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TECHNOLOGY AND THE BALANCE OF POWER

MILITARY ISSUES RESEARCH MEMORANDUM

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TECHNOLOGY AND THE BALANCE OF POWER

by

Alwyn H. King

15 December 1977

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FOREWORD

Using computer technology as an illustrative example, this memorandum discusses the dangers of allowing, and above all helping, the USSR to close the technology gap. The author points out that, during the past decade, support of exploratory research and development by both government and industry in the United States has dwindled. He asserts that, concurrently, the Soviets have emphasized R&D and are rapidly closing the US/USSR technology gap. He concludes that the United States must place increased emphasis on the pursuit of advanced technology.

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This memorandum was prepared as a contribution to the field of national security research and study. As such, it does not reflect the official view of the College, the Department of the Army, or the Department of Defense.

ROBERT G. YERKS
Major General, USA
Commandant

BIOGRAPHICAL SKETCH OF THE AUTHOR

DR. ALWYN H. KING joined the Strategic Studies Institute in 1973. He earned a bachelor's degree in engineering from McGill University, master's degrees in physical metallurgy from Columbia University and in economics from Babson College, and a doctorate from Stuttgart Technical University in Germany. He has been associated with the Brunswick Corporation Research and Development Laboratories and with Arthur D. Little, Inc., and has been awarded a number of US and foreign patents. Dr. King holds the rank of colonel in the US Army Retired Reserve.

TECHNOLOGY AND THE BALANCE OF POWER

> . . . power capabilities of nation-states must be counted among the conditions that facilitate or militate against armed conflict in the presence of other motivational factors. Evidence indicates that relative parity in power capabilities does have deterrent value . . . .
>
> —Wayne H. Ferris

The elements of national power are the means available to a nation for employment in the pursuit of national objectives. The individual elements may be defined as economic, geographic, military, psychosociological, political, and scientific and technological. The sum total of these resources, including their availability and utility, reflects the capability of a nation to influence the actions of other nations in the international arena. The ability to apply national power or any of its components is relative and locational, and must be appraised with due allowance for the strength and location of opposing power. With full realization that the elements of power are never completely separable, and weakness in one area can nullify strength in another, this memorandum will deal primarily with the influence of technological development, and its place among other factors, on the balance of power between adversary nations. Principal emphasis will be on the US/Soviet relationship.

The technological element of national power includes:

- the quality and quantity of research and development, and degree of support by the national command authority,
- the degree of industrial modernization,
- the number and proficiency of available technically-trained manpower, and
- the capability of management to apply scientifically-developed knowledge to practical use. While detailed information is not available for a precise comparison of all of these factors, general trends are discernible and overall comparisons of US and USSR technological competence can be made.

THE INFLUENCE OF TECHNOLOGY

> Technological change is not inevitable and human behavior in relation to it is not predictable. People have differing and complex structures of value, and each society shapes technology in its own way.
>
> – Lynn T. White, Jr.

The power balance among the nations of the world has teetered and tottered periodically throughout history. Reasons for such changes in influence and world leadership are often complex and the critical factors not clearly obvious. Technology in one form or another, however, has often been involved, if not explicitly responsible for the ascendancy of one or another nation to a position of dominance.

New or advanced technology, per se, cannot and does not alter the course of international events; its utility must be recognized and whatever power it represents must be effectively applied. The foresight of a nation's leaders, and their ability to convert the benefits of scientifically-developed knowledge to the solution of problems of practical significance is often the decisive factor in determining which nation achieves a position of economic or military leadership.

The impact of technology on society, and the resulting balance of power among nations, are strongly influenced by the way each society shapes, modifies, and applies or fails to apply available technology to accomplish its various ends. The sociological influence on technological change in the field of weapons development can be traced through the history of some significant items of early military hardware. For example, around 1330, the trebuchet, a descendant of the Roman catapult and a very effective siege weapon, had been replaced in most

national arsenals by the much more expensive and less reliable gunpowder cannon. Although less accurate and extremely dangerous to its users, the early cannon had become a status symbol among the rulers of the time because of its high cost as well as its impressive flash and roar. It was not until 125 years after its first appearance that the cannon was improved to the point where it could match the trebuchet. Nevertheless, for psychosociological reasons, the trebuchet had virtually disappeared about 50 years earlier.

