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The Soviet Weapons Industry: An Overview

DI 86-10016
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The Soviet Weapons Industry: An Overview

Summary

Over the last two decades, the Soviet Union has delivered weapons to its military at a level unequaled anywhere in the world. Over 50,000 tanks, 80,000 light armored vehicles, 9,600 strategic ballistic missiles, 50,000 aircraft, 650,000 surface-to-air missiles, and 270 submarines have been procured since 1965.

In the process, the Soviets have built the largest weapons industry in the world. Roughly 50 major design bureaus control the development of 150 to 200 weapons at any one time. Weapons are assembled in about 150 major production complexes scattered throughout the Soviet Union. Designers and producers are supported by thousands of organizations in Soviet academia and industry.

Since the 1920s, the entire complex has been operated in a way that exploits the priority given to defense and the advantages of a command economy, and minimizes the impact of Soviet technical weaknesses. Soviet weapons acquisition has been characterized by:

- Centralized management by party and government organizations, demonstrating continuity and stability in personnel and programs.
- Final leadership authorization of weapon programs and their funding early in the acquisition process.
- Relatively simple, low-risk weapon designs, emphasizing standard components and existing technologies.
- Easily manufactured systems, which can be fabricated by a technologically unsophisticated industrial base with semiskilled or unskilled labor operating general purpose conventional machine tools and equipment.
- Long production runs yielding large numbers of weapons.
- Weapon advances that emphasize incremental upgrades instead of the development of completely new systems or subsystems.

Developments in the economy, technology, and the foreign threat are inducing the Soviets to modify these strategies. The slower growth of the Soviet economy in the past decade and harsh constraints on the availability of key resources have led the Soviet leaders to stress efficiency more than in the past. At the same time, dramatic improvements in Western weapons and advances in their own and foreign military research and development

(R&D) have led them to seek greater advances in weapon performance and capabilities. Changes are under way in the Soviet defense industrial establishment that respond to these new conditions:

- *In resource allocation.* The Soviets appear to be evaluating more carefully the priority accorded the defense industries. Defense will continue to have a high priority, but the increasing costs and complexities of producing advanced weapons are inducing them to seek more cost-effective ways to meet military requirements. In addition, writings and statements indicate the Soviets recognize that their long-term defense needs require more balanced development in Soviet industry, services, and the technology base.

- *In weapon development.* The Soviets are shifting from well proven to more advanced technologies and from simple to more complex weapon designs. They will continue to rely on traditional, proven approaches to develop most of their weapons. But in several areas—such as strategic defense—they will find it more and more difficult to meet new threats by relying on those strategies. Development cycles for some systems may lengthen as a consequence, particularly in the test phase.

- *In production.* The Soviets are manufacturing advanced weapons in smaller quantities and at lower rates. Improved weapon performance and greater multimission capabilities, along with greater production problems and the higher procurement and maintenance costs of new weapons, are encouraging the Soviets in some cases to reduce the numbers produced. The danger of obsolescence from a more rapidly changing threat and military technology base will further encourage shorter production runs. Retrofit programs, which enhance and prolong the combat worthiness of older systems, are probably intended to partly compensate for this.

- *In the industrial base.* The high-technology support sector of the weapons industry—radioelectronics, telecommunications, specialty materials, and advanced production equipment—will generally continue to grow more rapidly than weapon and equipment producers. Throughout the defense industries, the Soviets are using incentives and investment policy to encourage the renovation and modernization of established facilities instead of new plant construction.

- *In administration.* Small-scale changes in planning and management are being implemented. The Soviets are modifying industrial organization and revising plan targets, prices, and incentives to encourage innovation and quality over quantity. They will not undermine the central planning system by providing managers with real autonomy, however, and the defense industries will continue to be the most thoroughly scrutinized part of the Soviet economy.

- *In seeking help from abroad.* The Soviets are stressing and supporting the buildup of the scientific-technical base of their East European allies and will seek more imports of technology and equipment from them. They will also continue to rely heavily on acquisition of Western technology.

Changes in the Soviet armed forces in the 1990s will drive—and be driven by—changes in the weapons industry. Alterations in doctrine, force structure, logistic organization, maintenance requirements, and manpower utilization are likely to accompany the evolution in the products of the defense industries. In some cases, the long-term impact of increasingly sophisticated weapons may be a reduction in total numbers maintained in active inventories. Overall force effectiveness is likely to increase, nonetheless, as the mobility, survivability, and lethality of new weapons improve.

Certain aspects of the weapons industry are unique in the Soviet economy, but many of its problems confront the civilian sector as well. Although the defense industrial ministries have never been completely insulated from civilian industry—an indispensable supplier of materials, components, and subassemblies—the lines between the two sectors have become increasingly blurred as weapons have grown in complexity. Since the last years of the Brezhnev era, the Soviets have been implementing policies to speed the modernization of both the civilian and defense industries.

The Soviet defense industries face considerable challenges in their mission to produce sufficient quantities of highly advanced weapons for the forces of the next decade. Nevertheless, expansion in high-technology industries, advances in precision machining and other fabrication technologies, and continued aggressive exploitation of Western technology will allow the Soviets to overcome some of the difficulties with which their domestic R&D base is currently struggling. Moreover, the Soviets' speed in introducing generic equivalents of Western technologies into their own systems and their ability to surge ahead along a narrow front of military technologies will help them remain competitive in deployed military capabilities.

In any event, the Soviet weapons industry will remain a potent force in the 1990s. It has been a vital ingredient in Soviet military power, which has been the primary instrument of the Soviet leadership in achieving national security, political leverage, and prestige throughout the world. The weapons industry will continue to be at the forefront of Soviet technology and industrial prowess, and it will absorb a large share of the best Soviet resources. Its leaders will continue to wield considerable influence on Soviet policy. And—because of growing economic constraints and the potential of advancing military technology—its performance is likely to be an even greater determinant of Soviet military power than is the case today.

Contents

Figure 1
Key Soviet Industrial Ministries That Support the Military

Ministry of the Aviation Industry
Responsibilities:
Aircraft, aerodynamic missiles, spacecraft, air-to-air missiles, defensive missiles (tactical and strategic), tactical air-to-surface missiles, and antisubmarine warfare missiles.

Apollon Sergeyevich Systsov, Minister

Ministry of the Communications Equipment Industry
Responsibilities:
Communications equipment, radar components, electronic warfare equipment, military computers, and facsimile equipment.

Erlen Kirikovich Pervyshin, Minister

Ministry of the Defense Industry
Responsibilities:
Conventional ground force weapons, mobile solid-propellant ballistic missiles, optical systems, antitank guided missiles, tactical surface-to-air missiles, lasers, and ASW missiles.

Pavel Vasil'yevich Finogenov, Minister

Ministry of the Electronics Industry
Responsibilities:
Electronic parts, components, subassemblies, and computers.

Vladislav Grigoryevich Kolesnikov, Minister

Ministry of General Machine Building
Responsibilities:
Liquid- and solid-propellant ballistic missiles, including submarine launched; SLBM fire-control systems; space launch vehicles, spacecraft, and surface-to-surface cruise missiles.

Oleg Dmitriyevich Baklanov, Minister

Ministry of Machine Building
Responsibilities:
Conventional ordnance munitions, fuzing, and solid propellants.

Vyacheslav Vasil'yevich Bakhirev, Minister

Ministry of Medium Machine Building
Responsibilities:
Nuclear weapons and high-energy lasers.

Yefim Pavlovich Slavskiy, Minister

Ministry of the Radio Industry
Responsibilities:
Radars, communications equipment, special-purpose computers, guidance and control systems, and lasers.

Petr Stepanovich Pleshakov, Minister

Ministry of the Shipbuilding Industry
Responsibilities:
Naval vessels and weaponry, submarine detection systems, naval acoustic systems, and radars.

Igor Sergeyevich Belousov, Minister

Other Key Defense-Related Industrial Ministries

Ministry	Responsibilities:
Automotive	Trucks, armored personnel carriers, and heavy equipment transporters.
Heavy and Transport Machine Building	Armored vehicles, diesel engines, and generators.
Electrical Equipment Industry	Batteries, electrical components, communications equipment, radar components, and biological/chemical warfare detectors.
Instrument Making, Automation Equipment, and Control Systems	Computers and instrumentation control systems.
Power Machine Building	Generators.
Chemical Industry	Fuels, fiberglass components for rocket motors, and propellants.
Tractor and Agriculture Machine Building	Tanks and tracked vehicles.
Petroleum Refining and Petrochemical Industry	Tires, rubbers, fuels, and lubricants.

310259 8-86

The Soviet Weapons Industry: An Overview

The Complex: Scope and Achievements

The Soviets have consistently accorded high priority to national defense, and this has fueled their development of the world's largest military-industrial base. This base has grown continually since World War II as the Soviets have produced a steady stream of new and upgraded weapons in large quantities. Their commitment—which has not varied substantially with the international climate—led them by the early 1970s to devote greater resources to armaments production than any other country.

Nine defense industrial ministries (see figure 1) currently oversee thousands of weapon and weapon component plants and at least 450 military research and development (R&D) organizations throughout the USSR. Roughly 50 major design bureaus oversee the development of 150 to 200 major weapon systems, a level of effort sustained for at least the past three decades. About 150 major plants assemble these weapons, and the plants have steadily expanded throughout the postwar era. These designers and producers are supported by a network of facilities that extends throughout Soviet academia and industry. The facilities are managed by government and military organizations that strictly control the allocation of resources and the pace of activity.

As is the case in most Soviet industry, defense industrial production is largely concentrated in the more populated and developed areas of the western USSR (see figure 2). Management of the defense industries—including the nine ministries and the relevant party and government organizations—is based in Moscow. Research and development facilities are principally located in Moscow and Leningrad, also the sites of the most prestigious facilities of Soviet higher education and science. The geographic concentration of the defense industries both reflects and intensifies the firm direction of the Soviet military-industrial complex from the center.

Allocation of Enormous Resources

Since the implementation of the First Five-Year Plan (1928-32), the Soviet leadership has lavished resources on the military-industrial complex. While millions starved in the early 1930s—because of forced collectivization and a crash industrialization policy—aircraft, guns, and tanks were beginning to roll off newly constructed production lines. This emphasis on defense continues to this day, with the USSR in the awkward position of having achieved superpower status and yet having per capita consumption statistics equivalent to those of a less developed country.

When Brezhnev came to power in 1964, he initiated an across-the-board modernization and buildup of both strategic and conventional forces. CIA estimates that Soviet defense expenditures over the next decade—and the subset of those expenditures devoted to procurement—grew at a real average annual rate of about 5 percent.[1] This growth reflected increasing resource commitments to all of the military services and missions.

In the mid-1970s there was a change in the rate of growth of Soviet defense spending. CIA estimates that total defense spending—which includes expenditures for research and development, procurement of weapons and combat equipment, manpower, construction, and operations and maintenance—increased by an average of about 2 percent annually from the mid-1970s until at least 1984. This slowdown in growth was primarily the result of a leveling off—at a very high level—in procurement spending.

[1] Procurement includes weapons and equipment produced for the Soviet armed forces but not those produced as prototypes or for export. We use the term "production" when referring to all of the military output of the defense industries.

Figure 2
Major Soviet Defense Industry Facilities

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Despite the slowdown in the annual growth rate in spending for weapons procurement, the share of Soviet resources committed to such procurement is extremely high by international standards. The USSR devotes appreciably higher shares of the output of almost every industry to military procurement than does the United States. Soviet weapons procurement absorbs about 7 to 8 percent of the Soviet gross national product and about a third of the output of the important machine-building sector.

The commitment over time to developing the defense industries is reflected in the persistent growth of weapon production facilities. Defense production capacity has doubled since 1965. The industries that produce missiles and aircraft expanded most rapidly.

Military R&D facilities have grown similarly. Facilities devoted to R&D for subsystems and components (radars, communications systems, and computers, for example) expanded more rapidly than those used for final weapons development. This difference reflects the increasing complexity of Soviet military equipment.

The growth at many defense industry facilities is the result of the traditional Soviet practice of building new facilities alongside older facilities, which continue producing and maintaining older systems and furnishing spare parts. This practice is partially the result of ineffective incentives to economize on construction, but it has often been necessary because of the unsuitability of older facilities for housing modern production-line tooling. Buildings constructed since the early

Table 1
Selected Civilian Use Goods
Produced by the Soviet Defense Industries

Ministry	Products
Aviation Industry	Cameras, vacuum cleaners, alarm clocks, baby carriages, aluminum kitchen utensils, snowmobiles, passenger aircraft
Communications Equipment Industry	Tape recorders, televisions, intercoms, facsimile equipment
Defense Industry	Fishing equipment, cameras, motorcycles, lasers, industrial and scientific optical equipment
Electronics Industry	Consumer radios, television sets, computers, telephone equipment, lasers
General Machine Building	Television sets
Machine Building	Bicycles, refrigerators, electric razors, samovars, drills
Medium Machine Building	Civilian nuclear power equipment
Radio Industry	Telephone equipment, televisions, radios, tape recorders, computers
Shipbuilding Industry	Pleasure craft (sail and power), commercial ships of all types, drilling platforms, irrigation equipment

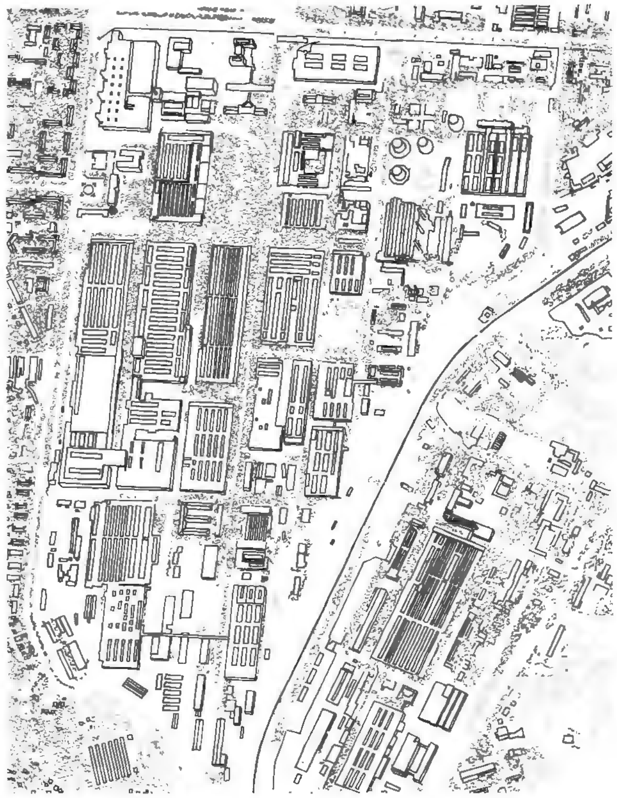


Figure 3. The Dnepropetrovsk Missile Development and Production Center. The Dnepropetrovsk Missile Development and Production Center is by far the largest missile-producing plant in the world, with more than 2 million square feet of floorspace devoted to the major fabrication and final assembly of strategic missiles and space launch vehicles. The Dnepropetrovsk Center is also the site of the Southern Machine-Building Production Association imeni *L. I. Brezhnev, an important source of tractors and other heavy agricultural equipment.*

1970s, however, are being designed as large, open-spaced structures of modular components. Their added structural strength and flexibility will provide the more vibration-free environment required for a greater variety of precision equipment, and they should allow production lines to be rearranged, upgraded, or replaced periodically as requirements change. This will lessen the future requirements for new construction.

The Soviet commitment to the defense industries is also manifested in the priority accorded them. The defense industries receive the highest quality raw materials and are given preferential access to the transportation and distribution networks for delivering materials. They also have access to the best machinery and labor.

Although the leadership has bestowed priority on the defense industries with respect to resources and personnel, it has endeavored to ensure that there are civilian spinoffs in return. At the 24th CPSU Congress in 1971, Brezhnev stressed that the defense industries were working for the economy as a whole. He noted that 42 percent of the output of the defense industries was devoted to civilian goods (some Western analysts maintain he was referring to just one ministry, the Ministry of the Defense Industry). More recently, General Secretary Gorbachev called upon the defense industries to share some of their management expertise with the rest of the economy, and in June 1986 the CPSU Central Committee ordered three defense industrial ministries to improve the quality and timeliness of their consumer goods production. In any case, the industry's support to the Soviet economy is extensive—defense industry enterprises produce many civilian products, ranging from refrigerators and baby carriages to electronics, tractors, and railroad cars. Table 1 and figure 3 illustrate the scope of such production.

The Soviet Demand for Weapons

The Soviet policy of maintaining a huge standing army creates a constant and heavy burden on the defense industries to produce the required weapons. The Soviets have over 210 Ground Forces divisions. Of these, approximately 40 percent are considered "ready divisions"—that is, they could be mobilized and prepared for combat in a short period of time. Rather than modernizing all units, the Soviets generally concentrate on upgrading equipment holdings of their frontline divisions in Eastern Europe and the western USSR. As of 1986, their Ground Forces inventory included approximately:

- *53,000 tanks.*
- *55,000 armored troop carriers.*
- *34,000 pieces of tube artillery.*
- *6,300 tactical surface-to-surface multiple rocket launchers.*
- *1,600 tactical surface-to-surface missile launchers.*
- *4,300 major surface-to-air missile launchers.*

The other Soviet military services also maintain huge inventories of arms and equipment. The Air Forces have some 10,000 fixed-wing aircraft and 4,000 helicopters. The Soviet Navy is second in tonnage only to the US Navy and has almost 300 principal surface combatants, over 380 submarines, and about 1,000 patrol and auxiliary craft.

The Soviet Air Defense Forces (PVO) and Strategic Rocket Forces (SRF) are also well equipped. The PVO has about 9,500 surface-to-air missile launchers devoted to territorial air defense. The inventory of the SRF includes launchers for approximately 1,400 ICBMs and more than 400 intermediate-range ballistic missiles (IRBMs) and 112 medium-range ballistic missiles (MRBMs).

High Levels of Production

The impressive size of the Soviet weapons industry is primarily due to the large force requirements of the Soviet military. Only the People's Republic of China has more men under arms, and, in number of weapon systems, the United States leads the Soviet Union in only a few types of military equipment, such as aircraft carriers. Maintaining the combat effectiveness of the Soviet forces demands massive procurement of regularly upgraded and improved weapon systems (see inset on the Soviet demand for weapons).

