The Strategy of Technology

Winning the Decisive War

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"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

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 Footnote 15deliberately 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 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 peristroika, 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 peristroika 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..Footnote 1

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 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, Footnote 2we 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 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 Footnote 3and 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 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.[1]

[1] The above section (1.1) was written in 1968. It is now (1991) 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

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.[2]

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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

[2]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.[3]

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. Footnote 11More 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 con-

[3]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.

ceivable area in which military conflict can occur. Yet, this is merely the 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, Footnote 4the 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 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. Footnote 13

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

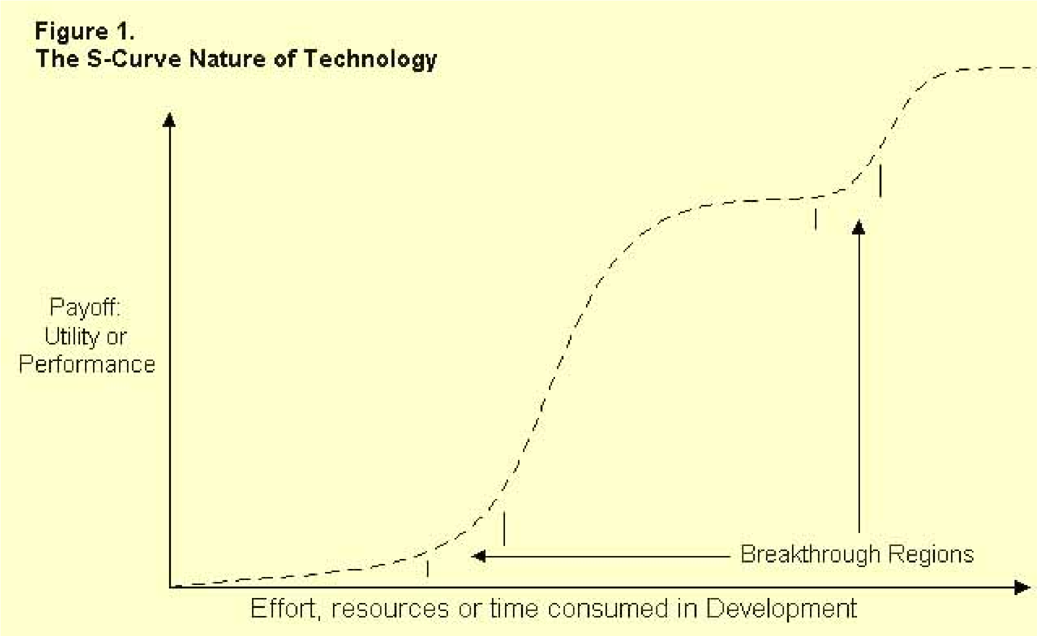

Figure 1.1: The S-Curve Nature of Technology

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.Footnote 5

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 certain mining operations that were previously financially infeasible. Examples of interdependence can be given without limit. Footnote 12

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 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 peristroika 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), Footnote 6surrender, 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 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.Footnote 7

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.Footnote 8 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.

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.Footnote 9

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.

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.Footnote 10

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
- 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.[4]

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

[4]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).

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.[5]

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.

[5]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.

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.Footnote 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 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.Footnote 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.[1]

The Soviet strategy in the Technological War would not be an optimum strategy for the West, precisely because neither motives nor resources are

[1] 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 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.

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.Footnote 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.[2]

[2] 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 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

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.Footnote 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.

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.

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%.

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.Footnote 7

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.Footnote 7a

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 quick brown fox jumps right over the lazy dog. the quick brown fox jumps right over the lazy dog. the quick brown fox jumps right over the lazy dog. the quick brown fox jumps right over the lazy dog. the quick brown fox jumps right over the lazy dog. the quick brown fox jumps right over the lazy dog. the quick brown fox jumps right over the lazy dog. the quick brown fox jumps right over the lazy dog.