The World War I period witnessed the first systematic and sustained application of science and technology to the solution of military problems and to the development of new and improved military hardware and weapons systems. This new military technology resulted in great improvements and increased effectiveness of existing machine guns, artillery weapons, and submarines, and in the new development, or new application to warfare, of innovations such as the airplane and the tank. Here, too, psychosociological factors affected technological change, and neither the airplane nor the tank reached its full capacity to revolutionize warfare until World War II. The slow pace of acceptance was partly due to technical deficiencies in early models, but full realization of the potential of these new weapons and their impact on the conduct of warfare was further inhibited by a simple reluctance to accept change (and to some extent the glamor, tradition and intransigence of a well-entrenched horse cavalry).

More recently, technology has played an even more vital role in the development of new weapons systems; the rapid exploitation of new technologies has yielded order-of-magnitude improvements in capabilities, and even dictated shifts in national strategy and defense policy. The development of fission and fusion weapons, precision guidance systems, and electronic warfare equipment has required long lead times, the concentrated efforts of a variety of disciplines and the application of new technologies. The emphasis is on science and technology; psychosociological influences now surface mainly in determining the national will to use or not to use the new weaponry.

THE GROWTH OF SOVIET MILITARY TECHNOLOGY

> The unresting progress of mankind causes continual change in the weapons; and with that must come a continued change in the manner of fighting.
>
> – Alfred T. Mahan

Since World War II, the United States has emphasized quality over quantity in its efforts to counter the threat posed by numerically superior conventional Soviet forces. Western technological superiority has until recently allowed this strategy a relative degree of success. The traditional Soviet emphasis on quantity, however, has more recently been supplemented by a massive commitment to defense research and development. The USSR is currently placing strong emphasis on military R&D all the way from the education of engineers and scientists to the production of sophisticated weaponry. Their total annual commitment of resources now exceeds that of the United States, and continues to increase each year. The result has been a rapid development of the Soviet technological base, and a corresponding and continuing improvement in the quality of Soviet military hardware.

Numerous studies and reports have been devoted to the comparison of relative strengths, degrees of technological proficiency, and levels of R&D funding for the United States and the Soviet Union. Precise figures for the USSR are not available, and various estimates have been used in these comparisons. Regardless of the specific conclusions of different analysts, however, the trends are unmistakable.

A review of Soviet policy related to science and technology stated that:

> . . . the Kremlin sees the U.S. as caught in increasing constraints on its ability to keep up the pace it maintained in the past in scientific and technological development. Yet it [the Kremlin] shows no indication of any intention to relax its own efforts and ease its own burden. On the contrary, it appears to see in the situation an unexpected opportunity to move more rapidly toward its [the USSR] purpose of capturing the scientific-technological lead which it considers decisive in the 'struggle between the systems.'[1]

Evidence of Soviet progress in achieving this goal is seen in statements by senior US officials. In the FY-73 US Senate hearings on DoD Authorization, Dr. John S. Foster, former Director of Defense Research and Engineering, stated that the "current US technological superiority is in jeopardy" and that our technological lead was "slim and dwindling."[2] Two years later, in the FY-75 hearings, then Secretary of Defense James R. Schlesinger noted that the Soviet development programs of four new ICBM's "provide the Soviets with the potentiality of achieving strategic superiority vis-a-vis the United States if we fail to take necessary action." He went on to state that:

> . . . We have been satisfied with the numerical and throw weight handicaps of the United States under SALT I because we have had technological advantages. But the events of last summer indicate that those relative technological advantages are waning and we must be prepared to offset any attempt by the Soviets to achieve real or apparent strategic advantages over the United States in the future.[3]

An Air War College research report by Captain Robert J. Dapogny, USN, in 1975, provides a detailed analysis of the entire R&D process in the United States, and compares the funding, and the relative effectiveness, of R&D programs in the United States and the USSR in support of national security. Recent and continuing trends are clearly depicted in Figure 1 from that report.