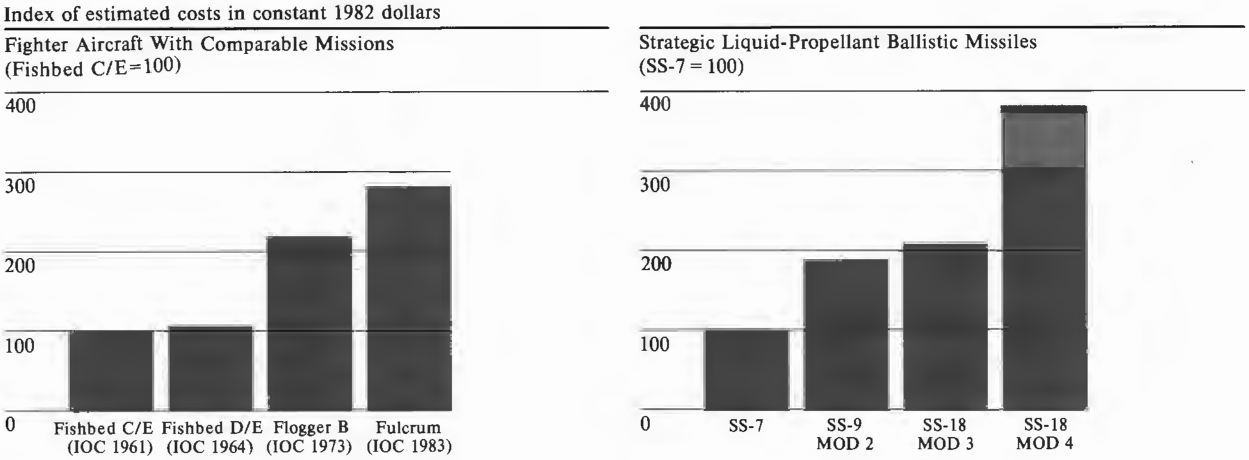
One of the most striking trends in Soviet weaponry is the escalating cost of new systems (see figure 4). Incorporation of more advanced technologies and modernization of the manufacturing base have combined to make new systems far more expensive than their predecessors. As a result, although total numbers produced in many categories of weapon systems have declined (see figure 5), total spending on defense procurement has not.

Changing Conditions

Despite the plateau in military procurement, the Soviet weapons industry is producing enough equipment to modernize Soviet forces and at the same time reap substantial benefits—both financial and political—from the export of military hardware (see inset on page 8). Capital investment in the defense industries has continued at high levels, and the number of weapons currently in development is at least as high as ever. For the last decade or so, however, the Soviets have become increasingly concerned about the ability of their military-industrial complex to compete in a high-technology arms competition with the West. A number of factors are causing them to closely examine their weapons industry and to seek changes in its operation and output.

Soviet writings on major trends in US and NATO force developments have shown concern about many programs in both the strategic and conventional areas that are viewed as having the potential to erode Moscow's hard-won military gains. Programs that might be considered especially threatening in the late 1980s and early 1990s are the Trident D-5 submarine-launched ballistic missile system; the B-1 bomber; air-, sea-, and ground-launched cruise missiles; and the Pershing II missile. Others are improved "real-time" reconnaissance systems; antisubmarine

Figure 4
Estimated Production Costs of Selected Soviet Weapons[a]



[a] The indexes displayed above reflect 1982 dollars, not actual Soviet expenditures. They are based on estimates of what it would cost to produce these Soviet systems in a US factory using US wage rates, material costs, and equipment operating factors.

310262 8-86

warfare systems; and a variety of improved tactical systems, including "smart" munitions, particularly antitank guided munitions, Assault Breaker weapons, the M1 Abrams and Leopard 2 tanks, and advanced antiradiation missiles. In addition, the Soviets undoubtedly perceive serious longer term threats associated with such Western systems as improved maneuverable reentry vehicles (MaRVs), directed-energy laser weapons, stealth aircraft, aerodynamic missiles, and technologies associated with strategic defense.

Advances in Soviet R&D, along with aggressive acquisition of foreign technologies, are providing new opportunities for Soviet weapon designers. Yet the technologies required to build advanced systems are in areas where Soviet R&D and production capabilities are weakest—electronics (including microelectronics), advanced high-speed computers, and sophisticated design and manufacturing systems. The latter include:

- Computer-aided design (CAD) systems, which allow designers to develop, record, display, and alter the design of a part or assembly at a computer terminal, then command a plotter to produce the engineering drawings.

- Management information systems—computerized systems for processing orders, scheduling production, and inventory control.

- Industrial robots, which move materials, parts, tools, or specialized devices through variable programed motions.

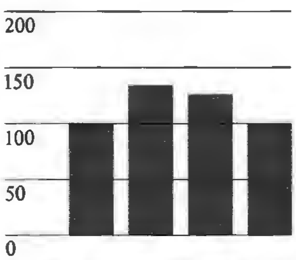
- Numerically controlled (NC) and computer numerically controlled (CNC) machine tools, which perform various functions along different axes, receiving instructions from paper tape, punch cards, or magnetic tape (NC tools) or from computers (CNC tools).

Figure 5
Estimated Production of Selected Soviet Weapons, 1966-85[a]

Index: 1966-70=100

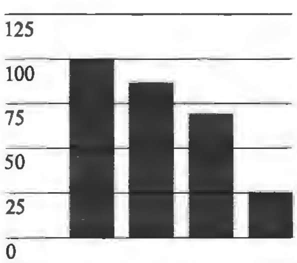
Note scale changes

Aircraft



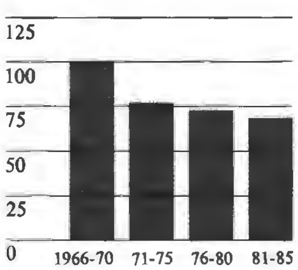
Soviet aviation plants currently produce 10 fighter aircraft models, including the MIG-31 Foxhound, SU-27 Flanker, MIG-29 Fulcrum, and SU-25 Frogfoot. One intermediate-range and two strategic bombers, seven models of transport aircraft, and five helicopter models are also being produced. Several aircraft models are produced for export as well.

ICBMs and SLBMs



Strategic missile production has been limited in the 1980s as the Soviet defense industries prepare to produce new models to modernize the force. The Soviets are developing a liquid-propellant ICBM to replace their SS-18; a solid-propellant ICBM (SS-25) is now in series production; and a second type (SS-X-24) is in prototype production. Two SLBMs, the SS-N-20 for the Typhoon nuclear-powered submarine and the SS-N-23 for the Delta IV nuclear-powered submarine, are currently in series production, and other SLBMs are in development.

Tanks



Tanks are the principal offensive component of the Ground Forces. Tank costs increased primarily because of the production of large numbers of T-64s, T-72s, and T-80s in basic, improved, and export versions and the growing cost of their increasingly advanced subsystems and components.

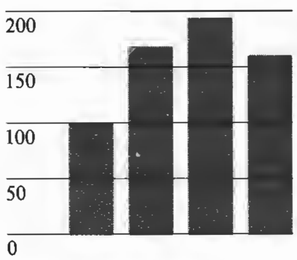
310261 8-86

Figure 5 (Continued)

Index: 1966-70=100

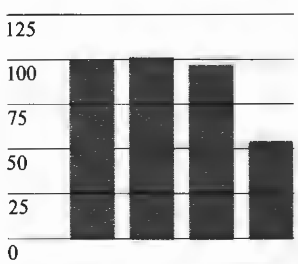
Note scale changes

Artillery



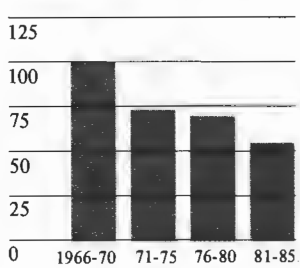
The Soviets have traditionally manufactured large numbers of artillery systems. Recently, increasing numbers of self-propelled systems have been introduced to increase the mobility and firepower of artillery units. Their gun calibers include 122 millimeters (mm), 152 mm (two weapons), 203 mm, and 240 mm (a mortar). Other towed and self-propelled systems are being developed and tested.

Major Surface Combatants



Although the number of major surface combatants produced is declining, the trend toward larger ships with increased endurance, greater weapon loads, and more sophisticated weapons and equipment continues. The Soviets are modernizing their surface fleet through the construction of several classes of large cruisers and destroyers with improved warfighting capabilities. They have also begun outfitting the first unit of a new class of carrier, probably nuclear powered, for conventional takeoff and landing aircraft.

Submarines



Over the last few years the types of submarines produced have increased at an unprecedented rate. Although production has declined, there has been rapid growth in the diversity of nuclear-powered general purpose units, such as the Akula and Sierra classes.

[a] For each weapon category, the graph shows our estimates, in index form, of the changes in the quantities of new units produced in each five-year period. The figures do not include conversions or refitted and modified older systems.The figures cover all weapons in the selected categories produced by the Soviet defense industries, not just those procured by the Soviet military.

310261 8-86

Soviet Arms Production for Export

For the past two decades, arms transfers have been the USSR's primary means of promoting its interests in the Third World. Initially designed to strengthen the Soviet Union's political and military position, this program also became, in the mid-1970s, a key factor in improving its foreign trade position. Although the USSR does sell some newer model systems, their largest sales are of older weapons, which are relatively inexpensive and simple, and thus compatible with the resources, tactics, and support capabilities of Third World military services.

The concentration on older models for export has influenced the organization and scheduling of weapons production. Although most weapons for export are manufactured concurrently with those for Soviet forces, the Soviets have often dedicated entire production lines and runs to export variants. Producing for export on a dedicated line facilitates scheduling and eliminates the need for frequent changes in equipment, tooling, and material supply to accommodate any differences in the design of an export variant. Export production occasionally continues after domestic needs have been satisfied, extending the production run and thus increasing the benefits of having mastered the design and production process.

Staying competitive in Third World markets, however, is complicating the export business for the Soviet weapons industry. Many countries are demanding state-of-the-art weapon systems, requiring Soviet plants to produce them concurrently for Soviet and foreign military services. Exporting more sophisticated weapons also means establishing a more complex training and logistic support pipeline. Some countries are purchasing licenses to produce Soviet weapons, obligating Soviet plants to transfer and install equipment and tooling, train indigenous managers and laborers, and provide ongoing material support and technical consultation. Soviet industry has had little experience in nurturing Third World defense industrial development. How far the Soviets will move in providing a broader array of arms transfer services is unclear.

- Flexible manufacturing systems—integrated systems of several CNC machine tools and robots that perform machining and transfer functions.

Most of these are already commonly used in the design and manufacture of Western weapons.

The changing economic environment is also challenging the way in which the Soviet weapons industry has traditionally operated. Additions to the Soviet labor force are dwindling, and the areas within the USSR where population growth continues at a high rate are not those in which most industry is located.

Soviet economic growth has also slowed—at least in part because of large expenditures on arms procurement—while the defense industries' needs for material resources are increasing. Continued high levels of military procurement, coupled with unexpectedly slow growth in the output of the machine-building, energy, metallurgy, and chemical sectors, almost certainly contributed to industrial bottlenecks in the late 1970s.[2] Even though they are shielded by the priority accorded them, weapon producers cannot be fully insulated from the general economic environment. Modern weaponry—which requires large inputs of new technology—must compete with increasing demands by other economic sectors for more modern technology.

Resumption of military procurement growth at or near the rates of the early 1970s would exacerbate these bottlenecks, further constraining Soviet economic growth. It would also reduce growth of investment and consumption by diverting resources away from the manufacture of producer and consumer durables. Limiting investment, in turn, would result in a slower accumulation and replacement of capital stock, thus hampering Gorbachev's industrial modernization program and curbing overall economic growth. Slower consumption growth would affect worker morale, hindering the leadership's efforts to spur labor productivity.

[2] Bottlenecks arise when the demand for a product exceeds supply and output cannot or does not expand sufficiently to close the gap. Because some consuming industries receive less of the commodity than desired, they produce less of their products, creating new bottlenecks. Thus the effect of the original bottleneck cascades throughout the economy.

Figure 6
Changing Conditions Affecting the Soviet Weapons Industry

Increasingly sophisticated military threat → The Soviet Weapons Industry in Transition ← Worsening economic environment

Traditional weapons acquisition strategies (Simple, rugged weapons) → The Soviet Weapons Industry in Transition → New weapons acquisition strategies (More advanced weaponry)

The Soviet Weapons Industry in Transition

Product technology Mastering production of such advanced components and subsystems as:	To achieve:	**Process technology** Installing and assimilating such advanced design and manufacturing equipment as:	To achieve:
Signals processing	Improved target differentiation and identification.	Advanced machine tools	Fabrication of complex parts to consistently high tolerances; more rapid changeover from one machine part to another.
Advanced optical and infrared equipment	Enhanced target acquisition and tracking; reduced vulnerability to detection.	Robots	Highly effective repetitive operations, speedier production, and uniformly high product quality. Freeing of laborers from hazardous tasks.
Nonmetal structural materials	Greater strength and lower weight, leading to increased speed, maneuverability, range, or payload.	Computer-aided design systems	Rapid change in product designs and documentation, timesavings, and a wider range of options.
Directed energy	Ability to attack targets at long ranges instantly.	Computer-based management information systems	Precise and responsive control of supply and production scheduling and performance.
Advanced electronic components	Improved command, control, communications, intelligence, target detection, and fire control; and electronic warfare capabilities for military systems of all kinds.	Computer-to-computer data links	Rapid exchange and update of management, design, and production information.
High-speed computers	Near-real-time reconnaissance; improved command, control, and communications; improved target acquisition and fire control.	Microelectronics	Control, data storage, and transfer functions for all the equipment listed above as well as for numerous other business and manufacturing operations.

Planning and Management

The Soviets' success in equipping their forces lies in their ability to make long-range, coherent plans; to command and focus resources on the most important programs; and to ensure continued commitment to programs under way. The Soviets have developed a system of planning and management designed to enhance the performance of their planned economy in satisfying the military's requirements for weapons and equipment. However, Soviet military-industrial managers operate in the same central planning environment as their civilian counterparts and are thus subject to many of the same problems.

Strong Centralized Management

Planning for and management of the Soviet weapons industry is the shared responsibility of the party and the government (see figure 7):
- The party draws up basic policy guidelines and monitors their fulfillment.
- The government, through its various ministries, state committees, and commissions, runs the economy and its defense-related industrial activities.
- The Soviet Ministry of Defense (MOD), as part of the government, generates requirements for the defense industries and is the consumer of their products.

High-level representatives of the party and government, including the military, serve on the Defense Council—usually presided over by the CPSU General Secretary—and advise the Politburo on major defense policy issues.

The party is involved in planning and management through the national planning process, by which priorities are set and resources allocated, and through its monitoring apparatus, headed by a party secretary with responsibility for defense matters. This party secretary oversees the Central Committee's Defense Industries Department and its counterparts at the local level. The nature and extent of the party's role in supervising the work of the defense industries has varied over time with different people in key positions.

Government management of the defense industries is centralized in the USSR Council of Ministers. Most of this management is performed by the Council's Military-Industrial Commission (VPK), which coordinates and controls all military-related research, design, development, testing, and production activities, and serves as a primary orchestrator for defense industrial acquisition and assimilation of foreign technologies. The State Planning Committee (Gosplan) serves as the central coordinating body for assigning production targets and allocating resources to the defense industries. Other key state committees are:

- The State Committee for Science and Technology (GKNT), which plans and implements scientific-technical policy for the entire Soviet economy. It determines the basic directions for the development of science and technology and works with the VPK to oversee foreign technology acquisition.

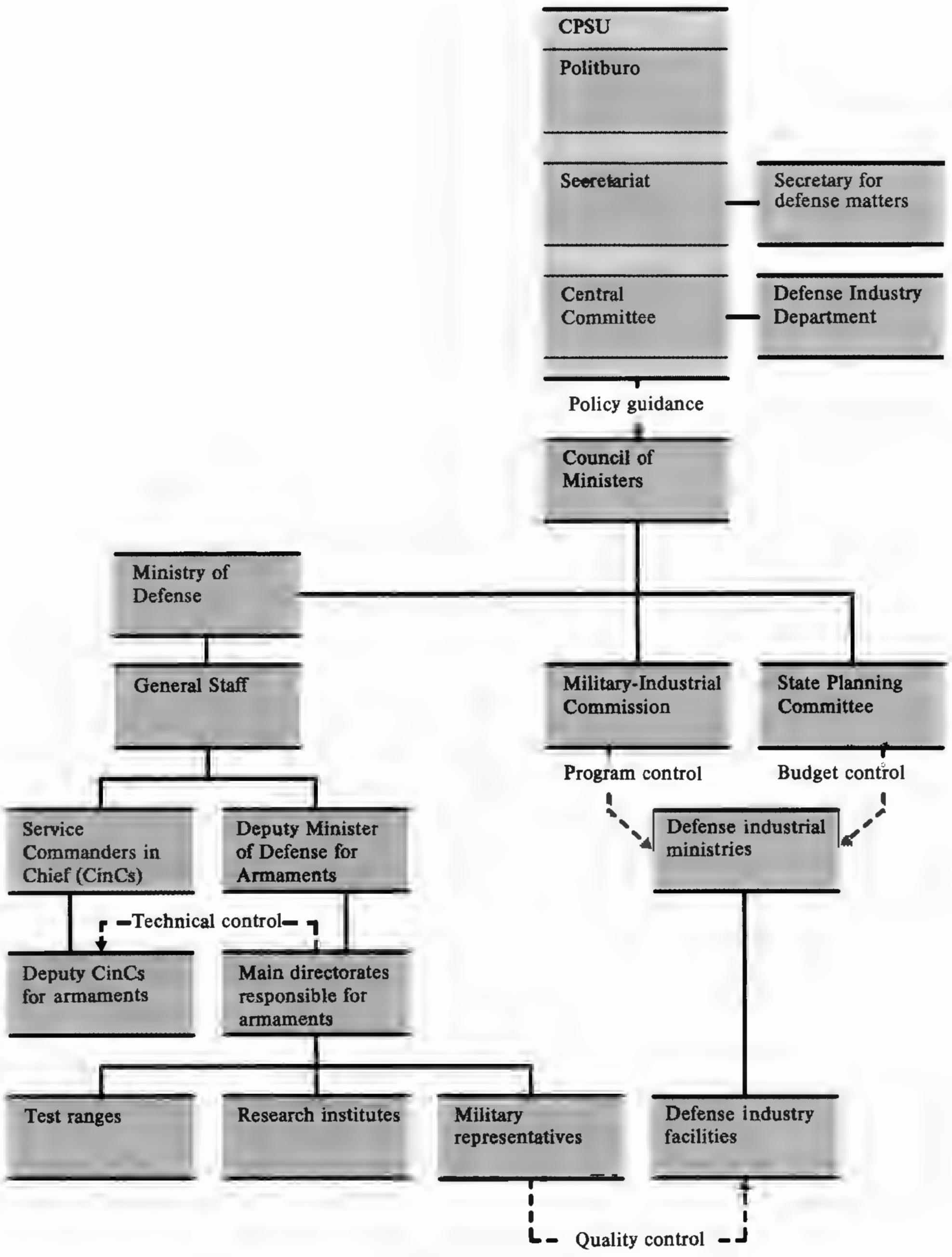
- The State Committee for Material-Technical Supply, which distributes supplies to Soviet industrial plants. It implements Soviet defense priorities by rationing goods in short supply to competing users.

- The State Committee for Standards, which sets technical specifications and quality standards for goods produced by Soviet industry.

Each of the nine defense industrial ministries oversees the work of design bureaus, R&D facilities, and production enterprises. Enterprises are frequently combined into production associations, which may also include experimental facilities and R&D units. In some cases an intermediate layer of management—a main directorate or all-union industrial association—has direct responsibility for specific functional areas within the ministries, but most of these have been abolished in an effort to trim the bureaucracy.

