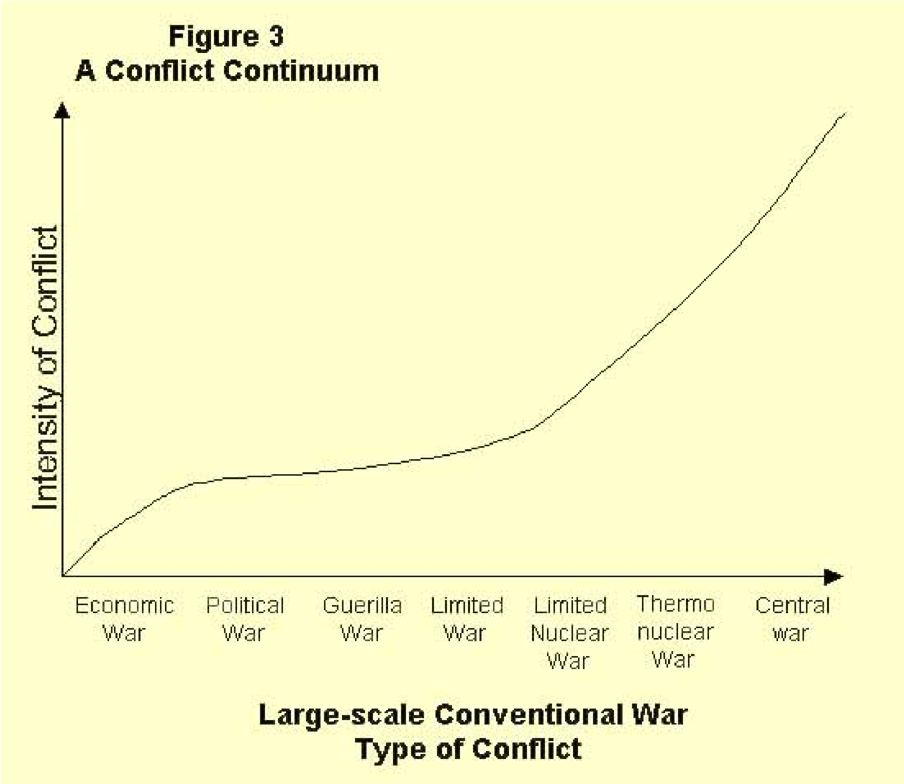
4. **REVOLUTION**: Recasting of the social order, often by violent means.

5. **THE REVOLUTION**: Lenin's inevitable class war when the Proletariat will rise against the bourgeoisie.

It is fashionable to portray conflict as a kind of continuum. This portrayal assumes that the intensity of conflict has some kind of measurable dimension; so long as this assumption is not taken too seriously, the continuum can be a useful conceptual tool. However, various conflicts can take place simultaneously at many points along the scale. The Soviets may be engaged, through proxies, in guerrilla and conventional war operations against the United States and her allies; conducting a trade and economic offensive, either openly or through other proxies; fully exploiting the illusion of arms reduction, offering numerous diplomatic ploys; fomenting subversion, sabotage, and terror in limited areas; and engaging in the Technological War through research and development, weapons construction, intelligence, and disarmament propaganda. All these events have been occurring over the past decades and are, in fact, occurring at this time. It may be useful to visualize some particular local operation, or phase, as being at one or another point on the spectrum of conflict, but it would be fatal to assume that because we are at a particular point on the escalation ladder we cannot be at three or four others as well. It would be particularly unhealthy to assume that because the U.S.S.R. is deescalating one or another limited operation as in Afghanistan in 1988 that is being fought with gunpowder weapons, they have also abandoned the Technological War.

Attempts to classify conflicts have had one important and beneficial result. We are becoming more aware of the many forms of violence the Communists are using to attain their goal of world domination. To that extent, reasonably precise definitions are useful, and, of course, analysis is not possible without a data language in which to discuss problems. At the risk of redundancy, we repeat that it is pointless to treat classifications as if they were the real world and to deal with abstractions to the exclusion of the actual situation. The Communists have more than once done what armchair strategists thought was impossible or unthinkable.

For example, it was proved after 1953 that the Korean War was an anomaly, and could not happen again. The United States would not again permit a war of attrition, dribbling away blood and treasure in the hope of reestablishing the status quo ante. This conclusion prevailed until 1965, when we did precisely what we thought we would never do again. Soon it



was realized that the war in Vietnam was actually larger than the Korean War, if measured by U.S. costs in manpower and gold. It also turned out that we had forgotten much we thought we had learned. We had improved tactically and technologically but we had retrogressed strategically.

Our initial strategy in Vietnam was based on the assumption that the war would remain small and sublimited. The subsequent expansion of the war was thought by many academic strategists to be the result of Communist reaction to our escalation of the war, and thus the fault of the United States.

In one sense, this was true. Our expansion of the war was in accordance with our misunderstandings, and concentrated on the military aspects of the conflict without any overall plan for the prosecution of the war as a whole. Unfortunately, the technology and aid that we supplied to Vietnam was almost wholly military; and although military effort alone cannot end guerrilla war it can prevent enemy victory. Military efforts result in a drawn-out war of attrition against an enemy who could afford to lose men indefinitely; in Vietnam, 50,000 North Vietnamese casualties per year was a price Giap was prepared to pay, while a tenth of that number of American dead was a price the American people were not prepared to pay for stalemate.

It would be more nearly correct to conclude that this kind of war begins with subversive organization and gradually expands through guerrilla operations to larger conflict. This is in accord with Communist doctrine, which recognizes that guerrilla operations cannot be decisive but they can soften up the target population until large military forces can be employed in the decisive phase. It is nearly impossible to draw a precise line that separates the resulting expanded war from the guerrilla war that preceded it, and this was a main cause of our troubles in Viet Nam. By concentrating effort on military operations and deliberately expanding the war we blinded ourselves to the fundamental problem, which is to provide safety to the individual citizen of the threatened country.

In this book we do not discuss the political and organizational aspects of a strategy for small wars, but we want to make clear that these are far more important than military operations in wars of the Vietnam type. Military efforts are defensive maneuvers in "wars of national liberation;" the offensive against the guerrilla must be conducted by nonmilitary means.

Examples of offensive action in counterinsurgency are: training of police; training of administrators; detailed plans for improvement of routine administrative services; recruitment and training of police intelligence officials such as in the Special Branch in Malaya; economic aid programs coupled with military action to defend the resulting improvements; codification of laws; road and communication net construction coupled with sufficient military protection. The role of the military is generally defensive in all cases.

This does not mean that there is no place for military offensives, but these are tactical, designed to break the enemy's hold on territory. Actual pacification requires something more flexible, and a great deal more permanent, than an army.

In Vietnam, U.S. efforts in the early phases were almost entirely military, even when the number of U.S. soldiers was small. Our economic aid tended to take the form of obsolete combat equipment, much of which fell into enemy hands either through capture or sale. As the United States committed more and more men and material to Vietnam, support from the North also was increased. While the United States was still maintaining a Military Advisory Group in South Vietnam, Ho Chi Minh and General Giap sent tons of supplies and entire regiments of northern regulars in an attempt to bring the war to a successful conclusion. Even after the United States had sent upwards of 500,000 men to Vietnam, and thereby prevented the military conquest the North had expected to make, guerrilla operations continued in many parts of Vietnam and the neighboring countries of Thailand, Laos, Cambodia, Burma, and India. Because U.S. operations in Vietnam were not seen as part of an overall plan to build an effective administration in the South, and we still hoped for a purely military victory, the North could afford to wait.

American surrender in Viet Nam did not mean the end of the problem; the war for South East Asia still continues. It will still take many years to end the conflict and bring peace in that region. Military force is still required to halt Communist aggression.

In addition to their actions in Vietnam, the Communists opened limited operations in the United States designed to sap our will and convince us that resistance to their war of "national liberation" was futile. It takes no great number of enemy agents to exploit discontent with a mismanaged war. Guerrilla operations are mainly a contest of will, not power, and anything that softens the will to resist can be used as a weapon in the struggle.

In actuality, the terms guerrilla war and limited war are or can be semantic traps. By attempting to fix the conflict at some point of the scale of conflict intensity, politicians also fix the limits of weapons that can be used without escalation. It should be fairly obvious, however, that strategy cannot be chosen by abstract categories. The decision as to which weapons to employ, assuming that one intends to engage in a conflict at all, is a military decision, although it has strong political and diplomatic overtones. It is not true that limitations on weapons to be employed are the only possible limits on conflict. An equally important limit is the theater or area of conflict; another is the objective sought.