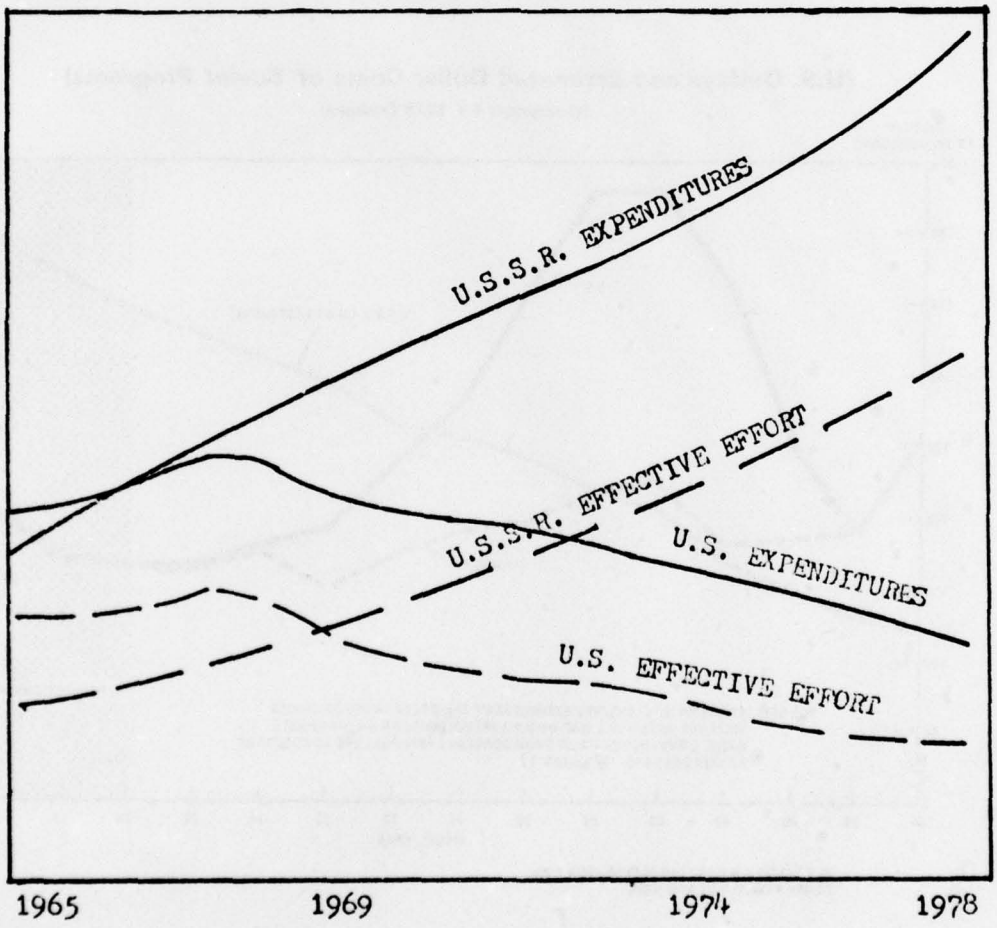

Figure 1. Recent and Continuing Military Research and Development Trends

Captain Dapogny summarizes the observed trends in R&D as follows:

> In brief, the USSR military program is larger than that of the United States, it is increasing while the US program is decreasing, and it has been producing some high quality items which pose great challenges to the security of the United States. The Soviets have a very good potential for even greater technological acceleration in at least the next decade, since all primary controlling factors are moderately or strongly positive in their case.[4]

Though differing in some detail, the Annual US Defense Department Report for FY 1978 shows similar historical and projected trends for US and Soviet defense and R&D investments (see Figures 2 and 3).[5]