The Ministry of Defense exerts considerable influence on the planning and management of the defense industries. As the primary customer, the MOD is

Figure 7
Soviet Bureaucracy for Weapons Acquisition



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involved in all stages of the arms acquisition process, from generating requirements to overseeing the manufacture and acceptance of new weapons. Through the General Staff and the deputy minister of defense for armaments—whose main armaments directorates provide tens of thousands of on-site military representatives at weapons-related facilities—the MOD wields a vigorous monitoring apparatus (see inset). This direct association of consumer with industry provides the quality control and feedback lacking in the civilian economy and is a principal reason for the better performance of Soviet defense industries.[3]

Continuity and Stability

The long tenure of managers in the Soviet defense industries has lent stability to the administrative apparatus, provided a continuity of approach, and helped to ensure that lessons learned from past experience are passed along. Although age is taking its toll among long-term defense industrial chieftains, continuity has been maintained by replacing them with their deputies of many years.

One result of this practice has been the development of a network of experienced senior planners and managers who have all worked with one another and who know each other's patterns of operation. The late Minister of Defense Ustinov appears to have been the center of this network. Men whose careers were associated with his today occupy leading positions throughout the Soviet defense industrial management hierarchy. In recent years this network has been spreading throughout the civilian sector as well. Apparently in an effort to share the experience and managerial talent of defense industry administrators, the Soviet leadership has transferred many of them to positions of responsibility throughout the government and party (see figure 8).

[3] In an attempt to ensure a similar high standard of quality control in the civilian sector, in July 1986 the Soviet leadership created a network of inspectors, subordinate to the USSR State Committee for Standards, to monitor output quality in civilian industries. It is too early to judge what impact this will have.

The Main Armaments Directorates and the System of Military Representatives

The Ministry of Defense has a number of main armaments directorates, subordinate to the deputy minister for armaments. They supervise a network of military representatives, who monitor all aspects of the military acquisition cycle and ensure that technical specifications and delivery deadlines are met. These main directorates station military officers and civilian technicians at thousands of plants and institutes—virtually every location where military items are designed, developed, produced, or delivered.

Through the military representative system, a vast amount of industrial data flows between the Defense Ministry and the defense industries—giving the military a clear advantage over nondefense ministries in the competition for scarce resources. Bridging the gap between customer and producer, military representatives create in the defense industries a responsiveness that is often lacking in the nonmilitary sector. The system thus allows the military to avoid some of the bottlenecks that plague civilian production.

Priority Claims on Resources

The military's requirements for weapons production are detailed in a five-year defense plan, a subset of the five-year plan for the economy as a whole. This military plan covers such activities as training, logistics, and military assistance and spells out the need for new weaponry and research. Long-term forecasts are incorporated into perspective plans for 15 years or longer.

Resources devoted to the military are shielded from diversion to other claimants by the mechanics of the planning system. The sheer magnitude of economic and technical data tends to prevent Gosplan from conducting "zero-based" reevaluations of programs and activities. Gross target figures probably are not the product of detailed calculations of defense and

Figure 8
The Network That Ustinov Built

Dmitriy F. Ustinov (1909-85)

People's Commissar, Minister of Armaments, 1941-53; Minister of the Defense Industry, 1953-57; Deputy Chairman of the USSR Council of Ministers and possibly Chairman, VPK, 1957-63; First Deputy Chairman of the Council of Ministers and Chairman of the All-Union Council of the People's Economy, 1963-65; CPSU secretary for defense matters, 1965-76; Minister of Defense, 1976-84.

Yuriy D. Maslyukov

Deputy Chairman of the USSR Council of Ministers and Chairman, VPK

Various positions, including chief engineer, branch of the Izhevsk Machine-Building Plant, 1962-74; chief of a main directorate, member of the collegium, and Deputy Minister of the Defense Industry, 1974-82; First Deputy Chairman, Gosplan, 1982-85.

Nikolay I. Ryzhkov

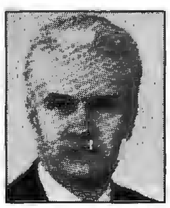
CPSU Politburo member and Chairman of the USSR Council of Ministers

Director of Uralmash Heavy Machine-Building Plant, which produces artillery, 1950s to 1970; general director of Uralmash Production Association, 1971-75; First Deputy Minister of Heavy and Transport Machine Building, 1975-79; First Deputy Chairman, Gosplan, 1979-85; Politburo member and CPSU secretary, 1985.

Anatoliy A. Reut

First Deputy Chairman, Gosplan and member of the USSR Council of Ministers

Director of Minsk Ordzhonikidze Computer Works until 1975; First Deputy Minister of the Radio Industry, 1975-83; Chairman of Belorussian Gosplan and Deputy Chairman of the Belorussian Council of Ministers, 1983-84.



Ivan S. Silayev

Deputy Chairman of the USSR Council of Ministers and Chairman of the Council's Machine-Building Bureau

Foreman, department chief, deputy chief engineer, chief engineer, and factory director, 1954-74; Deputy Minister and First Deputy Minister of the Aviation Industry, 1974-80; Minister of the Machine Tool and Tool-Building Industry, 1980-81; Minister of the Aviation Industry, 1981-85.

Sergey A. Afanas'yev

Minister of Heavy and Transport Machine Building

In the Ministry of Armaments in 1940s; Minister of General Machine Building, 1965-83.

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civilian needs, but percentage adjustments to previous aggregate figures. Moreover, Gosplan tries to minimize changes in the assignments of existing resources to maintain predictability in planning key military and civilian projects. Participation in the planning process by the VPK—which is staffed primarily with defense industry and military officials—further protects military-industrial interests.

In addition, the extreme secrecy accorded national security planning helps prevent other sectors from laying claim to defense production resources. This secrecy allows defense industry managers to make claims on resources without having to justify their requests openly. On the negative side, however, the secrecy inhibits the free flow of ideas between the defense and civilian sectors of the Soviet economy. Publication of scholarly work is difficult, discouraging many talented scientists and engineers from working in the defense sector.

The same mechanisms that protect military interests probably—in the short run—also make it difficult to change the level of military output, at least in peacetime. Dramatic changes in output require corresponding changes in capital investment, materials allocation, and labor assignments. Furthermore, because defense production is so closely tied to the rest of industry, major changes are not possible without greatly disrupting patterns in the rest of the economy.

The momentum engendered by the planning system makes it necessary for top leaders to intervene when entirely new programs or directions are sought. This occurred frequently under Stalin, who, for example, singlehandedly decreed the need for a Soviet blue-water navy and forced through a crash shipbuilding program on the eve of World War II. Such leadership pushes have been effective in engineering wholesale changes in resource allocations to new projects. The momentum of the planning system is such that the required resources often do not flow rationally, however, but rather appear in a "spasm" in which more resources are allocated at one time than can be fruitfully absorbed.

Early, One-Time Authorization of Programs

The Soviet weapon development process proceeds in an orderly progression from requirements formulation up to serial production. The entire procurement planning process is supervised and coordinated by the deputy minister of defense for armaments, Army General Vitaliy Shabanov (see inset). Because of the centralized nature of this system, Soviet defense industrial managers are assigned military requirements relatively unbuffeted by interservice rivalry. The system's momentum facilitates smooth programs, but makes it more difficult to terminate or redirect a program in response to changing threats or technologies (see inset on the MIG-25).

Weapon programs are authorized by a joint decree of the Central Committee and Council of Ministers. Formal approval may be a function of the Politburo. The decree—signed by both the CPSU General Secretary and the Chairman of the Council of Ministers—allows Soviet leaders to select weapon systems they want to develop and quickly commit resources to them. It has no direct counterpart in terms of authority in the United States, but it has the effect of combining in one decision the Department of Defense approval of a program, a presidential decision authorizing top priority, and multiyear funding of the program by Congress. This one-time authorization contrasts dramatically with the US practice of reviewing major weapon programs each year and adjusting their funding throughout the R&D and deployment cycles.

Coordinated operational and technical requirements are levied on the appropriate Soviet defense industrial ministry. Within that ministry, a design bureau is assigned on the basis of its technical specialization and availability. When the military and the chief designer agree on the basic system to be developed, the designer formulates the program plan, identifying prospective subcontractor participation, program schedules, and certain capital expenditure costs (see figure 9 for a comparison of the major milestones in

Vitaliy Shabanov

Deputy Defense Minister Vitaliy Shabanov came to his post without a career military background. After serving in World War II, he worked in the Scientific Research Institute of the Air Force, testing aviation equipment. From 1949 until the early 1970s he was with the Ministry of the Radio Industry, rising to be general director of a scientific production association (1972-74), then deputy minister. The first identification of his shift to the Defense Ministry came in a 1978 article in Krasnaya zvezda, *and he was first publicly acknowledged as having responsibility for armaments in 1980.*

As deputy minister of defense for armaments, Shabanov is the central authority in the Ministry of Defense for supplying the armed forces with armaments and related equipment. He coordinates their planning, development, production, testing, supply, storage, and repair. To carry out this mission, he oversees a number of main armaments directorates for different types of weapon systems or components. He also works with the deputy commanders in chief for armaments of the various services to formulate technical requirements for new weaponry.

As the focal point for arms procurement, Shabanov helps the Minister of Defense to:
- *Conserve resources through the coordination of programs.*
- *Coordinate military doctrine and armaments technology.*
- *Standardize weapons and equipment across services and throughout the Warsaw Pact.*
- *Raise the level of technical knowledge and combat readiness in the armed forces through training and propaganda.*
- *Assess the potential military threat to the USSR posed by foreign weapon systems.*

the US and Soviet weapons procurement cycles). The VPK oversees the preparation of decision documents detailing participants, schedules, and specific costs; disagreements are ironed out before the documents go to the Politburo and Council of Ministers for endorsement. Contracts are concluded between the main armaments directorate responsible for the type of weapon system involved (representing the military customer) and the lead design bureau. Funding, materials allocations, and general production targets are then fed into the next five-year plan, with the designation of precise delivery dates left for annual plans.

Planners Plan Too Little, Not Too Much

Ironically, a major problem of the Soviet centrally planned system is its inability to plan enough. The system lacks the technological entrepreneurs who in the West respond to new market opportunities without being directed—the self-generating "Silicon Valley" microelectronics industrialists. It relies instead on its planners' having sufficient vision and forethought to

Countering an Outdated Threat: The MIG-25

Soviet MIG-25 Foxbat

US B-70 supersonic, high-altitude bomber

The Soviet MIG-25 Foxbat was designed to counter the US B-70 supersonic, high-altitude bomber. The B-70 program was canceled in the early 1960s, but the Soviets had already begun to develop the MIG-25 and eventually produced hundreds. Although this fighter-interceptor can be effective in several missions, its original design was optimized to counter threats like that posed by the B-70. The primary reason for the production of so many MIG-25s—after the B-70's demise and the change in US tactics to emphasize low-altitude, subsonic penetration—was probably the momentum engendered by the Soviet weapons authorization process.

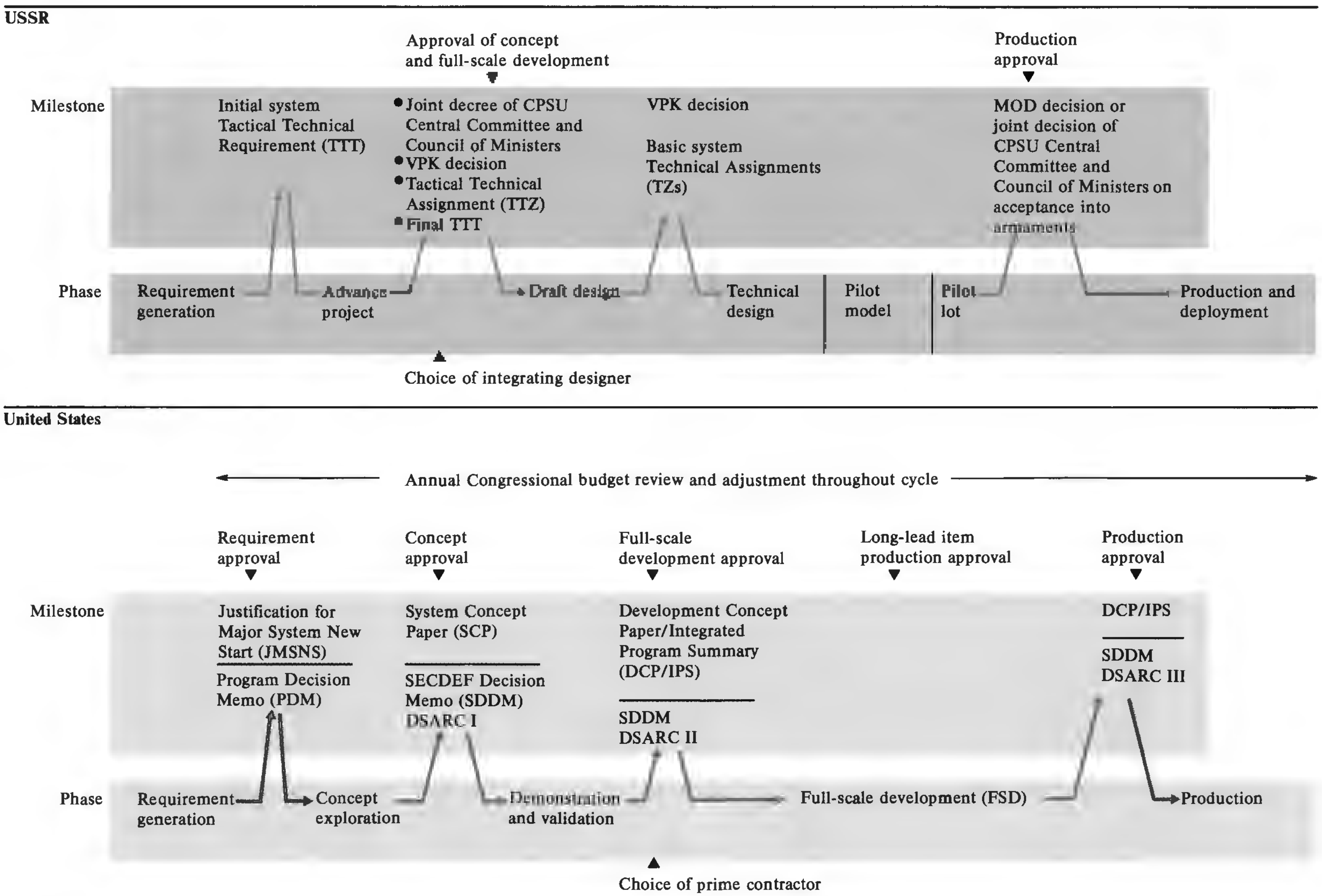
anticipate the demands of the future. Moreover, development by decree tends to focus planning activity on the weapon systems themselves and frequently leads to neglect of support industries. This neglect often means that development of materials and processing technologies lags development of system technologies.

The deficiency of detailed plans—for the use of labor, materials, and new technology, for example—leads to problems in production as well. Standard indicators, such as percentage of plan fulfillment or actual output levels, are used to judge performance. Incentives for managers and workers are based upon the achievement of assigned targets.

Such simplistic criteria have caused distortions and inefficiencies in Soviet industry as managers seek to maintain output (and thus protect their incentives) at the expense of quality, investment in new technology, and labor efficiency. Managers—including those in the defense industries—regularly inflate man-hour, material, and overhead costs in order to build reserves to be secretly retained for use in the event of unforeseen circumstances. "Storming" to meet production targets—a practice in which as much as half of a plant's output is produced in the last 10 days of each month—requires extra shifts, raises labor costs, and often degrades the quality of output.

The Soviets have recognized their planning and performance inadequacies for decades and have periodically experimented with various reforms. A major decree issued in 1979, for instance, has sparked numerous leadership measures to improve planning and management. Financial levers are increasingly used, and success indicators for enterprises have been modified to emphasize efficient use of labor, timely and complete fulfillment of contracts, and production of high-quality goods. Major revisions of agricultural and industrial wholesale prices have been implemented to encourage the introduction of modern production technologies, and efforts have been made to reward managers for increased productivity. However, according to a stream of editorials and leadership statements—highlighted by publicly expressed concern with economic reforms—success in solving planning and management problems has thus far been limited, and the search for better forms of planning and management continues.

Figure 9
A Comparison of US and Soviet Weapon Procurement Cycles



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Design and Development

The rapid advance of world military technologies over the past decade has greatly complicated the demands placed on Soviet weapon designers. The designers must create weaponry sophisticated enough to perform multiple missions and otherwise exhibit greater capabilities than older weapons, while keeping in mind the limitations of the production base from which the systems must flow.

Soviet weapons have historically reflected a commitment to functional designs that can be readily manufactured in labor-intensive factories and readily maintained in the field with a minimum of technical skill. Designers have not faced the competitive pressures that drive Western designers to press the state of the art. Rather, they have been required to adhere to industry standards, use off-the-shelf components, and employ the preferred design and manufacturing methods detailed in official design handbooks. This approach is intended to ensure producibility, maintainability, and ease of operation.

One reason for the success of Soviet weapon programs has been a low-risk development style. The Soviet emphasis on strict adherence to design and development schedules encourages technological conservatism on the part of designers once a decision has been made to proceed with the development of a weapon, thus ensuring a high probability of development success. This practice carries the potential for obsolescence in the resulting weapon systems, which the leadership tries to offset with almost routine approval of subsequent improvement programs.

Another reason for the success of Soviet weapon programs has been the continuity of personnel in the key development organizations. In contrast to acquisition in the United States, where program managers and other key personnel change frequently, individuals and organizations assigned to a program in the USSR normally stay with it from inception to completion. Moreover, the organizations responsible for the initial version of a weapon are usually responsible for all follow-on versions.

Designers Play Key Role

Soviet weapon designers are charged with broad responsibilities for weapon development programs. Their key role derives from Stalin's approach to developing successful weapon systems—identify an innovative engineer with a strong "can do" attitude, grant him broad authority, and give him the necessary resources. With this authority, of course, went accountability, and more than a few designers in Stalin's time found themselves disgraced or imprisoned as a result of failures. Designers who succeeded during World War II in developing modern weapons from the impoverished technological base carved out empires that still bear their names (see inset). Their successes brought fame, professional honors, elite status, and, in some cases, high political rank.

This approach continues. Key weapon designers—designated general designers in the case of major systems and chief designers for other systems and major subsystems—and their bureaus are still given broad authority. Their responsibilities and those of subordinate organizations (subcontractors) are spelled out in party-government decrees authorizing weapon programs, and they are held legally accountable for fulfillment of the decrees. The Soviet system relies on the weapon designer to cope with a science and technology base that, in many areas, is inferior to that of the West; to create advanced weapon capabilities using comparatively inefficient production technologies; and to manipulate the bureaucracy in order to get the job done.

Design Process Minimizes Development Risk

On the basis of long-range forecasts of anticipated threats, military planners—in concert with design centers and research institutes—project the weapon technologies required to meet such threats. The Soviets commonly develop series of successor weapons (each new variant using applications of recently proven technology) to incrementally satisfy the military's

Key Soviet Weapon Designers

Mikhail Mil (1909-70): Father of the Modern Soviet Helicopter Industry

Mikhail Mil graduated from the Novocherkassk Aviation Institute in 1931 and subsequently worked in research on helicopter aerodynamics. In 1947 Stalin ordered him to become the chief designer of a newly created experimental design bureau for helicopters. Along with his colleagues Aleksandr Yakovlev and Nikolay Kamov, Mil helped create the nucleus of the modern Soviet helicopter industry. Under his leadership, the bureau developed a greater variety of helicopters than either the Kamov or Yakovlev design bureaus, and Mil helicopters soon accounted for the largest part of Soviet helicopter production. Mil was highly effective in mobilizing resources to meet program deadlines. He is said to have coined this guidance for subordinates: make it simple, make it reliable, make it rugged, and make it work.