For example, any war that is to be fought in the homeland of one of the superpowers, and which has as its objective the extinction of the nation, will be a nuclear conflict. The destruction of either the United States or the U.S.S.R. through externally sponsored guerrilla activities and revolution is simply not possible in the nuclear era. The USSR is, of course, subject to internal pressures from its population and ethnic minorities, but this is outside the scope of this book.

Indeed a collapsing superpower presents special problems, since the nuclear forces will remain. Who will control them? Thus, even if the U.S.S.R. were to set up a successful coup d'etat against the United States, the nuclear weapons remaining in the hands of the U.S. military forces would have to be neutralized. There is no assured means for accomplishing this task short of physically destroying them, which in all likelihood would require nuclear strikes.

On the other hand, it is obvious that military operations for the possession of a minor island in the Pacific will not require the use of H-bombs on that island. There would be no point in their employment, and the objective would hardly be worthwhile even if there were some sound military reason for their use. Between these two extremes, a wide variety of conditions, locations, and objectives can determine the most expedient unit of weapons to be employed in a given situation.

It is unlikely that nuclear weapons will be employed in guerrilla or sub-limited wars, because there is little military necessity for them; furthermore, they would have to be employed on the defended territory, which would almost certainly have an effect on the decisions of the next government attacked by guerrillas; there is such a thing as having friends who are just too powerful to be helpful. Many anti-Communist leaders might well prefer Communism to being defended with 20-megaton or 20-kiloton weapons. However, this situation may change as fraction kiloton weapons become available in large numbers.

When, however, the guerrilla war has expanded to the stage of mobile war, and particularly when the sponsor requires large bases of operations to sustain his effort, the possible use of nuclear weapons needs to be considered. It is not automatic that nuclear weapons should be employed; there will always be great reluctance to cross the nuclear firebreaks, for political reasons. However, the war might be ended or substantially contained through the use of nuclear weapons. If the enemy can never be certain that nuclear attacks will not be made, his troop deployments, warehousing techniques, and supply operations will be adversely affected due to the necessity of dispersal.

As the stakes grow higher, the use of nuclear weapons becomes much more likely, and such weapons can deter escalation from a guerrilla to a large-scale conflict. As more important and industrialized belligerents become involved, and their possible fall more directly affects the central Technological War, both sides must realize that it is almost inconceivable that the other will surrender without using quality weapons.

8.9 Escalation to Centralized War

Generally speaking, no one is going to initiate centralized war–that is, war in and for the homeland of a superpower–unless he is ready to fight with nuclear weapons and take the consequences of such a conflict. The enemy is, of course, willing to foment unrest and revolt within the United States, and although it is never used, the same opportunity is available to the enemies of communism; but this tactic is useful mainly to drain energy from the real conflict, the Technological War. Assuming that the reserves of large countries will not be overthrown, the only way decisive victory can be achieved is through disabling the nuclear weapons. Nuclear weapons are also very likely to be employed for the defense of vital industrial areas, close allies, etc. In a prolonged war for a vital objective, military pressure for nuclear interdiction will be greatly increased.

Thus, certain small wars are more dangerous than others. Although guerrilla operations in remote places are unlikely to lead to thermonuclear hostilities, it is not reasonable to start limited wars in important areas on the assumption that they must remain limited, unless the defenders have so structured their forces as to preclude initiation of nuclear hostilities. This problem lies at the heart of the current controversy over nuclear weapon systems developments, and has been more thoroughly discussed in other chapters. However, it is convenient to summarize here.

The minimum deterrent school of strategic analysis contends that the United States should be satisfied with a small number of invulnerable city-busters. Such monstrous attacks are called by the euphemism 'countervalue strikes.' It also contends that development of first-strike or counterforce weapons is provocative as well as useless. The United States should, according to this school, make the enemy understand that his initiation of war against our homeland will automatically bring about thermonuclear destruction of his industrial and population complexes, and that once the capability for achieving this is achieved, nothing more is required. Some of the adherents to this philosophy contend that anything additional is over-kill, and morally reprehensible.

The problem with this kind of nuclear theory is that it would place the US in a strategic situation where it has no option in response to anything less than a mass attack on the U.S. homeland, and thus would virtually void the U.S. guarantee to Europe and other allies. If the U.S.S.R. is always allowed to fight wars at the level chosen by the Communists, and at the time and place chosen by the Communists, then sooner or later the Soviets will be able to obtain nearly every objective they desire. It is simply not possible, certainly not with a minimal force, for the United States to meet its strategic requirements at all levels of war in all theaters. To do so would require not only nuclear armies but mass gunpowder armies as well. Indeed, if the never-escalate dictum were strictly adhered to, the United States would have to develop tactics and weapons to fight wars against guerrillas with primitive equipment like theirs.

In the current phase of the nuclear age, the Soviets can risk a centralized war only if clear-cut qualitative and quantitative superiority has been achieved and surprise can be depended upon–in other words, if the Technological War has been substantially won. In the absence of technological victory, small wars that remain small are the only safe wars, and they become more dangerous as their objectives are expanded. The existence of a small war does not really change the probability of centralized war. Centralized war will begin when an aggressor believes he can win, not in an irrational response to his defeat in guerrilla operations.

8.10 The United States and the Future of Small Wars

Small wars are in reality a clever device of the technologically and economically inferior powers to neutralize superior U.S. strength. This strategy has been aided by the failure of the United States to develop the proper technology for dealing with these conflicts–this remark refers not only to weapons technology. Thus, the United States was induced to pour enormous quantities of blood and other treasure into far-away places, fighting the enemy on his own terms and with his choice of weapons and diverting resources from the decisive Technological War.

Clearly, small wars will continue throughout the near future; in fact, the United States will be faced with a profusion of them. In the Tri-Continental Conference held at Havana in 1966, the Communists called for "two, three, a dozen Vietnams," but the U.S.S.R. continues to put resources into the Technological War. Internal war, or people's war, is the device the Chinese Communists had chosen for the next phase of world conquest. The Soviets support this kind of attack at their convenience. These conditions prevail, and because this is one of the most sharply defined military realities of our time, we must make up our minds what we should do about it.

8.11 U.S. and Small Wars

The United States has a strong interest in keeping small wars under control: we simply cannot allow the Communists to take over countries and thus to strengthen their overall capability and influence in the worldwide Protracted Conflict. We must also make it plain that a U.S. guarantee is worth something, and not merely a paper promise. U.S. guarantees to otherwise unimportant allies must be kept, lest our most important allies cease to rely on our promises.

Any time the Communists take over a country, however insignificant it may be, they acquire bases, weaken and threaten additional free countries, and gain a capability to make main defense more difficult. Furthermore, whether correct or not, the containment strategy under which the United States presently operates states that Communism thrives on expansion, and will suffer internal changes only when it can no longer expand; thus, the central core of the U.S. defensive posture requires that Communism be contained.

Through small wars, the Communists acquire areas that have resources which may be vital to the Technological War, or to our economic system.

The absence of such resources through loss of a country to the Communists weakens the overall trade position of the free world and strengthens that of the Communist bloc. The communists desire to become self-sufficient so that they can use trade exclusively as a weapon in the Technological War, rather than only partly so as is the case today.

There is the still greater danger that as one country falls to Communism, and especially if it falls to Communism because the United States proved unable to protect it, other and presumably more important countries will seek accommodation with the Soviets and ultimately fall into the Soviet orbit. If the conquest by small war remains unchecked, ultimately, large portions of Africa, Asia, and Latin America will fall into Communist hands. Finally, a very significant shift in the balance of power may be effected through this type of war, which entails very little risk and hardly any cost for the Soviets.

Protracted small war operations provide the Communists with good agitational material and facilitate their favorite operation: mobilization of the masses in a maximum number of free world countries. Potentially, therefore, the small war strategy could create much economic and political disorder throughout the free world, and in addition demoralize the West and strengthen the resolution and moral power of the Communists.

A strategy of small wars has the advantage of making small gains over the short run which over a protracted period produce a composite of large gains in power and position.

In Asia, our loss of Vietnam gave the Soviets access to the military installations we built there. This greatly increased their capability to operate on the Asian/Pacific Rim.

In our own hemisphere we have seen two vital small wars, Cuba and Nicaragua, which have improved the Soviet global geoposition. As we lost each of them, we rationalized that they didn't matter. An "agrarian reformer" drove an "oppressive dictator" from power in Cuba, and "peace got a chance" to ratify the control by a Soviet creation in Nicaragua. We have yet to awaken to the Soviet exploitation of those advances which have given them bases for military applications, including potential use of nuclear weapons.