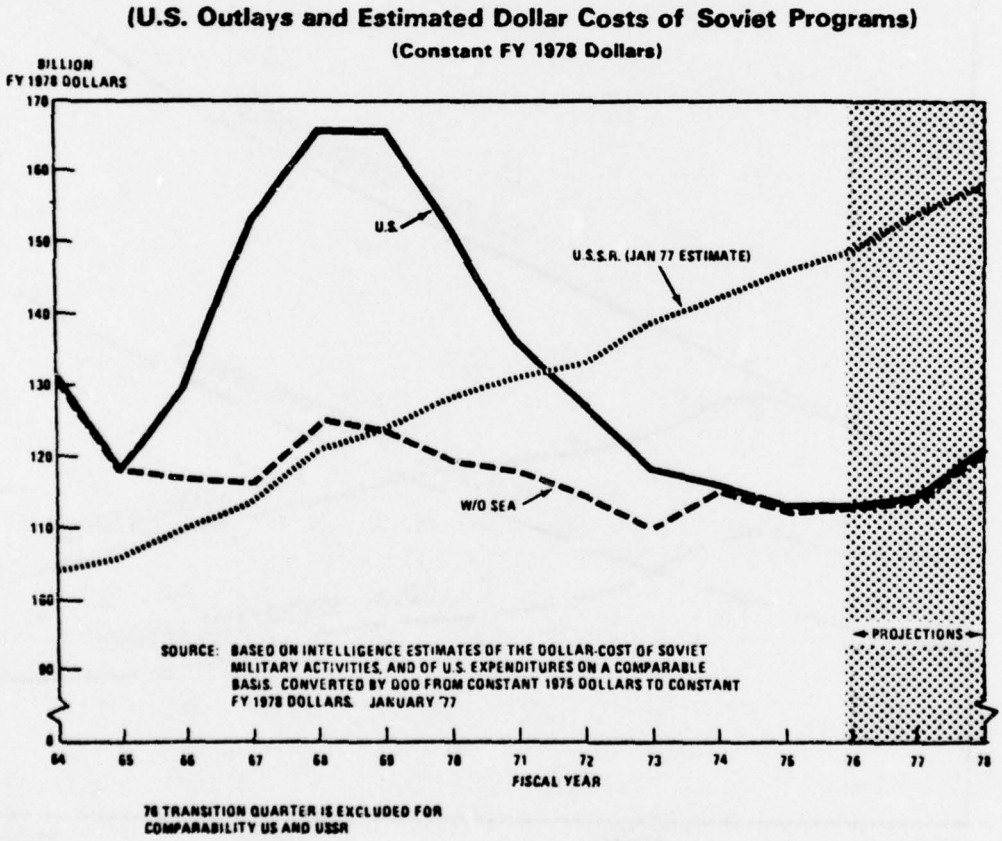

Figure 2. US and Soviet Defense Program Trends[5]

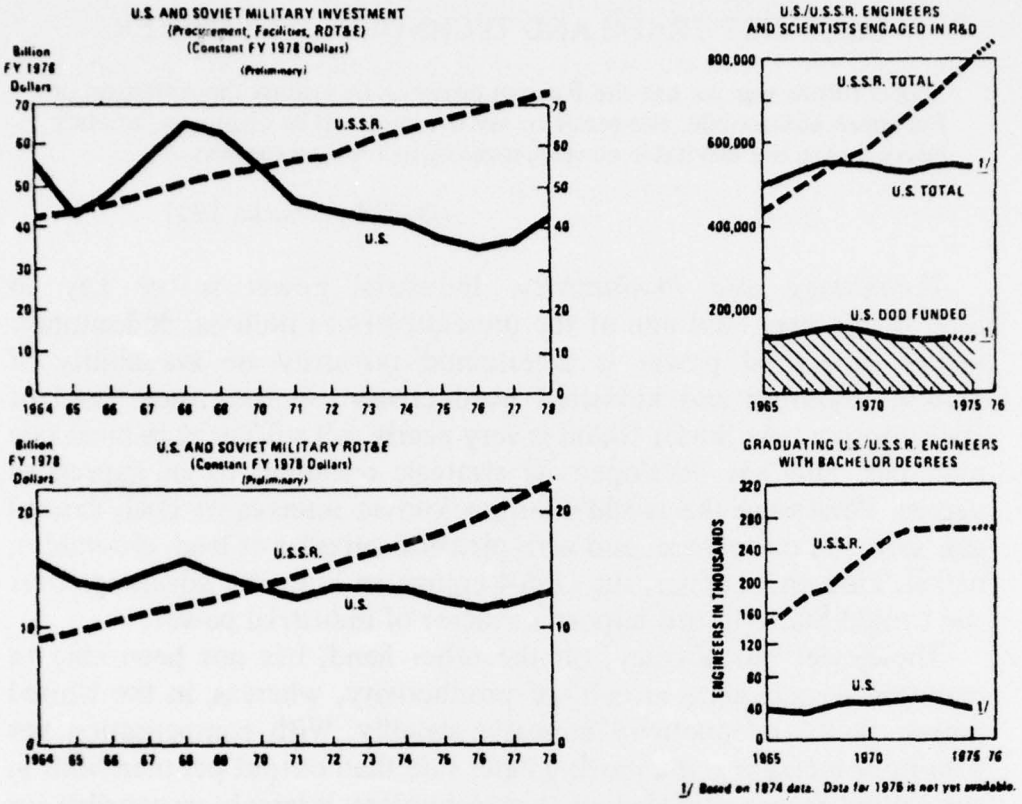

Figure 3. Comparative US and Soviet Technological Investment[5]

The long period of recognized US leadership in the application of science and technology to industrial and military production has come to a close. In addition to the intense competition with the USSR in military and space technology, the industrial countries of Western Europe and Japan are increasingly capable of applying sophisticated technology to industrial applications, to the point of matching, and in some cases surpassing, the United States in some areas. The danger of Soviet technological superiority is, of course, the most immediate threat, as it is concentrated primarily on military applications. A degradation of the economic element of our national power, however, could also pose a serious long-term threat to our national welfare if our industrial technology fails to maintain a competitive position among the industrialized nations of the world.