Petr Grushin (1906-): "Uncle SAM"

Petr Grushin and his design bureau have been responsible for the design and development of radar-guided missiles for many of the Soviet land-based and naval surface-to-air missile systems. A member of the USSR Academy of Sciences and one of only a few designers to have held full membership on the CPSU Central Committee, Grushin has enjoyed a great deal of political and scientific clout. Such influence is important for crossing ministerial lines to coordinate production of complete SAM systems.

Vladimir Chelomey (1914-84): Missile Designer

Vladimir Chelomey first designed jet engines, but he is better known as a designer of missiles. His first notable successes were cruise missiles. Capitalizing on the US-Soviet missile race and on the problems other Soviet designers were experiencing in meeting its challenges, Chelomey expanded his interests in the mid-1950s to include ballistic missiles and satellites. He is credited with the design of the SS-11 ICBM and its follow-on, the SS-19. He also developed the Proton family of space launch vehicles and a series of satellites. Chelomey's success sprang from a combination of designing genius, managerial talent, and marriage to Khrushchev's daughter.

Expediting the Application of New Technologies: Organizational Measures

The use of new technologies in the economy in general and in weapons development in particular has been retarded by (among other factors) the bureaucratic separation of the research institutes from the design bureaus. The Soviets have recognized this problem and created new organizational arrangements designed to combat it.

One such organization is the scientific production association (NPO), first officially proposed by a 1973 decree. NPOs incorporate research institutes, design bureaus, and prototype-production facilities. These associations have had mixed results. Their creation has been a slow process—since 1973, for example, only 250 NPOs have been formed. The weapons industry has been a leader in forming associations: in the Ministry of the Electronics Industry, for instance, NPO Pozitron in Leningrad is a stellar example. Another success is to be found in the defense-related Ministry of the Electrical Equipment Industry, where NPOs are said to have reduced by one-third to one-half the time required for the research-production cycle.

The creation beginning in 1985 of intersectoral science and technology complexes (MNTKs) is a more recent attempt to expedite the assimilation of the results of research into production. MNTKs are large associations of geographically diverse R&D establishments and experimental production plants organized for the purpose of working out key critical technologies. They are intended to break down bureaucratic barriers by coordinating and directing the work of organizations formally subordinate to different ministries. At least 17 MNTKs have been created so far, and their areas of concentration include robotics, fiber optics, welding and metallurgy, and personal computers.

The Machine-Building Bureau of the USSR Council of Ministers is yet another organization recently created to break down bureaucratic barriers and hasten the application of new technologies in industry. Headed by the former Minister of the Aviation Industry, this bureau was created to improve the work of the 11 civilian machine-building ministries. Its operation will probably be patterned after the Military-Industrial Commission, which coordinates the efforts of the defense industries and centrally supervises all weapon programs. The creation of the bureau reflects the Soviet belief in the importance of the civilian machinery sector in supplying the increasingly advanced manufacturing equipment on which the success of all industry, both military and civilian, depends.

long-range requirements. Although this design philosophy frequently results in follow-on programs, it slows overall technological progress. Weapons development in the USSR results more from a requirements "pull" than a technology "push."

Emerging technologies are proven in applied research, a process usually distinct from the development of actual weapons. Success in applied research may enable the designer to include a new technology—or an adaptation of an existing technology—in new weapon systems with little risk of failure. For example, even the development of a new weapon that incorporated a major technological advance—the SS-17 MOD 1, the first ICBM capable of carrying multiple independently targetable reentry vehicles (MIRVs)—need not have involved much risk. MIRV technology had been worked out in applied research for several years before its introduction into that system.

Thus, by the time Soviet weapon programs are formally authorized, all of the key technologies necessary to meet the proposed performance specifications and program obligations are generally well understood, if not in hand. Bonuses are keyed to successful program completion, and penalties can be levied for failure to achieve the stated goals. This emphasis on schedules gives the integrating designer and subcontractors a strong incentive to include in the weapon's development only those devices, components, or materials known to be producible or adaptable within the given time constraints. The designer must be confident that the chosen technology levels do not present any insurmountable design or production problems. The result is a de facto technology freeze on major system components before the weapon is developed.

Because of the emphasis on incorporating only trusted technologies in new weapons, Soviet designers are inclined to employ entire subsystems from previous generations of weapons. This practice allows the Soviets to continue using older equipment efficiently, because the parts for newer systems can be used in older systems as well. Fewer types of weapon components and spares need to be kept in inventories for maintenance and repair.

A classic demonstration of design inheritance is the V-2 diesel tank engine, which was adapted from a 1920s-design aircraft engine and used with various modifications in the T-34, T-54, T-55, T-62, and T-72 tanks over a 40-year period. The Soviets developed the V-2 from the M-34 gasoline, air-cooled V-12 aircraft engine—an engine similar to the American Curtis and the French Hispano-Suiza V-12s of the 1920s. The engine was modified for liquid cooling and was used in the first T-34 tanks in about 1938, and it has powered most of the tanks the Soviets have produced since. A scaled-down V-12 was also used in the PT-76, an amphibious light tank. It is simple to produce and compatible with many vehicle systems, and its many variants use many common parts.

Advancing Through Modular Upgrades

The Soviets commonly offset some of the drawbacks of the early technology freeze with subsequent improvement programs, using approaches and technologies that became available during the previous program. As a result, major design bureaus are often simultaneously working on new and modernized weapon systems in different stages of development. This process—which requires the commitment and occasionally the direct participation of the Soviet leadership—discourages designers from promoting unduly risky approaches to solving technical problems.

The Soviets pursue a three-track approach to stave off the technological obsolescence that could result from the early freeze:

- They frequently introduce modular upgrades for fielded systems. Such upgrades minimize design changes and are typically limited to one or a few components. (Some of the alterations can be done by military repair bases in the field.)

- They modernize systems more thoroughly by improving one or several major subsystems, such as missile guidance or avionics.

- Their most ambitious option is to introduce major modernizations or entirely new systems.

A good example of a system incorporating all these options is the T-64 tank. The initial variant of the T-64 featured several new tank components and subsystems, including the engine, turret, and transmission. The T-64A was equipped with a new 125-millimeter (mm) gun system, but it probably did not require a major change in manufacturing technology. The much-improved T-64B incorporated a new laser fire-control system and is capable of firing both antitank guided missiles (ATGMs) and 125-mm ammunition. The fire-control system probably required advanced electro-optics similar to those found in modern Soviet ATGMs.

In addition to allowing the incorporation of new technologies more quickly than if a new weapon system were started from scratch, modular upgrading helps hold down the cost growth involved in continually developing new systems. Manufacture is also easier, as modernized systems can frequently be produced on the same production lines that produced their predecessors. Finally, modular upgrades, because they do not call for major changes in resources or supplier networks, enhance the continuity of centralized planning and are thus easier for Soviet planners to cope with.

Western Technology Cuts Time and Costs

Soviet planners use Western technologies as a yardstick to evaluate their own capabilities. They also try to take advantage of basic research undertaken by Western engineers and, with some important exceptions, pursue technologies already proven in the West. The Soviets have a well-organized national program for the overt and clandestine acquisition and assimilation of Western—primarily US—technology. Key research institutes and primary design bureaus make long-range forecasts of critical technologies that they anticipate will be required in future weapon developments. A VPK-led commission gathers, edits, and assigns collection requirements for the acquisition of Western technology through legal and illegal means.

Technologies and engineering know-how acquired from the West have allowed the Soviets to strengthen their capabilities significantly in many areas basic to the development of modern military systems, particularly in the fields of microelectronics and computers. Soviet military projects using Western technology and hardware design concepts span all areas, including strategic offensive missiles, aircraft, conventional ground and naval forces, air defense, and reconnaissance. Incorporating the results of Western technology instead of relying wholly on indigenous R&D capabilities yields significant savings in program costs and allows earlier development of weapon systems. Western products enable the Soviets to demonstrate technology feasibility earlier and thus begin development of the operational systems earlier. Technology acquisitions also free indigenous R&D resources for other uses.

After they acquire foreign technologies, the Soviets usually take five to 10 years to field weapon systems incorporating them. Minor technical adjustments resulting from technology acquisitions have been made in ongoing programs, although this is more likely to occur if the program has not reached the prototype-production stage and if the acquired technologies do not require fundamental redesign of the system or its major elements. Because the Soviet procurement system tends to rely more on incremental improvement programs than the US system does, the Soviets can field upgraded weapons more quickly.

Design Simplicity Assures Producibility

Western analysts have often characterized Soviet weapon systems as "simple, rugged, and easy to maintain." Rigorous design specifications—such as mirror-like finishes and tight tolerances—are called for only where necessary for performance. Circuit designs are simple by US standards, and materials that are costly and difficult to machine are avoided where possible (some Soviet submarines, discussed in the inset, are important exceptions). Soviet designers have also developed a knack for keeping parts to a minimum. For example, the R-11 engine, which powers the widely deployed Fishbed MIG-21, contains many fewer parts than the roughly comparable J-79 engine, which powers the US F-4 (see inset). What appears to be crude, however, often conceals very potent combat capabilities. The "simple, rugged design" of Soviet weapons has not interfered with their combat effectiveness in the hands of well-trained troops.

The simplicity (relative to Western standards) chosen by Soviet designers has entailed trade-offs. Design simplicity increases reliability and reduces development and production costs. It has allowed the production of capable weapons by a labor-intensive industrial base without substantial investment in new manufacturing methods. The choice of a simple design, however, has frequently resulted in a less sophisticated weapon, often restricted in application to a single military mission.

Simplicity also poses trade-offs in terms of maintenance (see inset comparing Soviet and US aircraft maintenance). Most Soviet subsystems have a shorter

Titanium Submarines: The Alfa-Class

Aviation Week and Space Technology ©

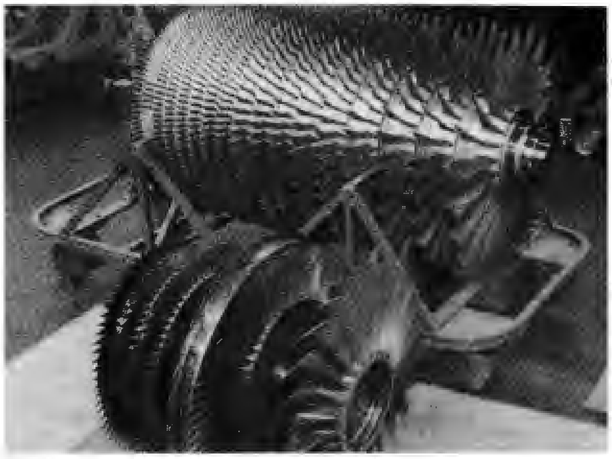
The Alfa-class nuclear-powered attack submarine is an example of the Soviets' infrequent use of expensive materials. The Alfa-class is constructed of titanium, which endows it with a lower magnetic signature and deeper diving capabilities than the Soviets' steel-hulled submarines. Because of these advantages, the Soviets are also building other high-technology submarines that have pressure hulls made of titanium.

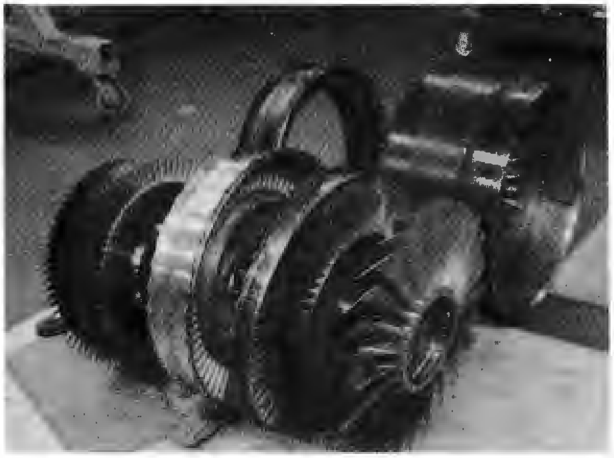
service life than those in the West, resulting in a greater burden of maintenance, component replacement, and repair. Thus, in Soviet logistics a large number of spare systems are in the maintenance pipeline at all times, and large numbers of technicians have to be available to do the frequent routine maintenance tasks. They perform only the simplest of maintenance tasks in the field; weapons and weapon components are returned frequently to the factory or major maintenance depots for repair and overhaul. Despite the seeming inefficiency of this practice, it probably reflects a policy chosen by the Soviets because of the low skill level of their conscript force. The simpler maintenance demands on troops are also attractive to Soviet clients in the Third World, where technical skills are at a premium.

Western Technologies Forcing Change

Although it has served the Soviets well for decades, the traditional Soviet design strategy does not appear well suited for some key challenges of the modern technological environment. A greater commitment to developing and manufacturing more complex weapon systems will probably become necessary as the Soviets strive to counter many of the new capabilities of Western armaments. In addition, the mission flexibility and lower total procurement levels made possible by advanced, multipurpose systems appear to be the most rational solutions to soaring weapon costs—despite the higher per-unit price tags.

Simplicity: The R-11 Engine





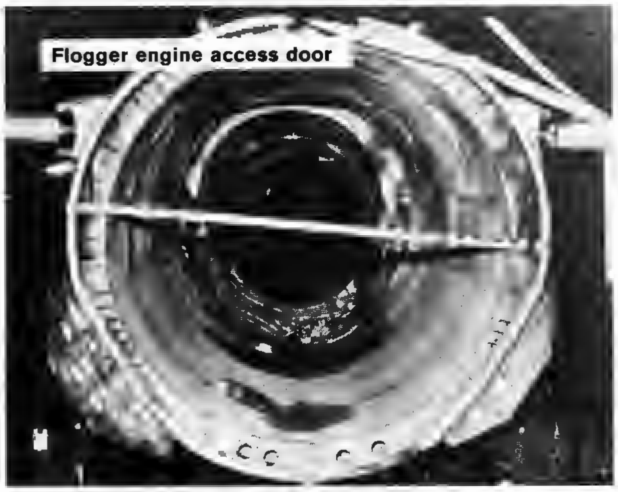
The Soviet R-11-300 rotor assembly (left photo, foreground) performs essentially the same work as that of the US J-79 (in back). The right photo shows the R-11-300 compressor components.

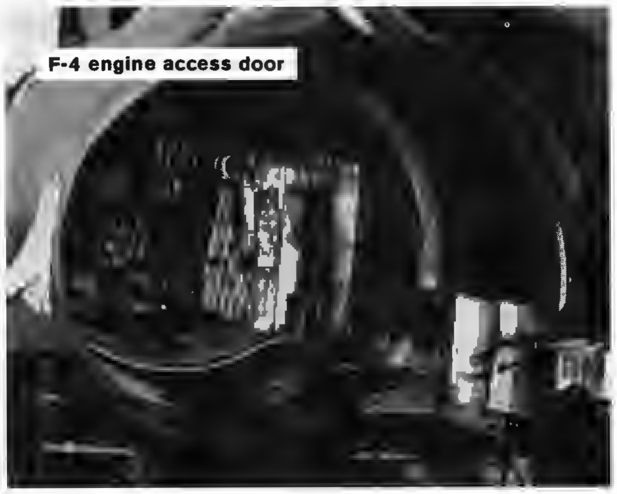
A clear example of Soviet success in designing simple but adequate systems is the R-11-300 jet engine, which has been produced in great numbers for the MIG-21 Fishbed fighter aircraft. The Soviet R-11-300 engine is roughly comparable to the US J-79 engine, which powers the F-4 Phantom. The R-11-300 is simpler (with 2,500 parts versus 22,500 in the J-79) and would cost about one-third as much as the J-79 if it were manufactured in the United States.

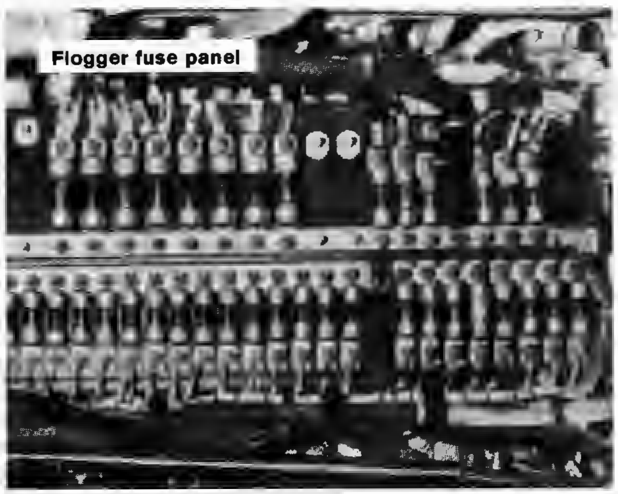
Design simplicity resulted, in part, from a lack of redundancy, the use of fastening techniques—such as spot welding—that would not be acceptable in the United States, the use of an efficient compressor design, and reliance on the framework of the aircraft for some of the structural rigidity required. The R-11-300's service life is much shorter than that of the J-79, and it is first overhauled after 300 hours of operation in contrast to 1,500 hours for the J-79. The R-11-300 does not have the same performance characteristics—such as a constant idle speed regardless of ambient conditions—as US engines, permitting much simpler engine controls.

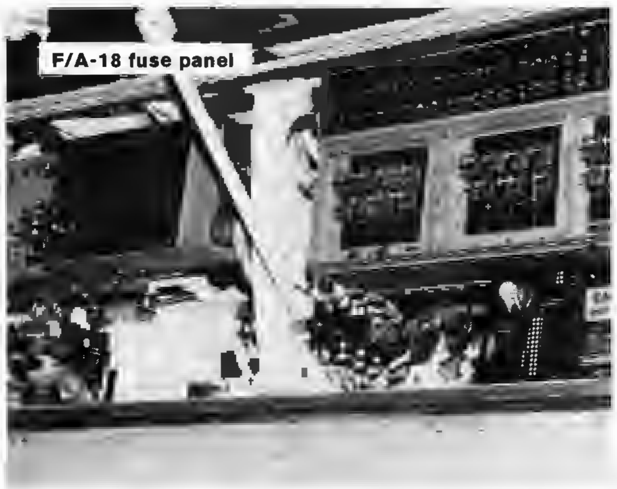
Another important factor contributing to the lower cost of the R-11-300 is the use of relatively crude tolerances and finishes where these will not impair its functioning. Except for a very few parts, the entire R-11-300 engine could have been manufactured with production technology available in the United States in the 1930s.

Soviet and US Aircraft Maintenance









These two comparisons demonstrate that, while US aircraft are designed to be maintained primarily in the field, Soviet aircraft design makes it necessary to perform any extensive maintenance in specially equipped facilities. The engine bay of the Soviet Flogger has very limited access for engine servicing and removal, whereas that of the F-4 has extensive access, allowing easy servicing and removal (top photos).