8.12 World Policeman?

While recognizing the danger of Communist exploitation of small wars, it is important to keep the problem in proper context. Some commentators have proposed that the United States deter all wars, Communist-led or not. The very number of conflicts occurring today should give us pause before we accept this idea as national policy. Reference is often made to the Pax

Britannica as a condition the United States should recreate in the nuclear age. This concept fails to take cognizance of the many small wars that were fought in that era, including many campaigns fought by the British themselves. Moreover, we should recognize the very considerable amount of resources we would have to allocate to create the military power necessary to implement such a policy.

The U.S. Congress, media and population do not understand limited wars, fought far from our borders and dragging on for decades. The military forces of the United States have not been organized for such wars, and even our professional military people do not really know much about them, nor do they want to fight in the bush.

The Congress has tried to legislate that the Defense Department give more attention to small wars. They mandated the establishment of an office of an Assistant Secretary and created a Special Applications Command with a four star general as CINC. There was considerable resistance within the military to this because of potential drain in resources required for other commitments.

Thus in order to preserve both our vital resources for the decisive Technological War and to avoid placing undue strain on the will of our population to resist, our goal should be to deter and defeat Communist attempts to use small wars to threaten our security, rather than simply to respond to each and every revolt. This will require a comprehensive U.S. strategy, including seizure of the initiative at proper times and places. At present we have no such strategy. We need not respond to every Communist initiative but we must not allow Communist proxies a continual unopposed march. This will require careful study of geopolitical realities, as each decision must be made independently.

The Communists can never complete their world revolution and conquer the globe through small wars alone. However unpalatable the consequences may be, the United States cannot be eliminated as a super power in Panama or South Africa, let alone in Burma or Vietnam. Precisely because we are living in the nuclear age some of these losses may prove to be of militarily lesser consequence. The loss of smaller countries does not reduce our nuclear stockpile, does not weaken our delivery force, and does not detract from our research and development programs. In order for the United States to be eliminated, American military power would have to be smashed by direct assault through victory in the Technological War, or dismantled by disarmament. Indeed, defeat in small wars may act to strengthen the will of the United States to engage on the technological battlefield and may, through elimination of some overseas commitments, release vital resources for this purpose.

On the other hand, it must always be remembered that a political movement has a momentum of its own. It is true that there is no substitute for victory, as General Douglas MacArthur said. Every Communist victory strengthens the resolve and power of the expansionist elements in the Communist ruling class (nomenklatura), and undoubtedly wins many converts to this position from among the waverers and power seekers within the bloc countries.

Territorial losses can weaken the United States, provide bases for multi-directional attacks, and give the Communists resources which might prove extremely useful in a future centralized war. The United States need not act as world policeman, but she is the arsenal of the free world and the only truly effective power opposing Communism. Whether we like it or not, the United States has assumed the position of being the sole defender of the tradition of liberty and freedom and must lead the opposition to Communism; this will not always be pleasant, nor will we always be able to admire our allies. While the preparations for small wars must never be made at the expense of the major technological war, they cannot be neglected.

There is, in fact, no reason why the United States cannot seize the initiative in small wars. The Soviet empire contains millions of people who would welcome the opportunity to strike back at Communism. The U.S.S.R. itself is dominated by an ethnic minority which firmly resists the efforts of other groups to rule themselves. These tensions can be exploited, and the means for sabotage and resistance can be provided to captive and oppressed populations. Judicious use of agents and expenditure of sufficient funds can turn the Communist empire into a battlefield; there is no reason for us to accept the term "peace zone", which the Communists use to describe nations within their orbit. The United States holds a superior industrial base, and this can be used to support wars of attrition to drain Communist strength. Indeed this was a major effect of the Korean War: China's rolling stock and many of her industrial goods were destroyed by both ground and air forces, contributing decisively to the collapse of the Great Leap Forward and delaying by decades the advent of China as a world power. If we keep our attention focused upon the main threat of Technological War, we can use small wars to our own advantage.

In dealing with this strategic issue in the late 1980s the American strategist of technology had to face a new constraint – Viet Nam. Viet Nam meant for him that no US forces could be involved in meeting strategic requirements at the "lower end" of the spectrum of conflict. But if the troops involved could not employ the high technology equipment developed for the "higher" levels how can high tech be brought to bear? The answer lies in applying the products of high tech and not necessarily advanced conventional munitions. In other words high technology command and control can be the "force multiplier" which can make low tech forces effective.

First of all, assassins, guerrillas and insurgences operate from sanctuaries. That was very clear in the Middle East in the 1970s and 1980s. Cuba, Syria, Iran, North Korea trained and equipped them, as did the USSR. That was not as evident in Central America, but the Soviet-sponsored guerrillas attack El Salvador from a sanctuary. With the consolidation of power by the Communist Nicaraguan government Nicaragua became a sanctuary for attacks on all its neighbors. Similar situations prevailed in Angola, Ethiopia, the Philippines to name a few.

Consequently, the essential step is to have continuous surveillance of such sanctuaries. There is another sanctuary from which to conduct the necessary surveillance – space. Space is a new ingredient to military operations. It may seem strange to say that in the fourth decade of the space age, but from the point of view of technological strategy the reality is that space and space technology have not yet been applied to the entire spectrum of warfare, let alone small wars.

The applications of space can be all-pervasive. They can be made in all functions supporting all types of warfare, not just surveillance, but navigation and position location, geodesy, weather, communications and data relay, surveillance across the entire electromagnetic spectrum, and eventually weapon delivery.

> In the 1960s the Soviets tested and displayed a space bombardment system, the FOBS.

All these functions support the Commander in his decision making, especially on the field of battle. Space is the place for the eventual automated battlefield, first described by the Chief of Staff, US Army General William C. Westmoreland. But the challenge to the technological strategist goes beyond the normal concept of battlefield surveillance.

In small wars, surveillance must exploit the entire electromagnetic spectrum, not just optical. Satellites must include multi-spectral coverage film visible through IR to LWIR to UV sensors. Soviet surrogates in the future, just as at present, will employ maskirovka (cover and camouflage) to defeat surveillance from space. That does not necessarily mean that multi-spectral satellite sensors. Cost and survivability may dictate proliferation of low cost, single purpose satellites for detection, tracking, and data relay to commanders.

The American technological strategist was slow to realize the impact of space on low-intensity warfare. The Soviets demonstrated in the Arab-Israeli

War and in the Falklands War that satellites can give to decision makers as remote from the scene of action as half a globe away the real time data they need for direction of operations. A new approach is obviously needed to the use of space in such conflicts.

But surveillance and relay of data are only two functions which space systems can play in warfare. We are constantly surrounded by streams of electrons transmitted by satellites for weather observation, navigation and communications. Forces operating anywhere on or above the Earth need only the appropriate receivers to collect those electrons and turn them into useful information.

For example, the NAVSTAR GPS can give precise location and time to thousands of passive users. That means in small wars, or any wars, that the location of targets and friendly forces can be precisely known continuously even in highly dynamic operations. Weather data have been available from satellites for decades for both instantaneous knowledge and for forecasting. Again, the application to commanders' decision making can be a matter of routine. Low cost communications via satellite have been a possibility for at least two decades. Simple, low-cost receiving equipment can make real-time commands of operating standard procedures.

The global coverage of satellite systems means that information can be made available to the commander on the scene, on an island in the Philippines, for example; to force commanders in Manila; to US decision makers in Pacific Command in Hawaii; and to Washington, simultaneously if desired. Local surprises with strategic importance can be avoided. Information for negotiations can be assured.

Of course, space systems are a new but vital overlay on existing technologies for combat operations. Ground based sensors were delivered for tracking hostile forces in Viet Nam. Aircraft have long carried out battlefield surveillance, target location, and intelligence collection. Remotely piloted vehicles have proven useful for surveillance and data collection. The aggregation of all these technical applications make possible the long-anticipated automated battlefield which can characterize small wars.

What makes the application of the satellite products useful in wars is that the Age of Computational Plenty is and has been with us. The dramatic changes in computers, the pervasive use of the personal computer, the incredible growth in software, especially through the use of expert systems, make data integration and display a matter of routine. Commanders can game "what if?" options in minutes and select the optimum course of action in a given combat situation. "Low tech" personnel can execute combat commands without the necessity for knowing the sources of the information or understanding how the automated battlefield is operated.

When it comes to the weapons used by "low tech" personnel the strategist of technology faces the opposite situation. Such personnel need to deliver firepower and to operate vehicles which carry it into combat. Furthermore, the logistics to support weapons and vehicles must be simple, reliable, and easy to maintain. The Soviet intervention in Nicaragua in the 1980s proved an exception to this rule. They trained Nicaraguans to operate and deliver fire from the Hind gunship helicopter to attack the anti-Communist rebels in remote areas.