US/SOVIET TRADE AND TECHNOLOGY TRANSFER

> If in a future war we use the Russian peasant cart against the American or European automobile, the result to say the least will be disproportionately heavy losses, the inevitable consequences of technical weakness.
>
> —Ossinsky, *Pravda*, 1927

Technology and Productivity. Industrial power is the key to economic power, and one of the prerequisites to political and military power. Industrial power is determined primarily be availability of natural resources and industrial productivity. At its present level of consumption, the Soviet Union is very nearly self-sufficient in most raw materials, and has developed its strategic resources to an impressive degree. Possessing the world's largest known reserves of coal, natural gas, iron and manganese, and with plentiful supplies of lead, chromium, nickel, zinc and copper, the USSR enjoys an immense advantage over the United States in this important factor of industrial power.

The Soviet bureaucracy, on the other hand, has not been able to maintain an adequate growth of productivity, whereas, in the United States, factor productivity increases steadily. With compensation per man-hour increasing at a much greater rate than output per man-hour in the United States, it is obvious that technology is largely responsible for this growth in productivity. It is also obvious that advanced technology, sorely needed by the Soviets for industrial growth, is a source of US strength.

Although there is no doubt that the overall level of Soviet research, experimentation and application of technology is still below that of the United States, in certain areas of scientific research—e.g., mathematics, astronomy, theoretical physics and oceanography— and in the practical application of science and technology, notably in heavy industry, the USSR does occupy a respectable world position. Furthermore, a note of alarm has recently been sounded by Dr. Jerome Wiesner, president of MIT and former science adviser to the President, who has observed that the pace of innovation in American technology is slowing down, and has cited several institutional factors tending to inhibit incentive to invest in more advanced technology.[6] If not corrected, this trend will predictably lead to decreased productivity.

US-Soviet Trade. Trade relations between the United States and the Soviet Union go back for many years. As early as 1837, the two nations signed a mutual most-favored-nation (MFN) tariff treaty. In the early

1900's, the United States became an important supplier of agricultural equipment to Russia. Interesting to note, also, is the fact that the US Government abrogated the MFN treaty in 1911 in an unsuccessful attempt to pressure the Czarist government into a policy of more humane treatment of Russian Jews.

History shows that, from the fifteenth century to the present, Russian leaders have perceived a great need to catch up with the more advanced nations of the West. An important factor in the catching up process has been the importation and employment of advanced foreign technology. There have been several clearly discernible periods of Russian history dominated by intense efforts to acquire advanced technology from abroad, usually paid for primarily through the export of raw materials such as grain, lumber and oil. During the reign of Peter the Great (1682-1725) a massive importation of foreign technology and technologists took place, with the primary purpose of building an economic base to support Peter's military ambitions. The current Soviet emphasis on technology acquisition appears to result from similar ambitions, with the immediate objective of achieving a much needed increase in the rate of growth of factor productivity, which has shown a steadily declining trend since 1950. This declining productivity has been reflected in a decrease in the average annual rate of growth of Soviet GNP (1950-58: 6.4 percent; 1958-67: 5.3 percent; 1967-73: 3.7 percent, by Western figures–10.9 percent, 7.2 percent and 6.4 percent, respectively, by Soviet figures).[7]

The Effect of Technology Transfer–Computers. Space will not permit separate discussions of the many diverse technologies which may influence in varying degrees the critical power relationship between the United States and the Soviet Union. In one very important area, however, that of computer technology, a critical analysis of the effects of transfer has been completed by the RAND Corporation for the US Air Force, with results most pertinent to this discussion.[8]

Although the basic concepts of computer technology are well-known in both the United States and the Soviet Union, radical differences exist between the two countries in the level of sophistication of computer system design and in application know-how. This significant US lead in computer technology is based largely on the unquestioned worldwide superiority of the US large-scale integrated circuit (LSI) industry. The ability to manufacture superior LSI logic arrays and memories contributes greatly to the quality of computer hardware, including reliability, resistance to shock and other environmental hazards, small