The Flogger fuse panel design makes it necessary to use tools for the installation and removal of fuses, and they have no protection from corrosion, moisture, or foreign objects (bottom photos). The US F-4, F-15, F-18, and AV8B aircraft make extensive use of circuit breakers—whose higher cost is offset by improved maintenance and service—for circuit protection.

The Trade-offs of Advanced Weaponry: The T-55 Versus the T-80

T-55

T-80

The sophisticated T-80 achieves much better performance:

- *The T-80 is faster—its diesel or turbine engine (almost 1,000 horsepower) allows this 40-odd-metric-ton tank road speeds of over 70 kilometers/hour. The T-55's diesel engine (580 horsepower) will only let the 36-metric-ton tank go 50 kilometers/hour.*

- *The T-80 has greater firepower—its armament includes a 125-mm smoothbore gun capable of firing both projectiles and antitank guided missiles. The T-55 has a 100-mm rifled main gun system that fires only projectiles.*

- *The T-80 is more accurate—it contains an advanced fire-control system, including an improved laser rangefinder and probably a full solution ballistic computer. The T-55's fire-control system is relatively simple.*

- *The T-80 has greater mobility—it probably features a new, improved suspension that greatly enhances cross-country mobility. The T-55 has a Christie suspension, which gives it a choppy ride, diminishing its firing-on-the-move capability.*

But at a cost:

- *Development of the T-80 took substantially longer than that of the T-55.*

- *Production of the T-80 required substantial investment. The Soviets erected a major new production facility and established a broad network of component suppliers.*

- *CIA estimates the T-80 costs about three times as much as the T-55.*

- *The T-80 and its complex subsystems require an extensive support structure. The T-55 can be maintained by crewmen with limited mechanical training and repaired to a greater extent in the field.*

A change in design strategy appears to be under way but is proving to be painful and slow. Translating new technologies into capabilities more quickly, for instance, means altering the traditional practice of perfecting them in applied research first. Because of this, some new weapons are proving difficult to assimilate into production. In the field, the operation and maintenance of extremely sensitive electronics and other advanced systems are being entrusted to a force of largely unskilled conscripts. Nonetheless, the appearance in the 1970s of several new, more complex systems designed to accomplish multiple missions—such as the SU-27 interceptor and the SA-10 multialtitude surface-to-air missile—illustrates the evolution in procurement policy already under way.

Production

By any measure, since World War II the Soviet weapons industry has churned out impressive quantities of weapons and equipment. Production since 1965 has included more than 50,000 tanks, 50,000 aircraft, 80,000 light armored vehicles, 650,000 surface-to-air missiles, 270 submarines, and large quantities of other equipment—making the Soviets the largest producers of weaponry in the world. The Soviets have traditionally emphasized numbers rather than sophisticated designs. They have relied on the extensive growth of the economy to continually expand weapon production, giving priority to weapon producers in the allocation of scarce resources.

The slower growth of the Soviet economy in the past decade, however, has led the Soviet leaders to stress efficiency even more than in the past. At the same time, dramatic improvements in Western weapons have led them to stress greater advances in weapons technology. To meet both these requirements, in the 1970s the Soviets stepped up the modernization of their production base, devoting a great deal of attention to the introduction of the latest machine tools and other advanced manufacturing equipment.

Stalinist Legacies

The Soviet industrial base for armaments production was created in the late 1920s and 1930s. Its development was a primary objective of the First and Second Five-Year Plans, and it continues to bear features typical of the Stalinist industrialization. Institutional continuities—such as a centralized and unified executive structure, long-term ties between cooperating enterprises, and plants producing the same product line for over half a century—assist Soviet industry in manufacturing weapon systems rapidly and in large numbers.

Production is usually concentrated in large plants, some of which are parts of multipurpose facilities. Soviet production facilities are generally much larger than those producing similar items in the United States, mainly because the Soviets frequently colocate plants producing components for the same system. Similarly, support industries are frequently colocated with final assembly facilities. This arrangement, known as vertical integration, has been employed over the decades as a hedge against the inefficiency of the Soviet transportation and supply network and the vagaries of central planning.

Labor has traditionally been treated in the Soviet economy as an inexhaustible commodity, particularly in the extremely labor-intensive machine-building sector. Large numbers of unskilled or semiskilled workers are employed to operate such relatively simple tools as lathes, milling machines, and boring and broaching equipment. This is partially the result of the Soviet policy of full employment, which has the added benefit of ensuring a high state of readiness to expand production in case of war.

The traditional view that the labor supply is inexhaustible has led to relatively inefficient use of labor. This inefficiency is aggravated by the weakness of incentives to economize on labor and by indifferent labor discipline—poor attendance, high rates of alcoholism, and theft from the shop floor. As the number of youths joining the Soviet work force dwindles, however, the Soviet leadership is seeking to increase labor productivity by experimenting with new forms of shop-floor labor organization and embarking on discipline campaigns.

Aging Factories

Visitors to Soviet production plants have noted outdated manufacturing equipment, some from the World War II period. Soviet managers typically do not replace equipment until it is worn out, rather than when it becomes obsolete, as is more typical in the West, and they sequester and stockpile replacement equipment. Even when new equipment is installed, plant managers tend to keep the older equipment as a backup. These practices dilute the effectiveness of capital investment, especially reducing its impact on productivity.

Krokodil, 1984 ©

***Figure 10.** This cartoon from* Krokodil *(June 1984) illustrates the problems of poor labor discipline and absenteeism in Soviet industry. Addressing the queue of white-collar workers waiting during the workday to buy tickets for that evening's entertainment, the manager says, "As long as we've got the whole department here, I suggest we begin our meeting on labor discipline."*

Krokodil, 1984 ©

***Figure 11.** A cartoon in* Krokodil *(July 1984) satirizes Soviet use of new manufacturing technology.*

Managers resist adopting new equipment because it disrupts operations. Assimilating new equipment causes downtime, which the central planners do not always allow for by lowering the plant's production targets for the period involved. Soviet enterprise managers reportedly also do not trust new equipment to work well. A new production process makes them dependent on outside experts and on new suppliers of components and services, such as software support. Plant managers do not willingly put themselves at the mercy of outsiders—especially from other ministries—and outsiders do not particularly care whether the equipment functions as planned in a given plant. Managers are loath to replace old (but operating) equipment lest their capacity to produce be lost completely.

Another factor limiting the willingness of managers to modernize is the relatively narrow selection of technologies and equipment from which they have to choose. For example, although the USSR produces more conventional and numerically controlled machine tools than any other country, many of them are general purpose machine tools that are relatively easy to produce in large quantities rather than special-purpose and complex types. This practice yields economies of scale that lower production costs, but it sacrifices diversity in the machine tools available for plant use.

Variation in Production Processes

The industrialization drive of the late 1920s and early 1930s and the Stalinist system combined to create a mosaic of industrial technologies. The scarcity of capital led Soviet authorities to ration it; and even today, in many Soviet plants, state-of-the-art equipment works in tandem with primitive, labor-intensive operations. An individual plant tends to develop unique production processes as its managers grab equipment whenever and wherever they can get it, and as the relative lack of competitive pressure enables plants to operate at widely varying levels of efficiency. Variations among industries tend to impede the diffusion of new technologies, as managers may find that advanced equipment developed elsewhere is technically incompatible with their operations.

These considerations, along with the differences in their R&D capabilities, have led the Soviets to approach basic manufacturing operations in a way different from that of US industry. For example, Soviet manufacturers seek to minimize the use of machining in the production of weapons to a greater extent than their US counterparts (see inset on comparative Soviet and US aircraft manufacturing practices). They attempt to use net-shape-forming techniques (casting, forging, powder metallurgy, and extrusion), which—although more labor intensive and time consuming than machining in the United States—eliminate the need for complex manufacturing machinery. The USSR has managed to stay abreast of the West in net-shape forming, and in some processes—such as titanium casting—it has surpassed the West.

The Soviets also rely more on welding than on the mechanical fastening techniques preferred in the West. In the aircraft industry, for example, US manufacturers prefer fasteners such as rivets because they tend to provide greater structural integrity than welds and because repair is less labor intensive. (Repair of welded systems requires cutting and rewelding.) The power of Soviet weapon designers is illustrated by their ability to make individual choices in matters of this kind. For joining fighter aircraft components, for instance, the late designer Pavel Sukhoy generally preferred rivetting, while the late Artem Mikoyan preferred welding.

Drive To Modernize

The Soviet leadership, recognizing that the production of more advanced weapons would place increased demands on the manufacturing base, accelerated efforts to modernize defense plants in the early 1970s. In many plants the Soviets have installed new types of equipment and are emphasizing the development and use of labor-saving automated machinery and robots. Other measures include the revision of incentives for managers to promote recapitalization; the use of systems planning; expanded training and employment of specialists in such fields as machinery automation; and construction of new types of facilities to house modern, integrated manufacturing lines.

Substantial improvement in the average level of manufacturing technology appears to have taken place throughout most of the defense industries. The high rate of expansion of defense industry facilities—which in the Soviet Union is usually accompanied by the installation of new manufacturing equipment—suggests that increasingly advanced equipment is being employed in many production lines. Soviet literature describes efforts to economize on labor with automated equipment in such labor-intensive production operations as shipbuilding.

Problems With New Technologies

Despite these advances, the weapons industry has been hampered by lags in support industries, particularly those producing machine tools and computers. The real revolution in Western manufacturing technology—the marriage of precision machine tools and microelectronics—has not fully reached the Soviet civilian or defense industries. The gains in recent years in Western manufacturing productivity that have resulted from the introduction of computer-controlled production processes and computer-aided automation of specialized equipment, therefore, have not been matched in the Soviet Union. Manufacturing equipment in some weapons industries—such as the aviation industry—now reaches technological obsolescence in an average of less than 10 years. Such rapid changes in technology particularly challenge the Soviets, who keep many conventional machine tools in production long past their obsolescence.

Deficiencies in computers and microelectronics have been a key obstacle for the Soviets in the introduction of new industrial technologies. Although the Soviets have been active and innovative in microelectronics theory since World War II, they apparently did not fully recognize the potential of microelectronics until 1961, when Khrushchev began a crash effort to

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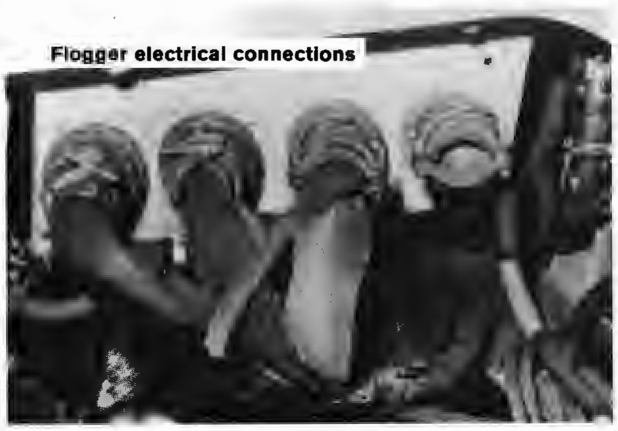
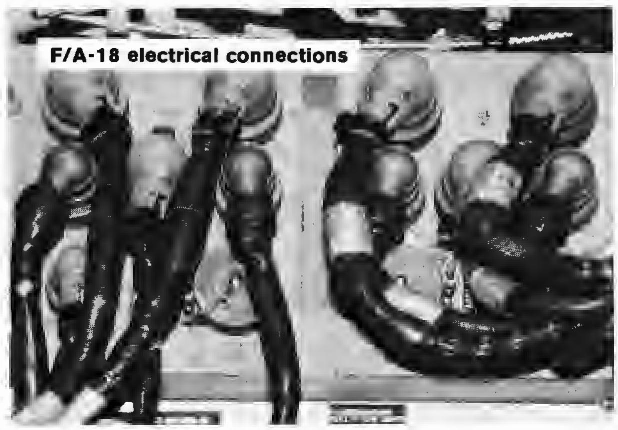
Soviet and US Aircraft Manufacturing Practices

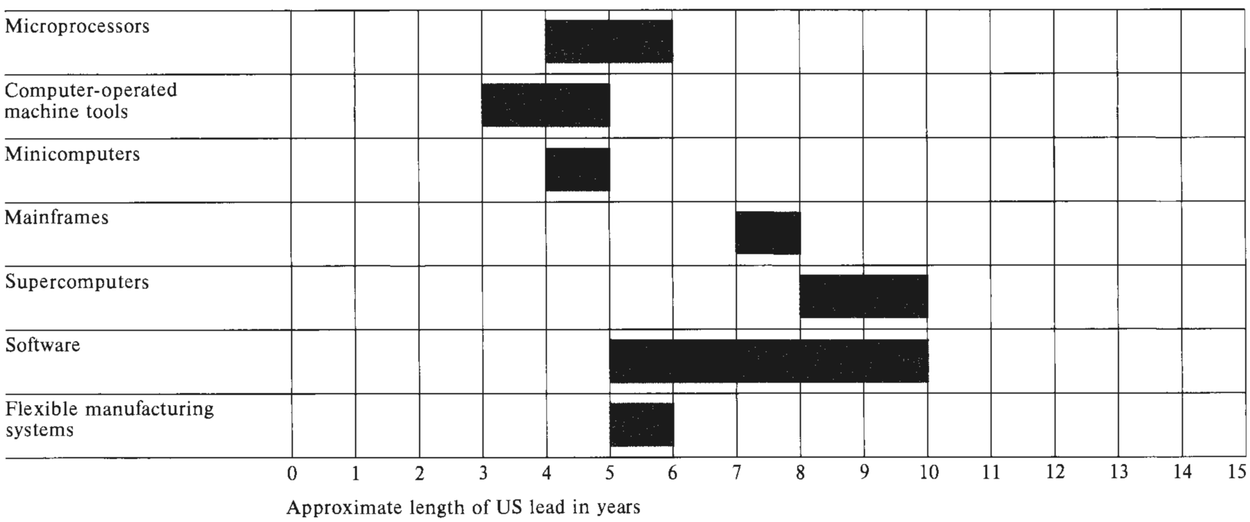




These photos illustrate the differences between Soviet and US manufacturing philosophies. The upper wing panel of the Foxbat fighter (top left) is marked by numerous spot welds, which attach the stainless steel skin surface to stiffeners under the skin. Spot welding in this assembly is a cost-saving, lightweight fabrication technique; however, the wing structure prohibits extensive inspection and quality control, and the materials used are obviously low grade (the spot welds are covered by rust and corrosion). The US F-15 and earlier US aircraft, such as the F-4, have mechanically fastened wing panels; these are more expensive, but they allow easy inspection and retard corrosion.

The Flogger's electrical connectors (bottom left) are heavy and cumbersome and have no self-locking features. The screw fasteners used require lockwiring—a costly, time-consuming process that must be repeated each time they are disconnected throughout the aircraft's service life. The wire bundles are assembled and routed in place on the aircraft (a very labor-intensive process), and the hand-tied, loose cotton sheathing on the bundles appears to provide no protection from moisture or corrosion. In contrast, the F/A-18, which contains technology typically used during the same time period in the United States, has abrasion-protected wire sheathing fabricated before it is installed on the aircraft and uses molded seals to inhibit corrosion.

Figure 12
Selected Advanced Manufacturing Technologies: The United States Versus the USSR



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energize this Soviet industry. He established the Zelenograd Science City near Moscow, where he collected the scientists and research efforts then under way in the Soviet Union. Zelenograd continues to be the focal point for the development of microelectronic components in the USSR and is the major research center for the Ministry of the Electronics Industry.

The measured success the Soviets have enjoyed thus far in developing mainframe computers has resulted largely from copying Western—especially US—developments. Even this has not come easily: Soviet engineers took longer to copy the IBM System/360 than IBM took to develop it in the first place.

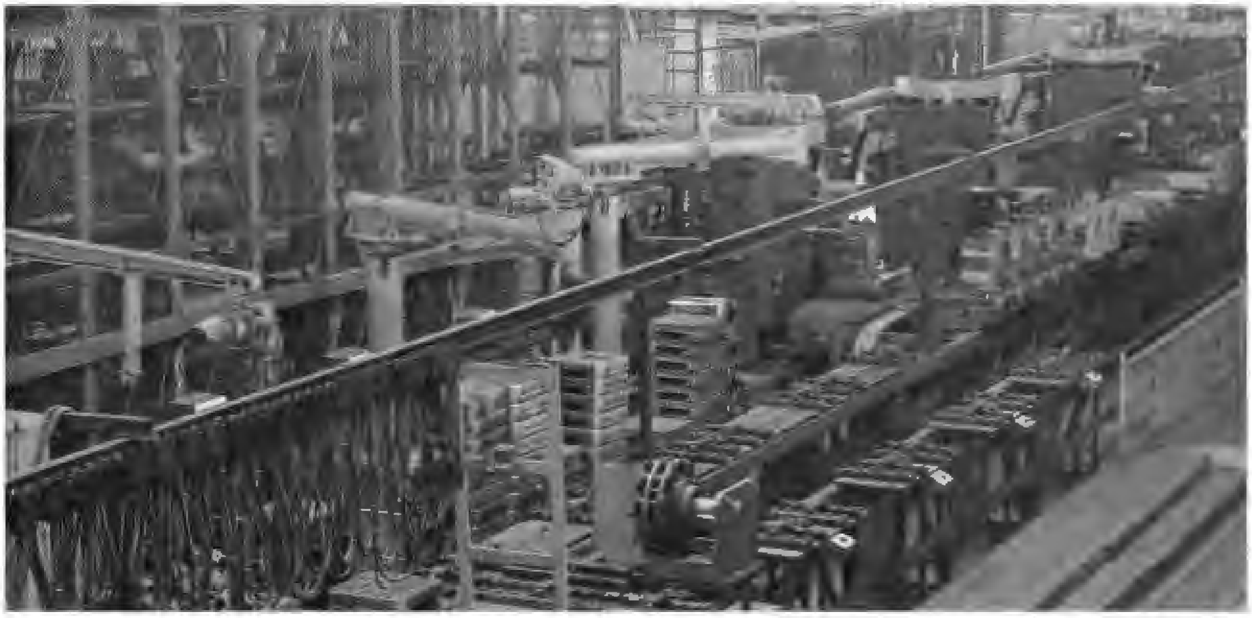
Since the early 1960s the Soviets have devoted considerable resources to the development of manufacturing technologies, but they have not been able to keep pace with the West (figure 12 illustrates the estimated US lead in several critical areas). Several factors have hampered Soviet development:

- Excessive compartmentation due to secrecy.
- Lack of innovation-promoting incentives.
- A late start in the use of computer-aided design and development equipment to create microelectronics.
- An underdeveloped network of software, service, and components support.
- A bureaucratic managerial structure that impedes rather than facilitates scientific-industrial interaction and cooperation.

Imports of Western Manufacturing Technology

Deficiencies in many of the manufacturing technologies necessary to modernize their armaments plants and other plants have prompted the Soviets to emphasize legal and illegal acquisitions (see table 2). They legally imported more than $4 billion worth of Western machine tools over the past decade. Three-fourths of these imports were conventional machine tools.

Flexible Manufacturing Systems



Five machining centers form a flexible manufacturing system called Talka-500 at the Ivanovo Machine Tool Building Association.