As discussed, nuclear weapons would be used in small wars only by small powers, such as Pakistan, threatened with extinction by the Soviets. Thus the American strategist of technology will not be concerned with nuclear weapons for small wars. On the other hand, there is a very important constraint on the types of gunpowder weapons which the US can develop for them.

Small wars, particularly those against guerrillas and insurgences, cannot cause casualties among the population being defended. In other words, in order to defend the sheep, friendly forces must eliminate the wolves hiding among them without killing the sheep. That has proven to be difficult in El Salvador, for example, where the Soviet sponsored guerillas have tried to destroy the infrastructure, power plants, bridges; have used assassination, kidnaping, and threats against the civilian populace; and have tried to "fade away" among the local populace to avoid capture.

Guerrillas can plant land mines which kill civilians; governments cannot. Government forces cannot use advanced munitions which have multiple warheads and hundreds of bomblets to carry out carpet, indiscriminate bombings of guerrilla-held areas. Air-delivered munitions must be placed with great accuracy. NAVSTAR GPS can be crucial to such accuracy, but local commanders must exercise judgment when calling for such air support and avoid collateral, unwanted civilian casualties.

Mobility for transport of personnel and equipment is not a special problem except for the US in the Middle East. Air and sealift are readily available for global movement to support US allies and friendly government. The Soviets have ease of access as well. Some of the tanks they delivered to Syria and having been operational for only a few miles were captured by the Israelis. In the continuing campaign of Libya's Qaddafi to capture Chad the Soviets supplied him with large quantities of arms. Similarly, the US support of the French forces backing up the government of Chad encountered no technological challenges.

In the conflict between Israel and Egypt in 1974 and the US use of force against Qaddafi, the NATO allies by and large proved the old adage, "Millions for tribute, but not one finger lifted against the Gods" [**®HUH??!!?!?!$^{-}$**]. The airlift of weapons to Israel required operational innovation and ingenuity. The same was true a decade later in the bombing of Libya. By and large, however, there appear to be no technological challenges in the aspect of small wars.

Mobility for maneuver is a different story in many remote areas where small wars are fought. Lack of a modern infrastructure – airfields, roads, POL pipelines, power – makes rapid movement of weapons, people and supplies difficult. Verttical Takeoff and Landing and Short Takeoff and Landing aircraft are an obvious answer. But, inasmuch as the US has not developed them in the past for bigger wars, the cost of developing such special applications have been excessive for this type of war. That special type of VTOL, the helicopter is a possible solution. However, the Congressional constraints on US forces in Central America has prevented the application of this technology in combating Communist forces in this hemisphere. When Nicaragua invaded Honduras in 1987, US pilots airlifted Honduran forces by helicopter to zones near the Nicaraguan invasion. While the Honduran reinforcements proved adequate to repel the invasion, the Nicaraguans proved to their satisfaction that the US would not be able to provide sufficient mobility to counter hit-and-run tactics of Communist guerillas in the region.

Soviet-supported forces have the advantage of surprise raids and hit-and-run tactics from sanctuaries. Government reaction forces require greater mobility for two reasons: 1) To attack before the guerilla forces escape back into their sanctuary, and 2) to react before the Soviets can give to them surrogate satellite data on the movement of the government reaction forces.

The strategic requirements of the US and the reality that small wars will always be a threat to meeting them create opportunities for the American strategist of technology. At the same time he must operate within highly restrictive cost constraints and political constraints. Some of the latter result from Congressional action; others from the nature of guerrilla and subversive wars. As we have seen, the nature of these wars have their greatest impact on the munitions developed and the discrimination with which they are delivered. The Congressional constraints dictate that defeat of Communist supported forces be accomplished by personnel who do not have the experience necessary for operating high technology vehicles and weapons. A real challenge for the strategist of technology is to create weapons and vehicles which they can operate.

The most fruitful avenue for the strategist of technology lies in applying the products of high technology satellite and space systems to command and control of friendly forces. The automated battlefield developed for higher intensity wars can have its counterpart in low intensity conflict in small wars. Real-time data, data integration, expert systems, displays, and real-time command and control can be spin-offs of developments of high intensity conflicts to small wars.

Implicit in this concept is the whole array of technological developments and applications to low cost, replenishable satellites, launched on command from low cost boosters and designed to support the commander in the command and control of combat operations.

The issue for a strategy of technology is the kind of technology to be used by the elite to defeat those who engage in small wars to gain power. Completing the issue is the fact that the military forces of the elite may not be capable of operating high technology systems.

The solution for the US is to employ such high technology systems and supply the government forces with their products. For example, such government forces may not be able to operate jet aircraft, yet they can be given the photographs taken by a recce [reconnaissance] aircraft. Similarly, they may never see a satellite but read a hand-held receiver of NAVSTAR signals and know their precise location. Similarly, they can employ communication and weather satellite readouts without studying orbital mechanics or electronics.

In sum, the US strategy of technology for small wars is to apply technology to intelligence, to communications, and to command posts for rapid reaction forces. This approach can also be used for that new, menacing form of small wars called drug traffic.

In the late 1980's, Gorbachev's glasnost produced an outpouring of the hatred and resentment of the peoples of the U.S.S.R and the Soviet occupied territories of Eastern Europe. The United States did little to exploit the situation, and there have been moves to prop up the Soviet regimes with loans and technology. Even after the collapse of the Communist regime in Poland there is a strong movement to send largess to the new Polish government, regardless of the effect on their economy.

8.13 Force Requirements for Small Wars

To establish force requirements for small wars, we are developing specific doctrines and forces for us in "This Kind of War." In addition, we must develop our technological resources in nonmilitary fields. For example, plows and seeds which enable backward nations to turn their jungles into productive land can be just as effective or more effective weapons in small wars than atom bombs. Nuclear power sources for desalinization of seawater can be used to produce centers of resistance to Communism in presently vulnerable areas. Western political theory, as well as recent experience, shows that the strongest deterrent to barbarism and Communism has always been good administration and a strong and healthy middle class dedicated to the government in power; U.S. technology can be used to create such a class, not at the expense of the peasantry but from the peasantry. Bourgeois nationalism can be a vital ally to the West.

In the military area, the United States must give up the illusion that because our forces are capable of fighting big wars they are also capable of fighting small ones. The U.S. Air Force, for example, cannot use against missile silos the same delivery systems it uses against coolie pack-trains. Experience has shown that the most sophisticated weapons are always the best weapons in air war, but it is not true that general-purpose craft useful for all missions can be designed and built more cheaply than several specialized forces. The B-52s were highly effective in Vietnam, even though their present strategic value is small, whereas many workhorses of the war are not even remotely useful for centralized war. Puff, the Magic Dragon, for example, was a converted 35-year-old propeller-driven cargo airplane mounting a modern equivalent of the Gatling gun, and proved to be a mainstay of ground support operations in Vietnam.

Navy and ground forces must also be developed for small wars. The U.S. system of using conscript, short-term soldiers for wars on the frontiers had the inherent disadvantage of a built-in lack of continuity. By the time the soldiers reached their maximum effectiveness, it was time for them to come home. Republics hire mercenary soldiers as their sole defense only at their peril, but there is no reason why the United States cannot maintain, in addition to citizen armies, professional armies for use on our external defensive perimeters in Europe, Asia, and, soon, Latin America.

Of course we now have a professional all-volunteer force, created since the above was written in the first edition. The results have been mixed, but by and large beneficial.

The issue for a Strategy of Technology is whether we must develop the technology for small wars. There is no inherent reason why our military forces must have a shamefully long tail of noncombatants for each fighting man in the field. There is also no reason why, with our industrial resources, small patrols cannot command large firepower. Weapon systems that allow small forces to direct and control missiles and rockets launched from aircraft, guiding them accurately to targets as close as 50 yards away, could be developed for a fraction of the cost of some of our morale-building programs. A truly professional force would infinitely prefer proper weapons to Thanksgiving turkeys and pumpkin pie on the battlefield.

Our mistake has been in assuming that, since Communism is supposedly mellowing, each small war will be the last one, and that the one we are engaged in at the time is the last and cannot last long. The Navy recommended that one of its battleships be refitted for use in Vietnam three years before the decision to do so was finally made, but the political authorities, convinced that the war could not continue, refused to provide the equipment the admirals demanded. There is still far too little effort being made to develop technologically superior equipment for use in guerrilla and small mobile wars, despite the evidence that we will be forced to engage in them for years to come. Even now, little is being done to produce doctrines and equipment for use against the Communist governments in what Brezhnev called "the peace zone."