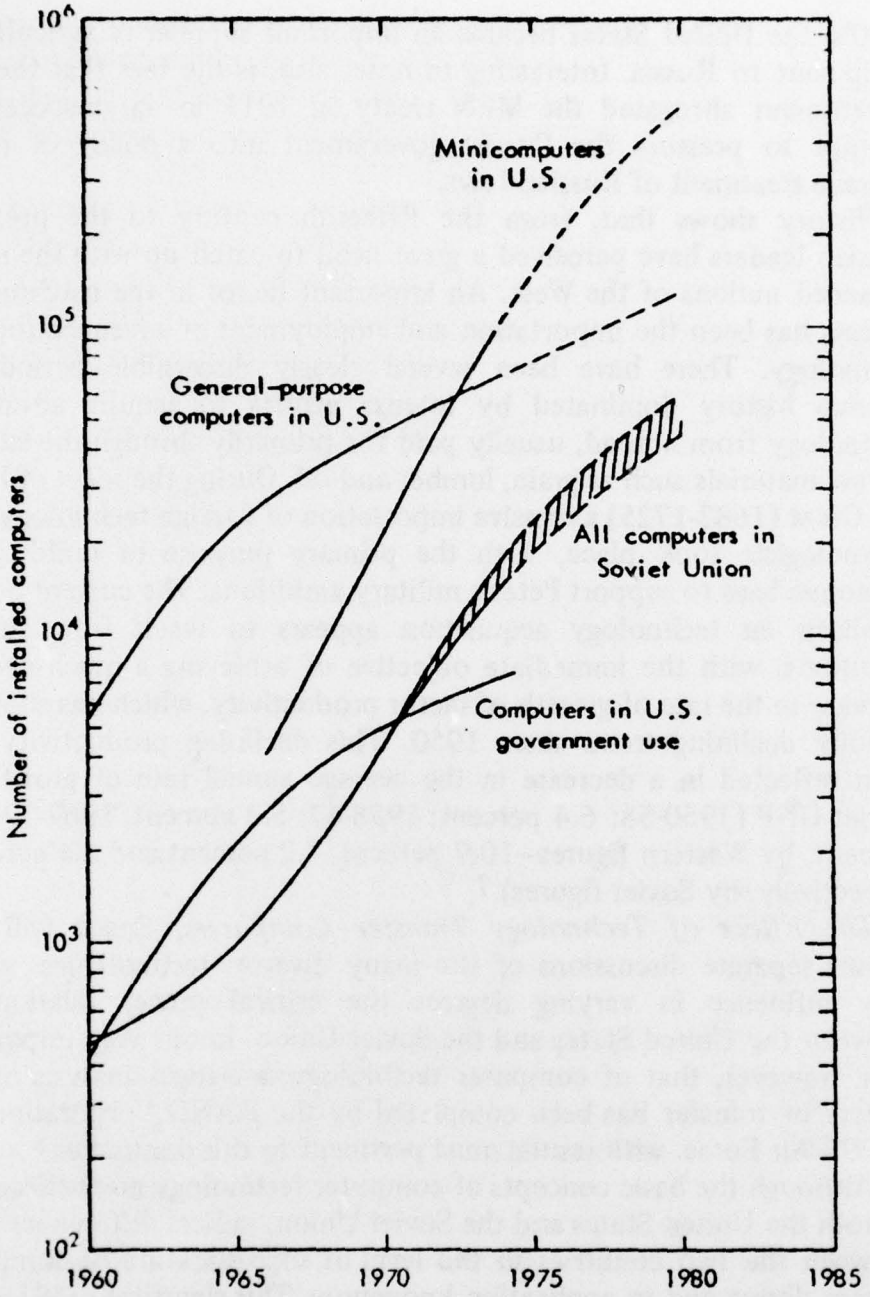

Figure 4. Trends in Computer Stocks.[9]

size, low power requirements and ease of maintenance and repair. Advanced LSI technology is especially important in the development of military computers, permitting significant reductions in critical physical characteristics such as size, weight and power consumption while improving performance, memory capacity and reliability.

A comparison of numbers of computers in use and projected (see Figure 4 and Table 1) suggests that the Soviet Union trails the United States in computer manufacturing technology by 5 to 10 years.[9] This is apparent in most computer technology areas, but the computer technology gap is smaller in the theoretical aspects of computer science, and in application-oriented programing languages and systems, in which they have successfully adapted Western-developed languages to run on Soviet computers.

Year	Computers in US	Year	Computers in USSR
1959	3,810	1970	4,500
1961	7,550	1972	8,000
1964	18,200	1975	15,000(est.)