The typical flexible manufacturing system (FMS) is built around metal-cutting machine tools. It often consists of a group of machining centers—multipurpose machine tools that can drill, mill, tap, and bore a fixed workpiece and that have automatic tool-changing and -loading features—which are linked by a centralized computer system. A material-handling system under control of the central computer—consisting of robots, pallets, conveyors, or carts—moves parts between machining centers. Advanced systems may also be tied in with automatic storage of parts, a computerized design system, and computerized information on inventory and output. In its most advanced stage, a flexible manufacturing system requires no human intervention except for maintenance and programing for new products.

The productivity gains and cost savings from these new systems are great. A flexible manufacturing system reduces the time parts have to spend waiting to go on a machine, increases machine utilization, allows fabrication of complex parts to consistently high tolerances, and permits a more rapid changeover from one machined part to another. Robots, carts, or other forms of transport reduce the required labor force. The linkage of computer-aided design systems with the process machinery in an FMS permits rapid change in product designs and documentation, thus saving time and increasing production options. The ability of an FMS to produce a variety of different items simply by changing the central computer program, for example, or transferring new designs immediately for programing is unmatched by any other form of automation. When these systems also incorporate computer-based management and information systems, they further increase productivity through precise and responsive control of supply and production scheduling.

Most flexible manufacturing systems are used in low-to-medium-volume production, such as production of machine tools, construction equipment, aircraft, computers, and specialized electronic components. If production volume is high, less flexible automated machinery dedicated to making a single part—such as a transfer line used to make automobile engine cylinder blocks—is more cost effective.

An ASU center at the Zil' Automotive Plant, which produces trucks for the Soviet military.

Izdatel'stvo Plakat, 1981 ©

Since the early 1970s the Soviet leadership has placed a high priority on the development of automated control systems (ASUs) at all levels of the economy as a means of facilitating planning and increasing industrial productivity without having to resort to more fundamental economic reform. ASU is a generic term used by the Soviets to refer to computer-based data-processing systems that have applications ranging from simple automated bookkeeping to the more complex tasks of collecting, processing, and distributing economic data. ASUs have applications at all levels of the economy, from the national, ministerial, and regional levels down to the enterprise and plant floor, where technical process control is a key component of industrial automation. Enterprise and plant floor computerization are widely used in Western industry.

ASUs have been neither as pervasive nor as effective in the USSR as the leadership has hoped, however. Their introduction and operation have been hindered by:
- *Deficiencies in computer software development.*
- *Supply bottlenecks, particularly in peripherals.*
- *The resistance of plant managers, who distrust the new systems and are unenthusiastic about computerized audit-trails.*
- *Insufficient training for users.*
- *The gap between designers and users of ASU systems and software.*

Table 2
Selected Soviet Acquisitions of Military Production Technology From the West

Western Equipment or Technology	Military Application/Improvement
Documents on KEVLAR-49 fiber for missiles	Missile development/production
Complete set of manufacturing equipment for printed circuit boards	Copied for 11 assembly lines for strategic missile, armor, electro-optics, and radar production
DTS-70 printed circuit board testing system	Military microelectronics production
Fiberglass manufacturing technology	High-pressure air tanks for submarines
Technical documents on tests of cold-rolled steel	Improved structural protection of warships
High-accuracy, three-dimension coordinate measuring machine	Copied for several industries

supplement domestic production (automated lathes), some to raise levels of precision and productivity (US gearcutting machinery), and some because the Soviets had no domestic counterparts (closed-loop, multiaxis numerically controlled machine tools). The Soviets also buy a substantial volume of these products from Eastern Europe, even though they are less advanced than those purchased from the West.

Although the Soviets reap substantial benefits from imported technology, they frequently have problems assimilating it into production. These difficulties are sometimes greater when the technology is illegally acquired, because in those cases Soviet engineers usually cannot benefit from foreign training and technical assistance. Modern critical technologies and equipment are generally more difficult to transfer—and much more difficult to duplicate by reverse engineering—than those that contributed to early Soviet industrial development. All these problems apply with a vengeance to sectors like computers and microelectronics, where the Soviets are experiencing severe deficiencies.

Prospects

In the decade ahead the Soviet weapons industry will face the challenge of meeting increasingly complex military requirements at an acceptable cost to the Soviet leadership. Many of the problems it faces, and their solutions, are unique to the defense industries. Nevertheless, they will have repercussions throughout the Soviet military and economy.

The Search for a New Production Strategy

As the preceding chapters have indicated, the Soviet defense industries have traditionally followed a simple strategy, capitalizing on the high priority given to defense, taking advantage of inherent Soviet strengths, and seeking to negate Soviet weaknesses. The Soviet people have shouldered a high defense burden, churning out very large quantities of weapons at the sacrifice of more rapid economic growth and higher standards of living. The military's requirement for large quantities of weapons has both enabled and encouraged the defense industries to emphasize simplicity, producibility, and ease of maintenance, thereby mitigating the handicaps of a relatively low-skilled industrial and military labor pool and a technologically stunted industrial base.

Since the late 1960s, changes have taken place—strains in the domestic economy, expanding military technology frontiers, and improving foreign military capabilities—that are undermining the effectiveness of the traditional strategy. To cope with the new conditions, the Soviet leadership is changing its weapon acquisition policies and the infrastructure and operating practices of the defense industries. The following changes appear to be under way:

- *In resource allocation, a more sophisticated evaluation of the priority accorded the defense industries.* Defense will continue to have a high priority, but the increasing costs and complexity of producing advanced weapons are inducing leaders and planners to seek more cost-effective ways to meet military requirements. They are less likely than before to give their relatively insular weapons industry first access to the trough by "rubberstamping" its requests for material and manpower and then dividing the remainder among other claimants. In addition, Soviet writings and statements indicate recognition in party, government, and military leadership circles that long-term Soviet defense needs will require balanced development among industry, services, and the technology base.

- *In weapons development, a shift from highly conservative to more advanced applications of technology and from simple to more complex weapon designs where necessary to achieve desired weapon capabilities and performance.* Opportunities for using alternative designs in place of sophisticated technology will diminish, although the Soviets will continue to rely on traditional approaches in most cases. Weapon designers will have to adapt to the new capabilities provided by computer-aided design and manufacture, which are already an essential part of the weapon design process in the West.

- *In production, the manufacture of advanced weapons in smaller quantities and at lower rates.* Improved performance and more multipurpose weapons—along with higher unit procurement costs, greater production problems, and more costly operational and maintenance requirements for modern manufacturing equipment—are likely to discourage the Soviets from manufacturing many advanced weapons at past rates. Along with these factors, the danger of obsolescence (given today's rapidly changing threat and military technology base) will further encourage them to have shorter production runs. For the same reasons, the Soviets may begin to produce fewer types of weapons. The Soviets have also embarked on retrofit programs, designed to ensure the combat worthiness of their older systems, as in the case of older tanks and fighter aircraft intended for export or deployment in areas away from the frontline.

- *In the industrial base, more rapid growth in the high-technology support sectors of the weapons industry—radioelectronics, telecommunications, specialty materials, and advanced production equipment—than in weapon and equipment producers.* Throughout the defense industries, the Soviets will press for renovating and modernizing established facilities instead of constructing new plants. They are experimenting with incentives to persuade plant managers that renovation is in their best interests, and they are redirecting investment to increase the availability of equipment for retooling.

- *In administration, small-scale changes in planning and management practices.* The Soviets have begun to revise plan targets, prices, and incentives to encourage innovation and favor quality over quantity. However, they are unlikely to undermine the central planning system by letting managers have real autonomy. And defense industries will continue to be the most thoroughly scrutinized part of the Soviet economy, subject to management by decree.

- *In seeking help from abroad, an emphasis on the buildup of the scientific-technical base of the East European allies and a greater reliance on them to fill some of the USSR's high-technology needs.* The Soviets will continue, however, to rely heavily on imports of technology and equipment from the West as well.

Other changes we expect to see include greater attention to quality control and an emphasis on reeducating the work force. These will become increasingly important as weapon systems incorporate more complex devices, components, and subassemblies. Increasing demands will be levied on the military and industry to find, train, and retrain sufficient numbers of engineers particularly knowledgeable about production technology.

Changes in the Military

Changes in the Soviet armed forces in the 1990s will drive—and be driven by—the changes in weapons technology and the Soviet strategy for weapons acquisition. Alterations in doctrine, force structure, logistic organization, maintenance requirements, and manpower use are likely to ensue.

The advent of new weaponry embodying advanced technologies—in both Soviet and enemy forces—will probably lead to some adjustments in Soviet military doctrine. The Soviets will probably intensify their efforts to develop tactical and organizational concepts that exploit the combat effectiveness of a force combining fewer but more capable new systems with large numbers of older systems. Overall force effectiveness will increase as the mobility, survivability, and lethality of weapons improve.

Force structure may also change in some instances to accommodate different numbers and missions of new weapons. In a few cases, the long-term impact of acquiring increasingly sophisticated weapons may be a reduction in total numbers maintained in active inventories. Weapons also may be employed in an entirely different fashion. For example, where large numbers of conventional weapons were controlled at lower command echelons, smaller numbers of more capable weapons could be controlled by higher echelons to accomplish the same missions.

Logistic support will have to be revamped to fit the force of the future. Increasingly complex weapons probably will require a larger support establishment as well as changes in the traditional Soviet maintenance philosophy. The weapons industry will be required to deliver considerably larger quantities of maintenance spares to military depots, and troops may begin to take more responsibility for diagnostic work. For example, the use of more complex and costly components for high-performance gas turbine and turbofan engines—which operate at higher temperatures—will compel the Soviets to increase the skills of those who will maintain them.

The new weaponry's greater requirements for skilled operators and maintenance crews will test the creativity of military manpower and training authorities. The recent extension of military recruitment for some job categories to include women is one sign that they are aware of this problem. Requirements for longer training times and more advanced skills could lead the Soviets to increase the period of service for conscripts serving in highly technical specialties.

Finally, the higher costs of weapons will probably lead the military to cut costs elsewhere. We have already seen signs that the military is being asked to economize wherever possible and that it is trying to comply. The introduction of new forms of work organization, more careful use of supplies, and better accounting and internal planning procedures are all designed to cut the fat from military expenditures in the face of growing procurement costs.

Changes in the Economy To Increase Defense Potential

In some ways the defense industries are unique in the Soviet economy, but many of their problems confront the civilian sector as well. Although the defense industrial ministries have had special status, they have never been completely insulated from civilian industry—an indispensable supplier of materials, components, and subassemblies—and the lines between the two sectors have become increasingly blurred as Soviet weapons have grown in complexity. Despite the secrecy that shields the weapons industry from public view, the recognition by Soviet leaders of the increasing interdependence of the two sectors is leading to increasing interministerial alliances.

Advancing weapon technologies have led the weapons industry to depend increasingly on Soviet academies of sciences and higher educational organizations for R&D developments. Civilian organizations are emphasizing applied research and are undertaking substantial R&D for the military. Civilian industries are supplying more of the materials, components, and production equipment needed for developing and manufacturing armaments, and defense industries are producing more for the consumer.

In the last years of the Brezhnev era, the Soviets began to map out a strategy to speed the modernization of both the civilian and the defense industries. The focus has been on a "high-technology revolution" and a revitalization of the entire industrial base. The leadership under Gorbachev has moved to reinforce the place of its science and technology policy as the linchpin of its economic strategy. Indeed, the leveling off of procurement spending in the last half of the 1970s may at least partially reflect efforts by the leadership to invest more heavily in the renovation of the industrial base to meet the challenges of the future.

A search for organizational forms more conducive to the development of new ideas is under way—particularly a search for ways to improve the movement of the results of the research lab into the plant. Media debates rage over the proper form of industrial organization, with suggestions ranging from greater centralization to the abolition of ministries. Experiments in different places and on different scales abound.

The Soviets are also trying to create better incentives for emphasizing quality over quantity. They have recently lowered production targets for managers who introduce new manufacturing technology into their enterprises. Within the plant, they are experimenting with team labor, worker involvement in norm-setting, and other methods of encouraging personnel to feel they have a stake in an enterprise's success. Educational reforms have been enacted to enhance the technical background of young people about to enter the work force. Computer education, while not yet widespread, is receiving a great deal of leadership attention.

Reforms are also being implemented to ensure more comprehensive and balanced plans for the future. Enterprises are experimenting with rolling five-year plans (plans in which the old year is dropped and another is added annually, rather than complete new documents every fifth year). The national leadership has duplicated in the science and technology area the long-term planning used for the military. The 20-year plan for development from 1986 to 2005 and the Comprehensive Program for Science and Technology to the Year 2000 of the Council for Mutual Economic Assistance—the Bloc economic organization—are intended to provide Soviet science with long-range forecasting such as has been devoted to defense for decades.

Finally, after nearly 20 years of unprecedented stability, the bureaucratic elite that oversees the Soviet economy is undergoing significant change. General

Secretary Andropov initiated the process of rejuvenating both party and government bureaucracies with new faces, and it is continuing under Gorbachev. Many of the new managers are better educated and more familiar with the requirements of high technology than their predecessors—and have been strong public advocates of industrial efficiency and modernization. Furthermore, the Soviet leadership is tapping managers from the weapons industry to serve throughout the economy, hoping to spread their managerial talents.

The Defense Industries in the 1990s

Despite all the reforms under way, the Soviet defense industries face a great many challenges in their mission to produce enough highly advanced weapons for the forces of the next decade. They are already experiencing problems with several advanced systems. Expansion in high-technology-related industries, advances in precision machining and other fabrication technologies, and continued aggressive exploitation of Western technology suggest that the Soviets will overcome some of the difficulties with which they are currently struggling. Nevertheless, the underlying major deficiencies—particularly the lack of support service industries, inflexible plans, bureaucratic inefficiencies, and excessive secrecy—are likely to persist.

Successful reform will depend in large part on Gorbachev's ability to stimulate innovation and increase productivity throughout the economy. All industries—including the defense industries—confront managerial inertia, weak and inconsistent incentives, and inadequate planning. Moreover, tension between current and future military requirements will influence the outcome.

Several factors will help the weapons industry satisfy future military requirements. Because the West frequently encounters a lag between technological advances and improvements in military capabilities, Soviet designers often succeed in incorporating generic equivalents of Western technologies (sometimes stolen) into their own systems as quickly as, or more quickly than, their Western counterparts. Also, the Soviets are likely to continue to be able to surge ahead along a narrow front of military technologies because their centrally planned system allows them to place more emphasis on those areas than the West does. Finally, where the Soviet military experiences shortcomings in weapon capabilities, it will continue to compensate with large numbers of weapons with complementary strategies and tactics.

In any event, the weapons industry will continue to be a vital ingredient in Soviet military power, which has been the primary instrument of the leadership in achieving national security, political leverage, and prestige throughout the world. The weapons industry will be at the forefront of Soviet technology and industrial prowess and will absorb a large share of the best resources. Its leaders will continue to wield considerable influence on Soviet policy. And—with the combination of growing economic constraints and the increasing potential and challenges afforded by advancing military technology—the performance of the weapons industry is likely to be an even greater determinant of Soviet military power than it is today.

Ollie North

6836

NATIONAL SECURITY COUNCIL
WASHINGTON, D.C. 20506

INFORMATION

September 20, 1986

OLN
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FILE ?USSR
COMMENT

MEMORANDUM FOR ROBERT LINHARD
JACK MATLOCK

FROM: JOHN G. GRIMES

SUBJECT: US/USSR Direct Communications Link (DCL) HOTLINE Meeting in Moscow - September 9-12, 1986

At Tab A is a Summary of Understanding between the US and USSR as a result of the last round of technical discussions held in Moscow, September 9-12, 1986, for DCL/HOTLINE facsimile operations. The facsimile capability was cutover for operations on September 1, 1986, without a hitch or any fanfair after a very successful nine months of operational testing. Soviet STATIONAR IV satellite circuit will be activated on November 20, 1986, and will provide for the three separate paths between the two countries as required by 1984 agreement.

The current diplomatic agreements call for the facsimile to augment the existing slow speed DCL teletype (TTY) operations. However, there is a tentative agreement by both parties for eliminating the existing TTY operation and to integrate the TTY function into the facsimile terminal. To do this the basic 1981 and 1984 agreements will require changes at the diplomatic level. This will be an agenda item at the next round of discussions in Washington. Other points of significance from the technical discussion were:

1. Throughout the discussions the Soviets emphasized the total DCL system reliability factor of 99.99%, especially the cable and STATSIONAR transmission paths. Because of their concerns they proposed to add an additional satellite backup (hot stand-by) channel over their STATIONAR XI satellite system which would terminate at Fort Detrick, Maryland, earth station. While this can be accomplished at minimal cost there are two U.S. earth terminals located at Fort Detrick; which was required for the MOLNIYA satellite operations. These satellite terminals have been operational for over 15 years and may require replacement due to age and the non-availability of parts. DOD/Army will be requested to evaluate the terminal prior to the next technical meetings.

2. The Soviets accept, after considerable discussion, the U.S. position for the U.S. to maintain and control the computer software for the DCL. A protocol was established for handling software change requests by either party.

3. The Soviets requested that the next round of technical discussions be held in Washington in the Spring of 1987 time frame.

As part of the original DCL/HOTLINE diplomatic negotiations with the Soviets in 1983 and 1984 the U.S. had proposed that both countries improve embassy-country communications capabilities, but the Soviets were non-committal. Through the DCL technical discussions, the Deputy Assistant Secretary of State, Robert Ribera, has been able to establish an excellent rapport with the Soviet Ministry of Posts and Telecommunications and the Soviets have tentatively agreed to providing 56 KB wideband service to the U.S. Embassy Moscow.

cc: ADM Poindexter/Al Keel
Bill Cockell
Rod McDaniel
Ollie North
Ken deGraffenreid/Dave Major
Gerry May
Mike Bohn
Ron St. Martin/Doug Doan
Bill Bogart, WHCA

Summary of Understanding

between

US and USSR Technical Experts

on matters related to the

Improvement of the US-USSR Direct Communications Link

September 5, 1986 Moscow

Acting in accordance with the US-USSR agreement of July 17, 1984, on measures to improve the Direct Communications Link, and the understandings reached between the United States technical experts and the USSR technical experts on matters related to the improvement of the US-USSR Direct Communications Link of January 17, March 28, May 21 and September 12, 1985, and April 25, 1986, the sides noted that the US and USSR had, on the basis of successful operational testing (Appendix 1), begun facsimile operation over INTELSAT and cable circuits on September 1, 1986.

They further agreed to:

-- Commence facsimile testing over STATSIONAR IV on November 20, 1986; to commence facsimile operations over STATSIONAR IV on December 20, 1986, such operations to be configured in accordance with Appendix 4 to the April 25, 1986 Summary of Understanding; and to continue current teletype operation over STATSIONAR IV;

-- Reroute the cable circuit as described in Appendix 1 to further improve cable circuit performance;

-- Procedures to Implement Configuration, Operating Procedure and Software Changes for the Direct Communications Link (Appendix 2), such procedures to become effective immediately;

-- Begin use on November 21, 1986 of US provided EPROMS incorporating software enhancements described at Appendix 3, noting that the USSR will study the printer disconnect solution provided therein to determine if the problem is software or hardware related; in the event the problem is hardware related, the USSR will, by service message, provide the US a description of the problem;

-- Discuss at the next meeting the desirability of discontinuing the existing teletype operation, merging it with the facsimile operation, and establishing a tentative target date for any change in such operations, taking into account the experience gained in operational use of the facsimile over INTELSAT, STATSIONAR, and cable circuits, and the need to amend, if necessary, the existing US-USSR agreements to establish and improve the Direct Communications Link;

-- Accept in principle, the Soviet proposal to use STATSIONAR XI as a "hot standby" for STATSIONAR IV. It is understood that "hot standby" means that modems will be installed at the US and USSR Direct Communications Link terminal points and tested periodically. The US and USSR representatives will examine and discuss the technical details of accomplishing such a "hot standby" at the next meeting which will conduct reviews regarding questions concerning improvement of the Direct Communications Link and its technical maintenance.