Small wars are fought in jungles, in nearly-inaccessible mountain areas, in deserts and in cities. The terrain is employed for cover and concealment just as it has been over the centuries. In these conflicts the Communist forces operate in small numbers, using isolated areas as the bases of their operations. They use terror against the people and infrastructure in remote villages as a means of destroying society and of concealing their identity. The resulting anonymity facilitates hit-and-run tactics with simple weapons and munitions. By defeating small units of the police and army of the government and by terrorizing the people, the foreign-supported forces undermine public order. Judicious support by the United States can restore this lost confidence and prevent the buildup of a Communist infrastructure.

Airpower is not necessarily the means to win such conflicts, but it can be of enormous assistance to counterguerrilla forces resisting communist aggression. To put it differently, a counterguerrilla force supported by truly effective airpower has a far better chance to be successful than a force without air cover. The air force must be able, first of all, to run effective reconnaissance missions in small wars being fought in each of the three basic types of terrain. Second, it must be able by the use of various types of equipment to airlift friendly guerrillas and to facilitate pursuit and capture of the enemy. It must be able to contribute heavily to the logistics of small wars. In addition, of course, the air force has to carry out combat missions to defeat the hostile air force, if any, to go after the logistics of the enemy guerrillas, to assist the ground guerrillas in battle, and possibly to fight in fast-reaction, independent air-to-ground actions.

To fulfill all these missions, the air and naval arms need specific doctrines for their contributions to small wars; they must design and procure equipments suitable for the purpose. It would seem self-evident that weapons and equipments designed for guerrilla wars will differ very greatly from equipments designed for tactical and nuclear air war. Small aircraft with slow speeds and low altitude capabilities, VTOL and STOL planes, as well as short-range, cheap helicopters can prove effective for guerrilla operations, without being useful for centralized war or large scale conventional operations. Note, however, that our support of the Afghan rebels, principally with the high technology STINGER hand-held anti-aircraft weapon played a significant part in defeating the Soviet aircraft.

Ships designed principally for small wars need not be designed for survival in centralized war, although seacraft can be made more versatile than aircraft. The point is that principles of design for small wars need to be developed and studied.

It is certain that whatever equipment the air force and the navy design must be readily and quickly deployable across the ocean using airlift and sealift; and must be capable of operating with a minimum of logistics from short landing strips and inadequate harbors. The proper choice of munitions also will be very difficult, but obviously it seems necessary to have the option both of small nuclear and nonnuclear explosives. On the assumption that use or threatened use of nuclear explosives ultimately will prove to be mandatory, the question remains whether such new devices as neutron bombs or other clean weapons may be preferable to traditional fission or fusion weapons. Furthermore, the blending of missiles with aircraft plus air-to-ground and (or) ground-to-ground missiles for guerrilla purposes will pose new operational problems and require new strategies and doctrines. We must be ready to employ new technology as well as develop it.

Our goal in small wars is not to kill people; it is to prevent communist seizure of the country. If we could achieve our goal by using more humane weapons, we certainly should do so, but the purposes of the munitions must be carefully thought out. Such munitions would have to be delivered primarily by aircraft. This is especially true if we need to use nonlethal weapons in the hinterlands which are the source of guerrilla operations.

The issue for the counter guerrilla force is to have weapons whose use does not cause civilian casualties. The use of 'impersonal' land mines against guerrillas also provides the guerrillas with a propaganda weapon. The Soviet use of terror weapons in Afghanistan did not produce the desired military result, and has left behind a legacy of hatred that will last a long time.

Air and naval forces, being based primarily in the United States, drain our economy and gold reserves less than massive overseas armies. They are also more flexible, enabling smaller military forces to accomplish their missions. They can be used in support of friends without massive U.S. casualties. Proper technological development, coupled with a doctrinal revolution, can bring about decisive victory in these wars at reasonable costs.

We are using our advanced technology to find new weapons and equipment. We have a wide base of industry and science which can give us conventional weapons and low-performance aircraft similar to those used in small wars in the past. However, when it comes to operational problems of locating small guerrilla bands concealed by thick jungle or moving over trackless deserts or of developing munitions for this specific type of conflict, we are just starting to develop new devices or components. One reason for slow progress is that we have not given the strategic attention to these wars that they deserve. Instead, we convince ourselves that each is the last, and have no long-range strategic plan, even for such a predictable conflict as the continuing battle for South East Asia.

Whatever the specific solution, it is self-evident that we must prepare for small wars. It should be added that such a mission, by its very nature, will be supplementary to the missions already given to the military services. It cannot be fulfilled by reducing the preparedness for centralized war.

With this important reservation, however, it is mandatory that the United States get on with the job of preparing itself for the wars which do in reality occur, precisely because by proper planning for the big nuclear event the strategic nuclear forces are succeeding in deterring centralized war. We are not deterring small wars, nor will we until we use our technology rather than blood and treasure to make small wars unprofitable for the Communists.

8.14 Small Wars and Escalation

According to Communist doctrine, small wars, once they are successful, might be catapulted into limited wars. At a given point the Communists pull the guerrilla forces together and reorganize them as regular armies. They are then used for operations in the classic military style. It would follow that it is in the American interest to contribute to the defense against guerrilla operations in their early phases and long before the guerrilla forces have become large enough to be constituted as armies.

As the free world capability of subduing guerrillas increases, the Soviets will be more careful about launching small war operations. Consequently, the dangers of miscalculation and of escalation of small wars to large wars would be reduced. Thus a better American small war capability is really an intrinsic supplement to the overall American deterrent posture.

The enemy is fighting small wars because even they pose smaller risks. Some fear that he may act out of desperation when his forces are about to be annihilated, and that to rescue them he would launch a massive nuclear attack. This fear is predicated on the assumption that the enemy really is willing to fight the nuclear war. It should be obvious that if he is not, then he will accept his defeat and go home. After all, defeats have been accepted throughout history.

> Since the first edition, both super powers have accepted defeat: Viet Nam and Afghanistan.

If there is intention to make generalized war, there will be generalized war. If there is not, the small war or the limited war will remain small and limited. Or to put it differently, whether the war escalates to the top or not is dependent on whether deterrence still exists or has been broken, on whether the United States still controls the escalation ladder. If our deterrence remains credible and is not weakened as a result of the small war, the Soviets will be hesitant to engage us in total war because of a setback in a minor conflict. This would be irrespective of whether we win or lose in the small war and irrespective of whether we use nuclear weapons or they use them. The important point is that if they escalate and escalate slowly, that is, shy away from the centralized war yet threaten strategic operations against the U.S. homeland, they are making the major error of giving us the first-strike option.

> Of course the US never really had a first strike option after 1960 or so; but the USSR could never be sure of that.

There is no reason to deny that escalation is a possibility, partly because public opinion pressures and irrationalities may, indeed, force the level of conflict up and up, but the problem has been given far too much importance. The fear of escalation has overshadowed the fact that nuclear weapons by necessity must be introduced into the ground forces, must by necessity be used in large future ground battles, and ultimately will be used if such battles occur. The necessity derives from the simple technological compulsion: unless ground forces are modernized they will not only become ineffective but will be too costly to procure and too vulnerable to use. Consequently, the risk of escalation must be weighted against the risk of not having an effective ground force at all.

Rather than neutralize our own technological capabilities through brooding over dangers, we should engage in constructive use of our resources to develop effective weapons that will not involve escalation at all. For a fraction of the $30 billion each year the Vietnam War was costing, we could have developed small, highly-accurate missile systems to be launched from aircraft and guided by ground forces to enter enemy-held territory and engage communist guerrillas. If the guerrillas learn to flee from patrols of this size, many more patrols can be sent. It is, after all, much cheaper to maintain a few regiments of patrols than many divisions, and, provided that the ground forces are given adequate fire power, much more effective as well.

The technical challenge is to make sure that many additional options are possible so that the ladder from the small to the large war becomes longer and many alternative strategies can be implemented. The escalation argument is the creed of those who are willing to accept defeat. The obverse argument is more persuasive: if the enemy is deterred from escalation up, our strategy must aim at forcing him to escalate down, into breaking large into ever-smaller forces. The nuclear weapon, while it is required for upward escalation, also can be an instrument to achieve deescalation.

8.15 Conclusion

Small wars should be looked at from the point of view of our security, not from that of fear. Our technological strength has made it extremely unprofitable for the Communists to use any means other than the small war for expanding their empire. Because at present they cannot attack us directly with impunity, they have been engaging in this restricted, piecemeal form of conflict.

Imaginative use of technology, and full development of our technological resources, is much cheaper than deployment of huge gunpowder armies. It is more politically effective, since it involves a smaller proportion of the home population; and by shortening the war it results in far fewer casualties for us, the enemy, and the innocent populations of Communist target nations. To object to the use of technological weapons as inhumane when the alternative is a longer and bloodier war seems to us to be not only contradictory but immoral.