Table 1. Numbers of Computer Installations in the United States and the USSR[9]

The Soviets themselves (in 1975) estimated that their lag behind the United States in computer production and application was only 2 to 3 years, stating that the Soviet Union was not merely repeating the American experience, and that the gap in capability was smaller than the gap in numbers in use would indicate.

Although it is difficult to establish a general functional relationship between computer technology and military advantage, there are a number of applications in both tactical and strategic systems in which improved computer performance would certainly enhance military capability.

Present and prospective capability-enhancing computer applications discussed in the USAF Project RAND report include the following:[10]

Tactical:

- aircraft avionics systems, for enhanced capabilities in navigation, sensor data processing, weapons delivery and fire control, electronic warfare, and flight control;
- command and control of remotely piloted vehicles; and
- command and control of tactical forces, to include planning and directing combat operations, processing information on friendly and enemy forces, and fire control.

Strategic:

- surveillance and warning systems, for an increase in number of objects tracked and improved resolution;
- terminal guidance and terminal targeting of ICBM maneuvering reentry vehicles;
- antiballistic missile defense;
- computer-aided bomber penetration of enemy defenses; and
- provision of increased survivability for strategic command and control systems through smaller size and airborne capability.

Little information is available concerning military computers and their applications in the Soviet Union. However, it is likely that their requirements and the direction of their computer development programs roughly parallel our own. Unclassified Soviet military literature has indicated interest in automated artillery fire control, troop movement control, reconnaissance and radar data processing, and computerized operational tactical planning. Installation of the Soviet Ryad ES-1020 (similar to the US IBM-360 system) in a van-type truck has been photographed.[11]

The computer industry in the United States and in other Western countries sees the Soviet requirement for improved computer technology as an opportunity for significant profits from increased trade. Export controls on computers, designed to prevent transfer of militarily useful technology to potential enemies, continue to be challenged. The prime question is whether or not such transfer would yield strategic advantages to the USSR and the Warsaw Pact.

The USAF Project RAND, mentioned above, has applied game theory to an analysis of this question with the postulate that the pervasive use of computer technology in R&D, and in the production, operation, and control of military systems, gives a positive acceleration to the overall growth rate of military technology. A numerical run of the RAND model showed that an increase in the growth rate of Soviet computer technology could have significant implications for requirements for improved US forces to maintain a desired strategic power ratio. For example, the calculation indicated that to have parity in 1982, the United States would need to modernize about 33 percent of its strategic forces, and the Soviet Union about 54 percent, if Soviet technology continues to grow at its unassisted historic rate. However, if Soviet technology were advanced to the same level as that of the United States by large-scale transfers, the above numbers change to 95 percent and 74 percent, respectively.[12] The conclusion, based on this model, is

that the United States must indeed have technological superiority to compensate for numerical inferiority.

CONCLUSIONS

> The inherent contradiction of capitalism is that it develops rather than exploits the world. The capitalistic economy plants the seeds of its own destruction in that it diffuses technology and industry, thereby undermining its own position. . . .
>
> – Lenin

In the final analysis, it is not possible to make a definitive judgment regarding relative levels of technical proficiency between the United States and the Soviet Union. Available evidence gives the United States an overall lead, but shows the USSR catching up rapidly in some fields. According to Dapogny, in three system areas in which the United States had superiority in 1973–namely SLBM's, strategic bombers, and man-portable air defense systems–Soviet versions deployed in 1975 indicated a reversal of this lead status. The vigor of Soviet heavy industry is illustrated by the fact that Soviet tank production is over five times that of the United States and submarine production four times. The sophistication of their space technology permits satellite intercept tests; the fourth of the current series was successfully performed in December 1976 (in violation of the spirit, if not the letter, of the Outer Space Treaty). The Soviet technology base has advanced to the point where technological advances gained in military weapon systems and development programs are being transferred to assist lagging sections of civilian production.

The continuing threat to US technological superiority is clearly recognized by the Department of Defense, and is reflected in the FY 1978 RDT&E funding request for $12 billion "to continue the real program growth begun in FY 1977 and to . . . ensure . . . the continuity of US technological superiority into the 21st century."[13] At times, however, US policymakers continue to demonstrate an unfathomable propensity for "giving away" the very advantages we need to retain to ensure a US position of strength. A recent example was the Ford Administration approval in October 1976 to sell modern and very sophisticated computer systems, capable of military as well as industrial applications, to both Communist China and the Soviet Union. The sale to China was justified "as a gesture of support to the new Chinese

leadership."[14] Justification for the sale of a Control Data Corporation CYBER 73 system to the USSR is not clear.