The US side took note of USSR reaffirmation that upon commencement of facsimile operation over STATSIONAR IV, there would be no need for the US to track MOLNIYA satellites for facsimile or teletype operations.

The US side also took note of USSR proposals for further software enhancements (Appendix 4), and agreed to provide comments thereon, through diplomatic channels, prior to the first occasion on which US and USSR representatives will meet to conduct reviews regarding questions concerning improvement of the Direct Communications Link and its technical maintenance.

The USSR side took note that the US would begin use of USSR provided key disks on November 1, 1986.

Each side noted that their representatives had heretofore addressed pre-operational questions. Upon the achievement of full operational status of facsimile service over INTELSAT, STATSIONAR, and cable circuits, their representatives would henceforth be concerned with conducting reviews regarding questions concerning improvement of the Direct Communications Link and its technical maintenance. The sides agreed on the desirability, in principle, of convening a meeting of representatives in Washington during the first half of 1987, the dates to be established through diplomatic channels. A proposed agenda is attached at Appendix 5.

The sides noted that the discussion of technical questions connected with the implementation of the Direct Communications Link systems upgrade took place in an atmosphere of cooperation and mutual understanding.

For US Technical Experts

ROBERT C RIBERA

Deputy Assistant Secretary
for Communications

Department of State

For USSR Technical Experts

BORIS I CHIRKOV

First Deputy Director

Department of Foreign
Relations

Ministry of Posts and
Telecommunications of
the USSR

Appendix 1

USSR/US

FACSIMILE OPERATIONAL TEST SUMMARY

10 JAN - 14 AUG 86

The USSR and US technical experts assessed the overall results of the facsimile operational test over INTELSAT and cable circuits during the test period as generally excellent.

The efficiency of the satellite circuit was approximately 99.2 percent, and that of the cable circuit approximately 97.7 percent. Overall system efficiency was approximately 99.8 percent.

The experts agreed that the objective for overall system efficiency is 99.99 percent.

In order to further improve cable reliability, a new cable route was discussed which would eliminate all microwave transmissions on that route. It was agreed that a plan will be developed to replace the existing ITT cable FAX circuit (TAT 5) with a new cable facility over TAT 7. The existing cable route from London to Moscow will be rerouted via Helsinki ITT World Communications will arrange for the provision of the Washington-London link, and the Soviet Ministry of Posts and Telecommunications will arrange for the provision of the London-Moscow link. A date for the new circuitry to become operational will be agreed to by all parties through diplomatic channels. Appropriate restoration plans will also be finalized.

Over 1270 facsimile messages were transmitted during 31 weeks of operational testing. The quality of more than 90 percent of these messages was deemed excellent.

Each side's technical experts agreed that line interruptions appear to be random in occurrence and are not attributable to any one cause or time period.

The Soviets agreed to adopt the US proposal on modem strapping to standardize both the US and USSR equipment configuration to the manufacturer's specifications. The US agreed to investigate, with the modem vendor, the potential for enhancements that could lead to the elimination of operator intervention upon the interruption in transmission due to modem power supply failures.

APPENDIX 2

PROCEDURES TO IMPLEMENT CONFIGURATION, OPERATING PROCEDURE AND SOFTWARE CHANGES FOR THE DIRECT COMMUNICATIONS LINK

1. The agreement of July 17, 1984 provides that, in consideration of the continuing advances in information and communications technology, the sides will conduct reviews, as necessary, of questions concerning improvement of the Direct Communications Link (DCL) and its technical maintenance.

2. Noting that the application of computer technology in the DCL, upgraded through the introduction of facsimile transmission, opens a wide range of possibilities for improving the technical and operating characteristics of communications through the improvement of terminal equipment software, and noting that as experience is acquired during the operation of the existing link, the desirability may arise for changes in DCL operating procedures and software, the US and USSR technical experts have agreed upon the following procedures for making such changes in the future.

3. All questions connected with the work of the DCL will be decided through the organizations responsible for the DCL and indicated in the DCL Maintenance and Operation Procedures. These organizations will create appropriate experts groups for implementing the mechanism for incorporating changes into the configuration, operating procedures and software for the DCL system.

Process for Managing Modifications to Operating Procedures

4. Each side will complete a written description of any proposed change, and utilizing an Operational Change Request Form (copy attached), submit it through diplomatic channels to the other side.

The form shall include:

a. Proposal Identifier: A narrative title to the proposal and its sequence number in a given calender year, to include the side originating proposal, e.g., US 1-86, USSR 2-87.

b. Reason for proposed change.

c. Explanation of proposed change.

d. Interim testing conducted/required.

e. Suggested implementation date.

5. Each side will evaluate any proposed change and, if found mutually acceptable, agree on an implementation date. This may be done by an exchange of correspondance through diplomatic channels. Either side may request that a proposed change be included in the agenda of a meeting of technical experts, in which case implementation of the proposed change shall be held in abeyance.

6. Development and testing of new procedures may be conducted jointly, if mutually agreed upon by both sides. Modifications will not be implemented prior to evaluation and acceptance according to the procedures described above. If an emergency situation dictates a procedural change, it may, upon mutual agreement of the two sides, be used as an interim measure. As soon as practicable thereafter, the measures outlined in paragraphs 4 and 5 are to be undertaken.

7. Each side will maintain a complete, dated record of validated and implemented changes.

Procedures for Managing Modifications to Software

8. The mechanism for incorporating changes will include, as a rule, five stages:

- the official stage of basic agreement;
- the stage of developing a new version;
- the stage of familiarization with and trying out this version;
- the stage of refinement of the version;
- the stage of testing and implementation of the version.

9. At the stage of basic agreement, the side requesting the changes will formulate proposals and send them through diplomatic channels. The sides can further clarify these proposals on changes through orderwire communication over the DCL. The other side will also use diplomatic channels to send its official reply to the proposals. Having achieved basic agreement on the incorporation of the changes, the sides will begin the working stage of the implementation.

10. At the stage of development of a version, the sides will agree upon the concept and details of the work to be done, as well as a plan and schedule for implementing it. After this, the US side will develop the new version in full. The developed version, together with the assembly source code on floppy disk, will be sent to the USSR via diplomatic channels for familiarization and testing.

11. At the stage of refinement, the USSR will examine the new version in detail and make recommendations in the event further adjustments are required. The US side will make any necessary adjustments and provide a revised version and assembly source code to the USSR for further testing.

12. At the stage of testing and implementation of the version, each side will conduct independent off-line tests of the system with

the new changes. If no further changes are required, the sides will conduct line tests of the system in accordance with a mutually agreed to test plan. The system's orderwire can be used to establish such a plan.

13. The final version approved by both sides will be implemented by the US side. The US side will provide coded EPROMS to the USSR together with detailed technical documentation, including the relevant corresponding basic and assembly electrical diagrams, description of the work and incorporated changes, program algorithms and listings with detailed comments, and other necessary documents.

14. Implementation of the new software version in the communication system, as well as any changes in the DCL Maintenance and Operation Procedures will be preceded, as a rule, by a meeting of technical experts of the two sides, at which there will be a detailed examination of, and agreement on, all technical and procedural questions connected with the incoporation of the changes, as well as the necessary relevant technical documentation. The technical documentation which is sufficent for implementation of the changes will be included in an annex to the summary document of the meeting and will enter into force after signature of the summary document by the leaders of the delegations of experts of the two sides. Implementation of the new version will be carried out in accordance with a mutually agreed to schedule and steps will be taken to assure that there are no interruptions on the operating line during the incorporation of changes into the system.

15. Bearing in mind that questions may arise at all working stages of incorporation of changes, and that these questions may require detailed discussion and consultation between the specialists, the two sides will plan, if necessary, to have meetings of technical experts in the USSR and in the US in turn, and will also exchange service messages for this purpose over the DCL, as indicated in para. ~~12~~ 9 of this document.

Attachment: Operations Procedures Change Form

ATTACHMENT to APPENDIX 2

OPERATIONS PROCEDURES CHANGE REQUEST

1. Proposed identifier

Narrative title:

Change number:..........

2. Reason for proposed change:

3. Explanation of change:

4. Interim testing conducted/required:

5. Suggested implementation date:

SOFTWARE ENHANCEMENTS

1. During the 23-25 April 1986 Joint Meeting of Technical Experts, The USSR proposed certain software enhancements be made to improve operation of the facsimile system. The purpose of this paper is to agree with the proposed enhancements, and to present enhancements proposed by the United States that will further improve operation of the facsimile system. In this regard, the US will be prepared to provide the USSR a new PROM version during the September 1986 Technical meeting of Experts that will contain the software changes as listed below.

A. USSR CHANGES/ENHANCEMENTS:

(1) AUTOMATIC DISK RELOAD PROCEDURES: As identified by the USSR, current automatic disk reload procedures will not allow proper interoperation of the transmit and receive terminals if the line block count on the disk reads between 4488 and 4563 (disk total is 4565 line blocks). To prevent a loss of continuity of transmission and avert the need of a manual reload during actual transmission, automatic reload procedures are inhibited after line block 4450.

(2) ELIMINATION OF PLAIN-TEXT FACSIMILE: The USSR requested the elimination of Plain-Text Facsimile for security reasons. Currently this mode is primarily used by maintenance personnel for trouble shooting and isolation. These procedures can be replaced by using system test disks and will have no effect on operations. Therefore, the software is adjusted to prevent the plain-test mode of operation.

(3) PRINTER DISCONNECT: The USSR had several instances of printer disconnect during the transmission and reception of messages. The US also experienced a minor problem in this area. US programmers have not completely isolated this fault but feel the current Line Oriented Printer Error Routine could be a probable cause. Therefore, this routine is being replaced by a Character Oriented Print Error Routine, which significiantly diminishes the probability of printer disconnect occurance.

(4) MESSAGE INTEGRITY: The USSR had concern for identifying errored messages upon receipt. Currently errors or interruptions to a receive message is displayed by a small white horizontal line/bar across the page. The USSR felt more was needed to detect errors in a message. The US proposed the white line/bar be replaced with a black line for easier visual display and the software be modified to print out "ERROR FREE MESSAGE RECEIVED": whenever a message is received without errors. The software has been changed to provide the above enhancement.

B. US CHANGES/ENHANCEMENTS:

(1) SYSTEM CRASH: This is a system deficiency recently uncovered by the US. The system will crash/abort if the transmitting terminal during an automatic reload has a used key disk in the active disk drive and the receiving terminal has a correct or unused key disk in place. The new software change prevents this system failure from occuring.

(2) STATION CALL-UP: Due to the number of key-strokes to initiate call-up procedures with the distant end, the US desires an automatic call-up procedure. This enhancement requires only that the operator depress the "ALT" and "A" keys simultaneously to initiate call-up procedures.

(3) PROM VERSION DISPLAY: To insure that the system is running on the current software version, the operators work area will display the current version PROM being utilized by the system on the monitor screen at the time the terminal is designated either a receiver or transmitter.

(4) TIME OF OCCURRENCE: To aid in analysis and maintenance isolation, the US desires a printout, on a real-time basis, showing the time of system timeouts and line interruptions. The new software version contains this feature.

(5) CALL-UP ALARM: The US desires a separate and distinct call-up audible alarm to differentiate from the current error/status audible signal. Currently, the IBM program outputs 6 volts to allow activation of a separate call-up alarm of a period of less than 10 seconds. With the US proposed enhancement an external alarm device can be attached to the rear power panel and the software is modified to recognize the separate call-up signal and produce a distinct, continuous audible tone which would require operator intervention to terminate. (Hardware procurement to implement this separate alarm would be at the discretion of the user.)

Предложения советской стороны

по внесению изменений в програмное обеспечение оконечного оборудования факсимильной связи

(сентябрь 1986г.)

Советская сторона предлагает внести следующие изменения:

а) Изменить принцип размещения системной программы в компьютере;
б) Исключить режим "ФАКСИМИЛЕ ОТКРЫТО";
в) Добавить режимы "ТЕКСТОВЫЙ" и "МНЕМОНИЧЕСКИЙ";
г) Изменить знакогенератор;
д) Использовать календарь и часы;
е) Ввести программную проверку достоверности переданной и принятой информации.

1. Размещение програмы.

Изменить принцип размещения системной программы "HOT LINE" в памяти компьютера. Размещать программу не в ПЗУ адаптера FICS, а в оперативной памяти. Вводить программу с гибкого диска в ОЗУ обычным порядком (Ctrl+Alt+Del).

Преимущества: Надежность, проверяемость, простота модификации.

2. Особенности функционирования программы.

2.1. При первичной загрузке програмы с диска загружается команд ный файл, обеспечивающий:

- блокировку перезапуска компьютера с клавиатуры;
- установку календаря и текущего времени обычным порядком;
- установку основного для терминала языка;
- установку пароля для работы в линию;
- установку статуса компьютера в одно из четырех состояний: "ПЕРЕДАЧА", "ПРИЕМ", "ОТКЛЮЧЕНИЕ ОТ ЛИНИИ", "ПРОВЕРКА".

(Выбор статусного режима осуществляется через "меню" нажатием клавиши "Enter", закрепление выбранного режима- "Ctrl+Enter").

2.2. По выбранному статусному режиму ОЗУ дозагружается с диска соответствующим файлом с именем этого режима, с возможностъю выхода в "меню" из любого статусного режима управлением с клавиатуры (Ctrl+Alt+Del+Enter).

2.3. В статусных режимах "ОТКЛЮЧЕНИЕ ОТ ЛИНИИ" и "ПРОВЕРКА" на дисплей выводится "меню" этих режимов, в статусных режимах "ПЕРЕДАЧА" и "ПРИЕМ" рабочее окно выводится на дисплей толъко после ввода с клавиатуры пароля.
(При установке и введении паролъ на дисплей и принтер не выводится).

2.4. В статусном режиме "ОТКЛЮЧЕНИЕ ОТ ЛИНИИ" предусматриваются слежующие режимы местной работы:

1. "Предварителъная подготовка текста"
2. "Распечатка текста"
3. "Форматирование дискетты".

2.5. В статусном режиме "ПРОВЕРКА" программа "HOT LINE" обеспечивает проверку работоспособности терминала и диагностику неисправностей в одном из трех проверочных режимов:

1. "Оперативная проверка".

В этом режиме обеспечивается проверка цепей подключения и работы всех устройств терминала по их реакции на управляющие воздействия компьютера (команды включения-отключения, пуска-останова, вывода пробного текста на принтер и факсимильный аппарат, считывания-записи информации с дисководов), правильность функционирования устройств компьютера по результату выполнения тестовой программы.

2. "Углубленная проверка".

В этом режиме обеспечивается полная проверка работоспособности терминала.

3. "Устранение неисправности".

В этом режиме обеспечивается диагностика всех доступных модулей.

2.6. В статусных режимах "ПЕРЕДАЧА" и "ПРИЕМ" действуют пять рабочих режимов:

- F1 – "Служебный" (Работа текстом без шифра);
- F3 – "Текстовый" (Работа текстом на шифре);
- F5 – "Факсимильный" (Работа факсимиле на шифре);
- F7 – "Дежурный" (Тест "бегущая строка" без шифра);
- F9 – "Мнемонический" (Формализованные сообщения).

На передаче рабочие режимы устанавливаются с клавиатуры (Ctrl+F), на приеме рабочие режимы устанавливаются по кодовым командам с линии.

2.7. В рабочем режиме "Мнемонический" через "меню" может быть выбрано одно из следующих сообщений:

F1 - "КОНТРОЛЬНОЕ СООБЩЕНИЕ" F2 - "ВЫЗОВ"
F3 - "СЛУЖЕБНОЕ СООБЩЕНИЕ" F4 - "УСТАНОВИТЬ РЕЖИМ"
F5 - "ПРАВИТЕЛЬСТВЕННОЕ СООБЩЕНИЕ" F6 - "ПОДТВЕРЖДЕНИЕ ГОТОВНОСТИ
F7 - "НЕМЕДЛЕННОЕ УВЕДОМЛЕНИЕ" F8 - "СИГНАЛ НЕ ПРИНЯТ"
F9 - "ПОДТВЕРЖДЕНИЕ СООБЩЕНИЯ" F10- "ПОВТОРИТЕ"

При выборе на дисплее сообщения клавишами управления F1 - F10 и подтверждении клавишей "Enter" на экране формируется соответствующая заставка с формализованным текстом и местом для ввода неформализуемой информации (порядковый номер сообщения, диска, блока, количество страниц в сообщении и др.). При нажатии клавиш "Ctrl+Enter" в формализованный текст автоматически вставляется дата и текущее время, и сигнал передается в линию. Формализованная и неформализуемая информация передается на шифре. Однако, если ключевой диск использован, или если перед установкой режима "Мнемонический" был установлен режим "Служебный", программа допускает передачу в линию без шифра сигналов, выбранных четными клавишами управления (F2,F4,F6,F8,F10), с предупреждающей рамкой и звуковым сопровождением об открытой работе в линию.

2.8. При выборе сообщения "УСТАНОВИТЬ РЕЖИМ" на экране формируется заставка: "УСТАНОВИТЬ ДИСК N ......". После ввода с клавиатуры номера диска и подтверждения (Ctrl+Enter) сигнал передается в линию, на экране формируется команда "ЗАГРУЗИТЬ ДИСК N ......" с указанием введенного номера. С вводом подтверждения (Ctrl+Enter) команда исполняется на передаче, в линию передается исполнительная команда для загрузки диска на приеме. При загрузке диска производится сверка номера установленного диска с заданным номером. При несовпадении номера на экран выводится сообщение: "НЕВЕРНАЯ УСТАНОВКА ДИСКА.

УСТАНОВИТЕ ЗАДАННЫЙ ДИСК, НАЖМИТЕ ЛЮБУЮ КЛАВИШУ". При отсутствии диска в дисководе на экран выводится надписъ: "ДИСК ОТСУТСТВУЕТ. УСТАНОВИТЕ ЗАДАННЫЙ ДИСК, НАЖМИТЕ ЛЮБУЮ КЛАВИШУ". Если диск помечен как исполъзованный, на экран выводится сообщение: "ДИСК ИСПОЛЪЗОВАН. УСТАНОВИТЕ НОВЫЙ ДИСК". При этом на передаче выводится дополнителъное сообщение: "ПОВТОРИТЕ КОМАНДУ "УСТАНОВИТЪ РЕЖИМ".

При успешной загрузке диска на экране передачи и приема выводится надписъ: "ДИСК N ...... ЗАГРУЖЕН".