We must realize that until we have effective means of dealing with Communist people's wars, we will be faced with a plethora of these small wars. The United States cannot allow this strategy of diversion to succeed, but we cannot prevent the debilitating effects of small wars by refusing to engage in them. We must, rather, seek to engage in them on our own terms. This will involve some heavy investments in small war technology and equipment but, considering the costs of these wars as we have fought them so far, all this will be cheap by comparison. There is no expectation that the Communists will voluntarily abandon guerrilla and small wars so long as they gain a net advantage from starting them. Hence unless we make these adjustments, the communists will continue to present us with the choice of costly resistance or surrender of allies.

We can cope with this threat because we are technologically superior. Technology devised to implement a well-thought-out strategy can give us the weapons that make small wars as unprofitable as other forms of violence.

Chapter 9

The Prevention of War

9.1 Why Wars Are Not Fought

The primary stated objective of the United States is to preserve the state we call peace. The Strategic Air Command, which controls more power than all other military organizations throughout history, has as its motto, "Peace Is Our Profession." Our diplomatic machinery is geared to negotiations for peace, and our alliances are defensive. If intentions alone would produce peace, we would have it.

Our pursuit of peace is complicated by two important factors. The first of these is confusion about the meaning of peace. In legal terms we are at peace whenever the Congress has not declared war. Yet we can be actively engaged in a shooting war, and as this book has shown, the Technological War goes on, without regard to legal niceties, as a permanent conflict.

Many of our international legal institutions were conceived and solidified at a time when there was a far greater distinction, even a chasm, between peace and war. In those nearly-forgotten times, when nations went to war they acquired "rights of belligerency," which they could invoke against other nations. Perhaps today there should be some recognition of the rights of cold-war belligerency and of the Technological War. If laws ignore the real situations in which people live and reflect fictitious assumptions, the legal order is decaying and society becomes vulnerable. The point is not to curtail rights, freedom, and democracy, but to keep them working during critical times and to provide a reasonable legal basis for the requirements of security.

The other impediment to the achievement of peace is the paradox known since Roman times: "If you would have peace, prepare thou then for war." The unprepared rich nation without armed allies has never survived for long. Wealthy nations have ever been forced to depend on their readiness for war to preserve peace and survival. Yet history seems to indicate that the greater the state of conventional armaments acquired, the greater the chance for war; and consequently many well-meaning people in the contemporary United States believe that the surest road to peace in the nuclear era is arms limitations which may hopefully lead to disarmament.

This misconception stems from an insufficient appreciation of the modern era. The nuclear weapon has changed the nature of warfare by providing the defensive power with a capability to deny victory to the aggressor, even if the aggressor has successfully destroyed all but a small fraction of the defender's military forces. Unlike conventional weapons, nuclear weapons do not increase the chances of war as both sides acquire them.

This is so because mutual increases in the nuclear power available to the superpowers do not cause mutual increases in their expectations of victory. In fact, the opposite is true. All but madmen recognize that as mutual capability for destruction increases, the possibility of gain through initiating that destruction becomes smaller. Whatever the effect of arms races in conventional weaponry, two-sided arms races in the nuclear era have a stabilizing effect in so far as the outbreak of total war is concerned.

Wars are fought because decision makers conclude that they will be better off after the war than they would be if they did not engage in them. This has been true whenever rational decision processes have governed the war decision. The calculation of success is not a matter of objective reality only, but is in large measure a process in the mind of a strategist controlling military power. It is not sufficient merely to be sure that no one can win against you; all those who might attack must be convinced of it as well. In addition, the definition of win may be different for a potential aggressor than for a popularly-elected chief of state; and it is necessarily different for one aggressor fighting for nationalism or nationalist imperialism than for another aggressor who fights for international communism or Communist imperialism.

The calculation of chances of success is spoiled by uncertainty; indeed, uncertainty about the outcome of a war is a powerful deterrent in the absence of clear indication of the enemy's power. When both sides are engaged in nuclear arms research and deployment, neither will be very certain that he has won the Technological War and can engage in nuclear strikes or blackmail. It is when one side drops out of the race, giving the other a clear shot at technological supremacy, that a strategist can begin to plan on terminating the contest by a nuclear strike.

Deciding on war is also a matter of will, which is essentially willingness to take risks and troubles. Virtually always, the will factors are vastly different for the two parties engaged in conflict. Circumstances that would cause one to initiate a war might not tempt the other. Dictatorial regimes are notoriously generous with human lives; democratic governments fear casualties and usually fight only, and frequently belatedly, to preserve their own security. The will factors change when political systems are on the rise or decline. A dictatorship, for example, is optimistic early in its youth–it may combine determination with caution, or it may be exuberant. But it reacts differently when it is senescent: it then has the rationality of despair, and it may prefer a last chance through war, and even defeat on the battlefield, to ignominious overthrow. World War I would hardly have occurred if Russia, Austria-Hungary, the Ottoman Empire, and China had not been decaying. There will be decaying regimes in the future. In particular, the Communist dictatorships won't last, but the period of their departure will be difficult and dangerous, and the rationality of their last leaders may be influenced less by probabilities of success in a nuclear contest, than by considerations of last chance stratagems, envy, revenge, and pure hatred. There is no such thing as equal rationality for all.

Calculation of military results, then, is only a part of the decision to go to war. Strategy serves as a tool for the political decision maker, and the calculation of military success sets the probable price in blood and treasure that must be paid in war. The political objectives are the factors that determine what price a government is willing to pay; and these objectives are not set in absolute terms. If world domination is the objective, then no price is too high provided that the rulers of the aggressor nation will survive and remain in control and all other countries will be reduced to impotence. Conversely, if the probable result of the war will be the overthrow of the ruling structure, no victory, no matter how cheap in lives and property, is worth the winning.

The calculation of political objectives, the disparity of objectives between the major powers of the present world, and the state of the Technological War are the primary factors in the decision to begin wars. However, they have received less attention than mathematical calculation of military factors, which has become prevalent. It is supposed by many that even if the political objectives of the U.S.S.R. can never be understood with certainty, at least the military calculations on which they must base their decisions can be replicated with some assurance. This assumption needs to be examined in some detail.

9.2 The Nature of Strategic Decisions

Military calculations must take into account numerous objective factors such as force levels, weapons performance, defense systems, and the like. A strategist's advice will thus be based in part on his predictions of the material factors of battle. Success in war, however, is dependent on the competence of generals and commanders as well as on their equipment. Bad generals can lose wars even though they have the best armies, as witness the performance of the "finest army in Europe" (that of France in 1940), while good generalship can more than make up for numerical and even technical inferiority. The strategist calculates his chances of success not from statistics but from an operational plan.

His plan must take into account the quantitative factors, but it will also seek to create and exploit opportunities. War is a matter of will as well as equipment, and paralysis of the enemy's will through surprise is one of the most successful of all techniques. In war, there are real uncertainties as well as statistical probabilities. Many factors can never be quantified. The strategist is dealing with the enemy's creative force, and will counter it with his own. The calculation of destruction by means of slide rule and computer can only be a part of this process.

If this appears vague and uncertain to those more used to scientific calculation, it is because war is uncertain. War is after all an operation primarily against the will of the opponent. In some few cases, of course, the opponent is so reduced in capability that his will is no longer an important factor, but most wars have ended long before the loser's capability to damage the victor was destroyed. The great losses have occurred after surrender, in pursuit or by deliberate execution of prisoners, rather than before the decisive moment of battle. But once a combatant has lost the will to fight, his means are unimportant; and often this failure of will has been caused by surprise, by the opponent doing the unthinkable, and by so doing producing overwhelming paralysis.

It is generalship, not a calculus of forces, that decides the outcome of wars. A good general identifies opportunities to paralyze the will of his opponent and exploits them. Indeed a good strategist creates such opportunities. Generalship operates against the enemy's forces as well, of course, but even then the war is primarily against the will. When the enemy ceases to fight, the war is over, no matter that the vanquished may actually be stronger than the victor–as Darius was at Arbela. Success in war is above all dependent on generalship; it is not that objective factors such as force relationships do not count, but that generalship is far more significant. And generalship means optimal utilization of available strengths and out-thinking the enemy. Bad generalship is a repeat performance, whereas good generalship is an act of creation, hence unpredictable by either side.

Historical experience is explicit on the crucial impact of generalship: a bad general can lose despite superiority in material force and a good general can win despite considerable inferiority. Given reasonable means, and sufficient strike and reserve forces, so that the aggressive side would not be crushed even if mistakes were committed, the aggressor will calculate his chances of success not on the basis of statistics, but an operational plan, as we have pointed out. If he is a sound planner, his plan will take into account all the qualitative factors, but go beyond them to employ surprise in all elements such as strategy, technology, tactics, training, direction, concentration, and phasing. If the would-be aggressor estimates that the defender will be unable to anticipate his plan and will not have ready countersurprise operations to upset the implementation of the operation plan, he will conclude that his chances of success are high.