A book by Antony Sutton, published in 1973, argues strongly against technology transfer, both industrial and military, to the Soviet Union, citing examples of items from trucks to merchant ships built by the Soviets with US technical assistance and later used to our military disadvantage in various parts of the world. Though somewhat strident in tone, the claims made in this publication cannot be taken lightly. Noting that free trade is eminently desirable in a free world of noncoercive societies, Sutton poses the question: "If we can show that trade is a carrier for self-destruction, then is free trade desirable?"[15]

Technology transfer to the USSR, and even reduced safeguards and policy exceptions based on "overriding foreign policy interests," continue despite DoD proclamations that

> . . . we must continue to restrict the transfer of those technologies–particularly production technologies–which would enable potential adversaries to close technological gaps in vital defense areas.[16]

Since such advanced developments as Terrain Contour Matching guidance techniques (TERCOM) for cruise missiles depend critically on advanced computer technology, it would seem that here is certainly a technology gap which must not be closed!

Norman R. Augustine, Under Secretary of the Army (R&D), reported in 1975 that Soviet expenditures on military research and development exceeded those of the United States by well over $2 billion a year–sufficient *additional* funds to match our R&D expenditures on the XM-1 tank, SAM-D, UTTAS, the AAH, the B-1 bomber, MICV, Site Defense, Trident, and several other programs combined.[17] Since the development and exploitation of new technologies is the priimary means available to the United States to compensate for quantitative weakness, all available evidence emphasizes the urgent need to strengthen our R&D activities in the military as well as academic and industrial areas. This view has been clearly expressed by Dr. Malcolm Currie, former Director of Defense Research and Engineering, as follows:

> In this increasingly competitive, often hostile and rapidly changing world Americans seem to have only one real choice. Clearly our national well-being cannot be based on unlimited raw materials or on unlimited manpower and cheap labour. Rather it must be based on our ability to multiply and enhance the limited natural and human resources we do have. Technology thus appears to offer us our place in the sun–the means to insure our security and economic vitality.[18]

During this period of apparent retrenchment of US foreign military commitments, the increased pursuit of advanced technology would afford the United States one of the best guarantees for maintaining an acceptable balance of power, and would increase US credibility and leverage in negotiations with the Soviet Union by demonstration of a renewed, vigorous technical leadership.

ENDNOTES

1. Robert J. Dapogny, *Research and Development Supporting US National Security: A Declining Process*, p. 73.
2. *Ibid.*, p. 93.
3. *Ibid.*, p. 94.
4. *Ibid.*
5. Donald H. Rumsfeld, *Annual Defense Department Report FY 1978*, pp. 3 and 12.
6. Harold W. Schmeck, "Technology Pace Found Declining," *The New York Times*, April 20, 1976, p. 11.
7. Herbert S. Levine, "An American View of Economic Relations with the USSR," *USA-USSR: Agenda for Communication*, p. 4.
8. USAF Project RAND, 1975.
9. *Ibid.*, Vol. I, pp. 12, 13.
10. *Ibid.*, Vol. II, pp. 22-26.
11. *Ibid.*, Vol. I, p. 49.
12. *Ibid.*, Vol. III, p. vi.
13. Rumsfeld, p. 264.
14. Leslie H. Gelb, "U.S. Agrees to Sell China a Computer with Defense Uses," *The New York Times*, October 29, 1976, p. 1.
15. Antony C. Sutton, *National Suicide*, p. 19.
16. Rumsfeld, p. 267.
17. Norman R. Augustine, *New Technology for an Army of Opportunity*, p. 190.
18. Richard Burt, *New Weapons Technologies: Debate and Directions*, p. 1.

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Technology; Technology transfer; Military research and development; Soviet research and development; US/USSR technology gap; US/USSR power balance.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Historically, the United States has emphasized quality over quantity in its efforts to counter the threat posed by numerically superior Soviet forces. Western technological superiority has until recently supported this strategy. This memorandum reflects the author's concern that the advantage the United States currently enjoys is being rapidly eroded by two factors: a decreasing emphasis on R&D and new technology in the US, aggravated by a simultaneous

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20. Abstract (Cont'd)

increase in the USSR, and insufficient control of the transfer of advanced technology from the US to the USSR, particularly in those areas in which the technology gap is closing most rapidly, e.g., computers. Closer control of international technology transfer, and increased emphasis on R&D and the pursuit of advanced technology in the United States are strongly advocated.

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