It is very important to understand that in these matters the calculus of generalship is far more important than the calculus of force relations. A homely example would be an investor who plays the stock market through mutual funds and thus essentially benefits by or loses from the overall movements of the market. Such an investor can calculate his probable successes on the basis of curves depicting the performance of the market in the past. However, the most successful investors operate both with and against the market. In like manner, a good strategist can identify special situations or opportunities and work out a scheme to take advantage of the openings. Naturally, in a war where there are many opportunities there are only a few that hold great promise of massive success, even if they are exploited with the greatest skill. Furthermore, good opportunities may be fleeting and there may not be enough time to exploit them properly. On the other hand, the strategist who possesses large resources, like the market operator controlling large funds, can create suitable opportunities.

These observations apply to both the offensive and the defensive strategist. Success always depends on more than the resources in hand. It results from a clear knowledge of the objectives to be gained by the particular strategy and from seizing the initiative in carrying out the strategy.

Whether planning aggression or defense against aggression, the strategist must calculate the results of the clashes of forces. He must always remember that he is dealing with human action, the essence of which is creativity. As a consequence, he knows he is grappling with uncertainties, with the basic uncertainties that result from the creativeness of the adversary.

> In these days of high speed computers and complex computer simulations, we often forget that strategy comes from a strategist, and victory and defeat are events in the minds of the victor and the defeated. We shouldn't. JEP 1985

9.3 Offense and Defense

In this interplay of creativities, the aggressor has certain advantages that come from his position. The decision to attack is his. Thus, he knows when hostilities will begin. The defender cannot have this certainty. Every moment can be the moment of the attack. To heighten the effects of his blow, the attacker strives for surprise in as many elements of his strategy as possible. One of the problems of the defender is to prevent his being the surprised. This increases his needs for information about the intent of the enemy and requires him to expend resources on being constantly ready.

The attacker can build his plan for aggression around the availability of a decisive weapon. This can take the form of a technical surprise for the defender, but it need not. If the aggressor calculates that the defender cannot counter his new advance in time, he can make his decision on the basis of this crucial superiority.

In the present age of total conflict, the aggressor can manipulate the many facets of his strategy to produce a wide variety of threats and opportunities. Political warfare, economic warfare, propaganda, the struggle for technological supremacy, diplomatic maneuverings, subversion, and military operations, taken together or individually, give the aggressor many opportunities. The defender, for his part, must provide a total defense against all these forms of conflict. Most important, he must avoid being second in technical advances that can lead to a decisive military advantage.

The defensive strategist is not without advantages on his side, provided that he does not passively wait for the blow. he can take initiatives to gain and maintain a position of superiority in the various forms of conflict. By having such superiority, he prevents the aggressor from finding the moment for the attack. The defender can plan and execute his own surprises against the would-be aggressor. The combination of initiative and surprise on the part of the defensive strategist produces the creative uncertainty that negates the advantages of the attacker. It is a military truism that strategic offensive and tactical defensive is often a superior position. Sun Tzu says, "Take what the enemy holds dear and await attack."

It is axiomatic that the objectives of the attacker and defender are asymmetric. Thus, the initiatives they take and the advances they make need not and probably should not be of the same kind. They should be chosen for their potential ability to reach the objectives of the strategy.

9.4 The Modern Strategic War

The strategy of the United States, and indeed free world strategy, is defensive. We seek no political, economic, or territorial aggrandizement. We do seek to prevent war. These objectives are clearly in direct opposition to those of the Communist bloc. They seek world domination. They create opportunities to use warfare to attain it.

> This was written long before the falling dominoes in Indo China or the Soviet invasion of Afghanistan, and indeed before any but a handful of Western analysts understood the importance of the ideology of conquest in justifying the dominance of the tiny ruling group (known as the nomenklatura) over the Soviet masses. JEP, 1985

We should recognize clearly that our defensive strategy must include initiatives and surprises. Ours need not be a reactive strategy. In fact, the struggle for technological supremacy makes a reactive strategy a most dangerous one. Waiting for clear indications of Soviet initiatives can prevent us from acting in time. We must be constantly on the initiative to anticipate their moves and to create situations to which they must react.

> General Daniel O. Graham first proposed Project High Frontier as a "strategic sidestep into space". In 1981 a Strategic Defense Initiative – STAR WARS® in popular parlance – was urged by the Citizen's Advisory Council on National Space Policy as a means of seizing the initiative in the Technological War. JEP, 1985

In the past, we used technology to overcome the advantages of the Soviets both in the resources they control and in the initiatives we conceded them. We succeeded in negating their quantitative superiority by the qualitative advantages we acquired through a superior technology.

The circumstances today are radically different. The Soviets have challenged us in technology. They have enlarged the spectrum of conflict, taking advantage of the inevitable new struggle, the Technological War. No longer are we free to follow an independent course in implementing our strategy. We must meet the technological threat as well as the threats in other forms of conflict.

> Since this was written the Soviets have developed, among other things: neutral particle beams; laser weapons; mobile medium to long range

ballistic missiles; satellite destroyers; etc., etc. JEP, 1985

This form of warfare has become crucial. A technical advance can lead to a decisive military advantage. It is not enough for us to continue past approaches to our total strategy. The strategist must recast his thinking if he is to make his defensive strategy effective. He must find avenues for the initiative in technology. He must prevent the would-be aggressor from attaining a clear advantage in any aspect of technology that could be translated into a decisive military advantage.

Broader horizons are needed in another aspect of the problem of the defensive strategist. Planning methodology and decision processes reflect the past situation. They are no longer adequate. The time has come to break the shackles of science on planning methodology. We need to rehumanize planning and strategy. This process will have a direct impact on decision making. Decision makers can no longer find refuge in the alleged certainties and probabilities that past planning provided them. We are now in an era of creative, dynamic uncertainty. We must have a strong defensive position. But we must also create strategic diversions, feints, deceptions, and surprises.

Only in this way can the defensive strategist ensure that the attacker will choose not to strike. A viable strategy poses insurmountable problems for the aggressor.

In 1983 the United States began, haltingly, to shift toward a strategy of Assured Survival rather than Assured Destruction. Some of the principles set forth in this book were applied, in may cases by officers who had been assigned the first edition in their service academies and war colleges. By 1989 the benefits of this strategic shift became obvious, as the Soviet Union found itself short of resources, and doomed to watch its expensive Strategic Offensive Forces becoming, in President Reagan's words, "impotent and obsolete." Their first response was to redouble their efforts to achieve technological victory. The result was a great strain on their economic resources; ultimately a strain they could not bear. Shortly afterwards the Soviet Empire in Eastern Europe began to unravel. Then the Berlin Wall came down.

This is not to say that the Cold War is over; it is certainly not to say that the Technological War is finished. That can never be. The silent and decisive war will continue well past the end of this century. It does mean that we have won a major battle in the Technological War. We have not yet exploited that victory with technological pursuit.

9.5 The Effect of Nuclear Weapons

Nuclear weapons have not changed the nature of strategy; however, they have introduced new complications, just as they have introduced new opportunities. The major new opportunity is that the strategist, once he decides to strike, can apply far more power, over larger areas, than could any of his predecessors who fought with low-energy weapon systems. The main new complication is that the defender, even though deprived of a large portion of his initial strength in the course of the first battle, would still retain enormous firepower to hurt the attacker far more dangerously than it was ever before possible for a defensive force to do. This residual force can be used against the attacker's population, industry, urban areas, government control centers, and armed forces, provided that the defender has not acquired active and passive defenses, and the defender's will to retaliate has not failed. The scope of war has grown to include entire undefended populations, not merely military forces.

Also, it is easily conceivable that under some circumstances the attacker, although he may defeat the defender, may achieve only Pyrrhic victory. Or, even if he achieves an unqualified victory, he would not enjoy the fruits because he has paid an excessive price. In fact, he may have lost his country to the blows that his defeated adversary was still able to inflict. Nuclear weapons have not worked totally to the advantage of the attacker.

It would be a grave mistake to assume that this particular strategic problem is new. Even if it were new, the significant aspect is whether the danger of devastating retaliation would prevent war. To put it in different terms, the question is whether such a hazard would prevent the aggressive strategist from planning for war in a rational manner. Obviously a great deal of the strategist's mental effort must be devoted to the security of the aggressor's homeland. If the defender can be induced to leave his weapons unused, the aggressor can still achieve decisive victory.

In order to prevent aggression, the defender must seek safety in strength. He must seek superior technology, modern weapons that can survive attack, and engage actively in the Technological War. He cannot rely on agreements, planned weaknesses, or minimum strength.

In the last analysis, superior strength remains the most reliable insurance for survival of the defender. The strategist of the superior power has some chance of predicting what his enemy might do; the strategist of a greatly inferior power can only hope. A defensive strategy aiming at superiority in power offers the only dependable hedge against errors in planning.

9.6 Force Levels in the Nuclear Era

It is clear that as the armaments race takes place on high force levels the aggressor will be hard-put to achieve decisive superiority. The conclusion to draw from this is that relatively low levels of nuclear power are a chief prerequisite for nuclear attack. This is especially true in a period when cities have not been fully dispersed and populations have not been cannot be effectively protected by a program of active and civil defense. Low levels of forces in being are more of a danger to the United States than high levels–fears of genocide and the arms race notwithstanding. This is an important finding, which casts a very disturbing light on the recent history of U.S. armaments and armament negotiations.

Of the two belligerents, the one who is able to continue the war beyond the initial strike will have an enormous advantage because the side that does not have this capability will cave in morally and will be unable to reconstitute its force. Such a capability can only be provided by vigorous pursuit of technology, including the design and the deployment of weapons.

The survival force is one key to security. As long as the U.S. has secure weapon systems that can ride out the initial and follow-on strikes, the U.S. will be able to deter any rationally planned attack. The in-being power that is still effective after the battles are over will determine the final outcome.

> Project 75 concluded that due to increasing Soviet missile accuracy, by about 1980 the Minuteman force would no longer be able to ride out a full Soviet first strike, and that sometime thereafter the US would be forced to choose between active defense and launch on warning. Launching Armageddon on early warning of attack is not an attractive alternative. As warning times grow shorter, the US is forced seriously to consider computerizing the launch decision. This is even less attractive. Fortunately, the advent of SDI changes the equation. See below.

Our defensive strategy requires us to have a survivable force. Hardening, dispersal, mobility, and concealment contribute to survival, but they are supporting strategic themes. The single most important element of our defensive strategy is to have in being a clear superiority in effective and reliable numbers. This is the one factor in the strategic equation that is most easily understood and the one the enemy is least likely to misunderstand. Numerical superiority on our side is necessary to convince the aggressor not to strike.

A would-be aggressor, if he were to act rationally, would realize that he cannot cope with high force levels. Therefore, he must make an attempt to bring forces down to a level where he can fight nuclear war–especially if through clandestine armaments of his own he achieves an enormous superiority. It is clear that the aggressor is not particularly perturbed by high force levels of his own, let alone by relative superiority, but is disturbed by a high force level owned by the defender. His problem, therefore, is to achieve a substantial quantitative superiority. To achieve this goal he must persuade the defender to be content with moderate strength.

Another reason why the aggressor needs the low level of forces is that decisive increments in strength are difficult to conceal if they have to be produced within the framework of high force levels. This means that psycho-political strategy is an integral part of nuclear strategy, first to achieve some sort of reduction of armament levels, then to provide a cover to conceal the aggressor's armaments and third, to facilitate nuclear blackmail and prevent retaliation.

> This was entirely true in 1969 when it was written. Since then the Technological War has continued. ICBM accuracies have been greatly increased to the point where it is nearly impossible to deploy survivable fixed-site missiles without active defense. However, we now have the economic and technological resources to defend our SOF. The same defenses will also greatly reduce damage to our cities if deterrence fails. Practical strategic defenses allow reduction of strategic offensive forces without consequent loss of stability. In the absence of those defenses, though, the above arguments apply with full force.

For the foreseeable future, strategic stability depends on both numbers and defenses.

9.7 Security Through Arms Control

The unending process of armaments has often been criticized as the greatest waste of which mankind is guilty. It is true that if both sides stay in the race and run well the world situation will remain stable and no war will occur; the weapons will then be said to have been wasted. The arms control argument is that if both sides agree not to engage in arms races, peace would be preserved effectively and at far less cost.

However, we have already seen that by lowering the levels of destruction war would bring, reductions in arms make war thinkable and more therefore likely. This, it would seem, is one major argument against arms control and disarmament. However, it is hardly the only such argument.

Since technology is dynamic, no one can agree to stand still. Force relationships change in the course of armament cycles despite the best planning possible. Sudden accretions of military power can come to a side not even expecting them. New technologies create new power.

It is true that the tempo of this eternal race can be accelerated or slowed. Aside from the technological factors that often determine this tempo, the speed of the process is largely set by political factors, including strategic intentions. If no disturber power is at work, the tempo will slacken almost automatically. If there is a disturber power, explicit or tacit slow-down agreements are at best highly unreliable and temporary. The side that takes the risk of slowing down unilaterally will soon be punished.

The history of disarmament agreements teaches an explicit lesson: international promissory treaties are almost invariably broken and are therefore an utterly undependable instrument of national security.

The fundamental reason for the defender to stay in this expensive race, and to run hard in it, is to stay alive and not allow the would-be attacker to achieve such an advantage that he might be inclined to break the peace and impose his will on the naive and gullible defender.

So long as the defender must stay in the arms competition, he does not really have the option of running a selective race. He cannot leave open any geographical or technological flanks, or the opponent will take advantage of his opportunities. Thus, the United States does not really have the free choice of saying that it will stop communism in Europe and defend the East Coast, but ignore Communist advances in Asia. Nor can it say that it will maintain offensive nuclear weapons but not acquire defensive ones, or that it will try to be strong in inner space but will assume that outer space is of no military relevance. Least of all can the United States entrust its security to so-called disarmament treaties, not because it must necessarily and always presuppose bad faith on the part of other nations (although sometimes it must make precisely such an assumption of bad faith), but for the far more elementary reasons that (a) reliable inspection of disarmament agreements is unfeasible, (b) that enforcement against treaty violations requires war, and (c) that disarmament agreements apply to weapons already in existence, but will be speedily outdated and be rendered irrelevant by new weapons, the characteristics of which were unknown at the time the treaty was written.

9.8 Security in the Modern Era

As we have seen, security cannot be guaranteed by Soviet intentions; not only do Soviet theorists predict inevitable victory by the U.S.S.R., and Soviet generals hasten to install the latest weapons, but, even were we convinced that the U.S.S.R. is ruled by men who have lost their aggressive drives, there is no guarantee that a new Stalin will never again take power.

Security cannot be guaranteed by passive measures. The most modern force purchased at enormous cost will become obsolete in only a few years. Security cannot be guaranteed by agreements to halt the Technological War; the stream of technology moves on without regard for our intentions. The only way to guarantee security is to engage in the Technological War with the intention of winning it. It is as true today as in Roman times that "If you would have peace, prepare thou then for war."

Regardless of the enormous effects of modern weapons, organized brainpower remains the strongest and ultimately decisive factor. The experience of Vietnam, the test ban, and the Sputnik have shown that we do not excel in that department. It is not that we lack intelligent people but that we lack an effective organization through which we can optimize our brainpower and collective memory. On the contrary, the more we have overorganized, the more we reduced brainpower and the more we forgot. Secretary McNamara even organized strategic amnesia.

We must decide to engage in the Technological War, and we must create the planning staff to guide us in this decisive conflict. To do anything short of this is to risk national suicide. At the same time, we must preserve the values that make our society worth defending; we cannot contemplate ending the Technological War by destroying our enemies without warning. Our goal is the indefinite preservation of peace and order, and our hope is that in such an environment the root causes of conflict will slowly wither.

The era of Technological War has not ended conflict, and that millennium may never come. Technological War does, however, have the advantage of being relatively peaceful, so long as the stabilizer powers remain strong. Despite the greatest threat Western civilization has ever known, since 1945 the amount of blood shed to preserve the peace has been quite small–smaller than that shed on the highways. The Technological War can be kept silent and apparently peaceful so long as we continue to engage in it successfully.

Despite fashionable rhetoric, history shows that American supremacy brings relative peace and stability to the world; where the U.S.S.R. has enjoyed local superiority the results have been quite different. American success in the Technological War is the primary prerequisite for the preservation of world peace.

In 1985 Secretary of Defense Caspar Weinberger said, "To the extent that we in the United States desire true peace with freedom, peace based on individual and sovereign rights and on the principle of resolution of disputes through negotiation, we must acknowledge and follow our interests in creating conditions in which democratic forces can gain and thrive in this world. A world not of our making, but a world in which we must fight to maintain our peace and our strength. And a world in which the very best way to maintain peace is to be militarily strong and thus deter war." Of course we agree.

The dramatic benefits of that strategy became apparent in 1989. It is vital that we understand that despite the events in Eastern Europe the Technological War is not over. It has only changed fronts.