Любой из мнемонических сигналов может бытъ отменен вводом команды отмены (Ctrl+Break). При этом на передаче осуществляется возврат к "меню" мнемонического режима. Если в линию был передан сигнал на исполнение предыдущей команды, на экран приема выводится сообщение: "КОМАНДА ОТМЕНЕНА НА ПЕРЕДАЧЕ", и ее действие прекращается.

2.9. Во всех пяти рабочих режимах на экран передачи и приема выводится рабочее окно, обрамленное рамкой, окрашенной в красный цвет при работе без шифра, и в зеленый цвет при работе на шифре. В верхнем поле рамки над рабочим окном располагается статусная строка с индикацией даты, статусного режима, текущего времени, например:

"08-18-86 "П Е Р Е Д А Ч А" 12:34:51" .

В верхней части рабочего окна располагается строка рабочих режимов с индикацией рабочего режима, номера диска, текущего номера блока, например:

"Режим: ФАКСИМИЛЪНЫЙ" "ДИСК N 000365" "Блок N 4023"

В нижней части рабочего окна располагается системная строка для вывода на экран системных извещений, например:

"ДИСК ИСПОЛЬЗОВАН. УСТАНОВИТЕ НОВЫЙ ДИСК"

В рабочем окне на передаче выводится текст, вводимый с клавиатуры, на приеме выводится текст и системные команды, поступившие с линии. На передаче и на приеме предусматривается возможность выбора цвета окна с автоматической установкой альтернативного цвета цифро-буквенной информации.

3. Особенности рабочих режимов.

3.1. Режим "Служебный".

В режиме "Служебный" передача и прием информации осуществляется без шифра. Для напоминания об этом каждый вводимый с клавиатуры знак сопровождается низкочастотным звуковым сигналом, ввод информации ограничен одной строкой текста, в пределах которой возможно исправление ошибок и стирание всей строки. Передача строки в линию осуществляется при вводе "Ctrl+Enter", после чего может заполняться следущая строка рабочего окна. Рабочая строка индицируется в инверсном виде. В "служебном" режиме рамка рабочего окна всегда имеет красную окраску. Режим используется для вхождения в связь.

3.2. Режим "Текстовый".

Текстовый режим предназначен для обмена текстовой информацией на шифре, как в диалоговом режиме с клавиатуры, так и в режиме передачи заранее подготовленного и отредактированного текста.

При установке этого режима в верхней части рабочего окна под строкой рабочих режимов выводится рамка редактора текста, в которой индицируется имя файла, счетчик числа строк и знаков, состояние клавиатуры, состояние регистра "Русский/Латинский", например:

___"файл:"Т01"______Строка_12/165____Знак_67/4078____Осн____РУС____

(Имя файла необходимо для обращения к информационному диску. В указателе счетчика строк и знаков в правой части показывается полное число строк и знаков в файле, в левой части- соответствующее положению курсора. Состояние клавиатуры выбирается клавишей "Num Lock"- основная или дополнительная клавиатура. Русский или латинский регистр выбирается клавишей "Caps Lock". В основной клавиатуре расположение клавиш с нанесенными знаками соответствует стандарту основного языка, в дополнительной клавиатуре ввод вспомогательных знаков- знаков препинания, скобок, служебных символов осуществляется на основном регистре).

В текстовом режиме используются как строчные, так и прописные буквы, знаки как русского, так и латинского алфавита.

(В этих целях ПЗУ знакогенератора с русскими и английскими знаками изменяется).

Программа редактора обеспечивает стандартные возможности обработки текстов.

Введенный с клавиатуры текст передается в линию при нажатии клавиш "Ctrl+Enter", переданные знаки на экране меняют цвет и выводятся на печать. При установке курсором указателя, в линию передается только помеченный указателем текст.

При передаче заранее подготовленного на информационном диске текста информация считывается с диска в оперативную память, выводится на экран и передается в линию также, как и при вводе с клавиатуры. Передача текста в линию может быть остановлена повторным нажатием клавиш "Ctrl+Enter".

На приеме поступающая с линии информация выводится на экран, на принтер и записывается на информационный диск.

4. Особенности организации информационных пакетов.

4.1. В текстовом режиме используются пакеты такой же информационной длины, что и в факсимильном режиме- 320 байт. Минимальная информационная длина текстового пакета- 80 байт.

4.2. Для контроля достоверности переданной и принятой информации в линию будут автоматически передаваться контрольные пакеты с указанием переданного в факсимильном и текстовом режиме количества байт всей и "полезной" информации. Под "полезной" информацией понимается только та информация, которая поступила на шифрование. Контрольные пакеты будут формироваться при каждом окончании передачи факсимильной страницы и при окончании передачи каждого массива текстовой информации, если его об'ем превышает длину информационного пакета (320 байт).

На приеме информация, содержащаяся в контрольном пакете будет сравниваться с количеством реально принятой информации, результат сравнения будет выводиться на экран и принтер, например:

"ФАКСИМИЛЕ ЗАКОНЧЕНО, ПЕРЕДАНО 3678/4056, ПРИНЯТО 3678/4056. ОК", или:

"ТЕКСТ ЗАКОНЧЕН, ПЕРЕДАНО 2435/2767, ПРИНЯТО 2334/2543, ОШИБКА".

При обнаружении расхождения в количестве переданных и принятых байт компьютер выдает прерывистый звуковой сигнал низкой тональъности.

Appendix 5

Proposed Agenda for Next Meeting

1. Review of performance of facsimile service over INTELSAT, STATSIONAR, and cable circuits.
2. Discussion of the desirability of discontinuing the existing teletype operation, merging it with the facsimile operation, and establishing a tentative target date for any change in such operations.
3. Discussion of the technical details of accomplishing STATSIONAR XI as a "hot standby".
4. Discussion of USSR proposals for further software enhancements.
5. Discussion of the printer disconnect solution contained in US provided EPROMS.
6. Other business.

SECRET

Coy

7264

file: USSR

136476

NATIONAL SECURITY COUNCIL
WASHINGTON, D.C. 20506

October 8, 1986

SECRET

INFORMATION

MEMORANDUM FOR JOHN M. POINDEXTER

FROM: CRAIG P. COY

SUBJECT: U.S.-Soviet Maritime Boundary

Attached at Tab I is an informational memo from Platt outlining the current state of play in the long running dispute over the U.S.-Soviet boundary in the Bering Sea. Beginning today a U.S. delegation consisting of State, Interior, and Coast Guard officials will meet with the Soviets. Initial indications from the U.S. delegation point to the possibility of progress toward resolution.

There is no reason to believe this subject will be raised in Iceland.

Steve Danzansky, Jack Matlock, Judyt Mandel, Jim Stark and Steve Sestanovich concur.
(Not available)

RECOMMENDATION

That the memo be filed for record purposes.

Approve AA 10-10 Disapprove ____

Attachment
Tab I - Platt Memo to Poindexter dated October 6, 1986 w/Attachment

SECRET
Declassify: OADR

SECRET

8630728 7264
XR-8630724

SECRET

United States Department of State

Washington, D.C. 20520 136477

October 6, 1986

MEMORANDUM FOR VADM JOHN M. POINDEXTER
THE WHITE HOUSE

SUBJECT: U.S.-Soviet Maritime Boundary

The seventh round of Soviet maritime boundary discussions is scheduled for October 8-10, 1986 in Washington. The Soviets owe us a response to our counterproposal tabled in April 1986, for a full boundary settlement based on a combination of rhumb line and great circle depictions along the length of the 1867 Convention Line. We intend to reject their April proposal for formal interim arrangements to regulate fishing and impose a moratorium on hydrocarbon development in the disputed area. We want to keep the discussion focused on an overall settlement. We will make clear that we expect the Soviets not to interfere with U.S. fishermen who recently have begun to fish in the disputed area.

Last April, we identified our problems with the 1985 Soviet proposals to settle the boundary. They proposed to relinquish their previous 200-mile zone claim to the "red zone" lying beyond 200 nautical miles from our coast on our side of the Convention Line, a claim we have never recognized. In return, they proposed as "compensation" to move the Line eastward almost to their original rhumb line. This "compensatory" line would give the Soviets full maritime jurisdiction over a 9,000-square-nautical-mile area north of the "red zone," the area of the greatest resource interest. We indicated we could not accept either this or their proposal for joint or common access to most of the "blue zone," which lies on our side of the Convention Line beyond 200 nautical miles from both coasts. Our April proposal was a variant of our 1983 proposal for a mid-line splitting equally the difference between the Soviet rhumb line and U.S. great circle depictions of the Convention Line along its entire length. Our proposal would revert to our original great circle north of the red zone in the area of greatest resource interest and would employ the Soviet rhumb line in the red and blue zones. (See attached maps.)

SECRET

DECL: OADR

-- We will not make any new proposals to settle the boundary at the October round. We will continue to press our 1986 proposal using the U.S. great circle depiction (and U.S. turning points) north and south of the blue and red zones and the Soviet rhumb line depiction in those zones. We will continue to reject any Soviet claims on the U.S. side of the Convention Line, including any proposals for joint or common jurisdiction in the blue zone. If the Soviets indicate interest in pursuing other possible combinations of rhumb, great circle and mid-line depictions without pressing their blue zone claim, we may signal willingness to consider a proposal to continue the rhumb line south of the blue zone. We continue to believe that U.S. resource and other interests that led us in 1977 to choose the 1867 Convention Line as our maritime boundary position still make that Line our position of maximum advantage.

We will continue to reject Soviet proposals for negotiation of interim arrangements for fisheries and a moratorium on hydrocarbon development in the disputed area. The hydrocarbon moratorium is a non-starter, which would restrain U.S. development while the Soviets catch up to our technology. In 1984, we instituted special procedures to offer oil leases in the disputed area and put deposits in escrow; the Soviets have not begun development activities. Moreover, interim arrangements on hydrocarbons and/or fishing would remove any incentive the Soviets may have to settle the boundary. They would also tend to perpetuate the dispute and could entail the same difficult definitional problems as a final boundary settlement if we are to avoid prejudicing the U.S. position.

Thus, we prefer to handle the fisheries matter informally if possible. Fisheries enforcement problems were the original impetus for beginning the boundary talks in 1981, and we already have instituted a policy of restraint toward Soviet fishing vessels in the disputed area, issuing them citations but not seeking to board, seize or impose sanctions. We will make clear to the Soviets that we expect them similarly to refrain from enforcing against U.S. fisherman in the disputed area. We also will advise Japanese vessels not to fish in the disputed area and that we will take enforcement action if we find them fishing pursuant to Soviet permits. We will tell the Soviets we expect them to do the same. If the Soviets react positively to such informal understandings, we should be able to satisfy U.S. fishing industry and congressional interest in interim fishing arrangements spurred by recent enforcement incidents involving U.S. and Japanese fishing vessels and U.S. and Soviet enforcement vessels. We will assess Soviet reactions on both the overall boundary settlement and interim fishing arrangements after the October round.

As before previous rounds of our boundary discussions, we draw your attention to an issue that is not directly part of the boundary negotiations but that would be affected by a final boundary settlement based on the Convention Line. The question of sovereignty over Wrangel, Herald, Bennett, Jeannette and Henrietta Islands continues to generate public as well as Congressional interest. Our position with respect to these islands, which we stated in my memorandum to you of March 31, 1986, remains the same.

This memorandum has been coordinated with the other interested agencies. We will undertake appropriate Congressional consultations.

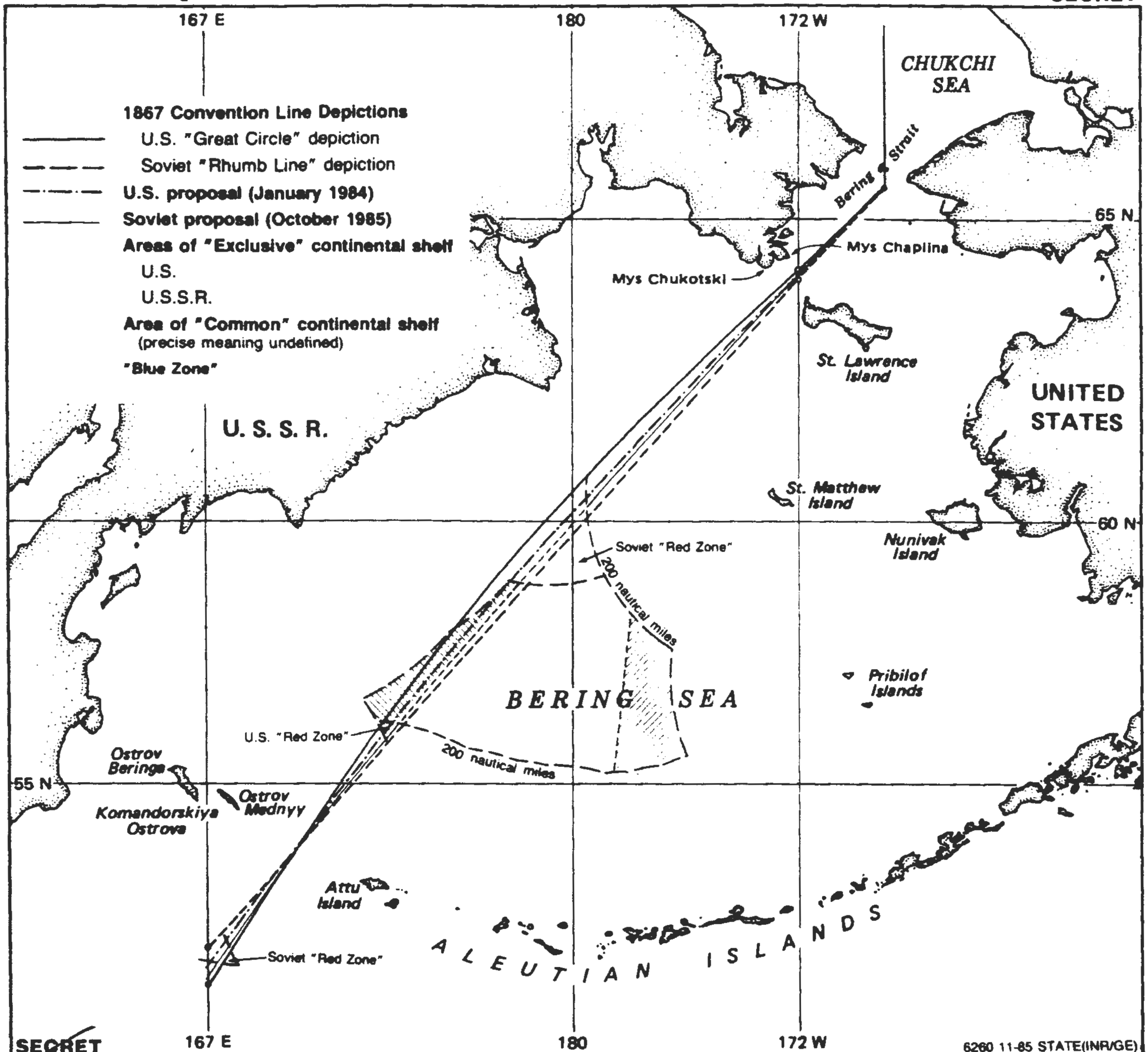
Nicholas Platt

Nicholas Platt
Executive Secretary

Attachment: Maps

U.S. - U.S.S.R. Maritime Boundary Negotiations: Soviet Proposal - October 1985

SECRET



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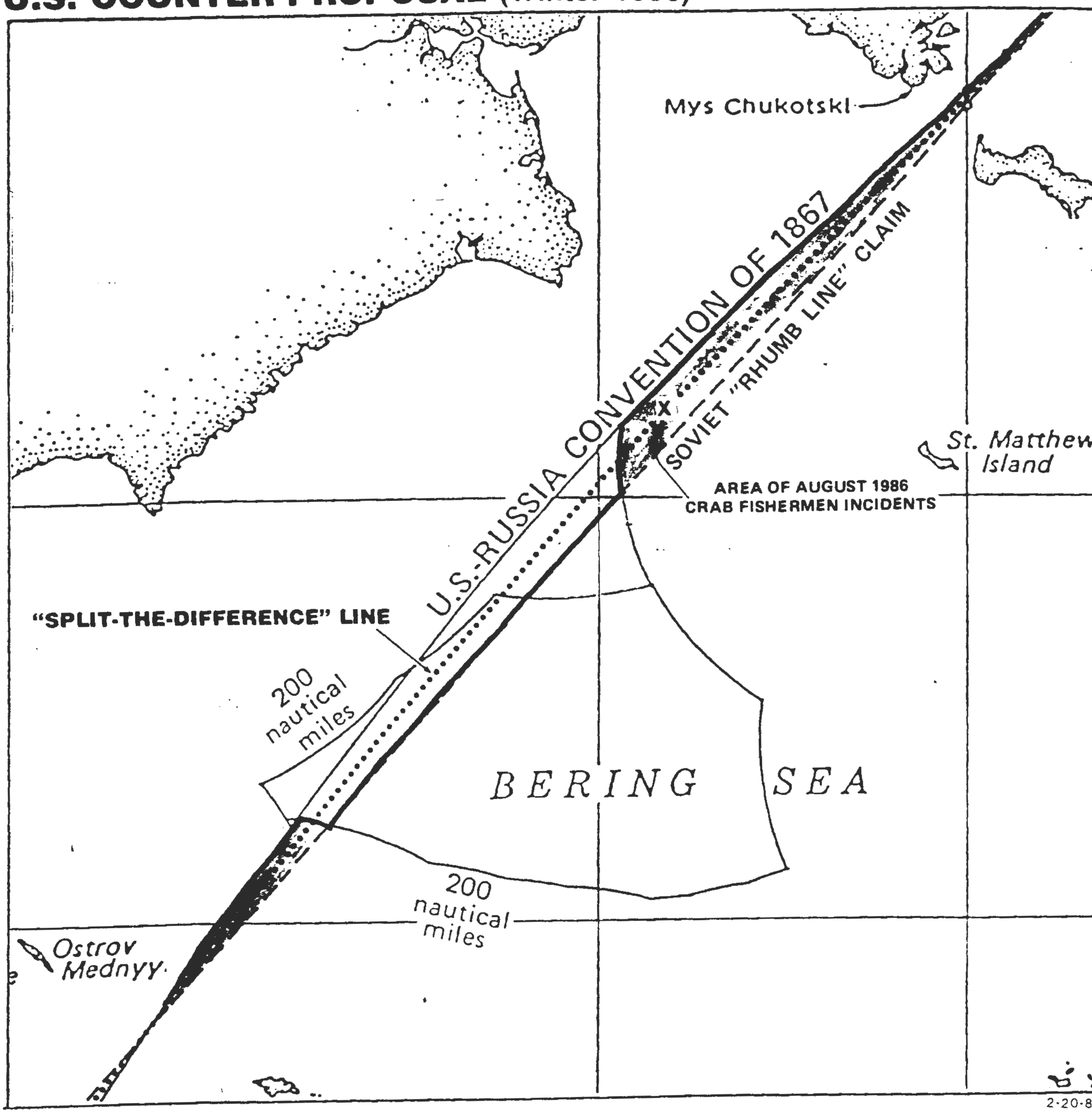
U.S. COUNTER-PROPOSAL (Winter 1986)



U.S. Counter-proposal

Area Between U.S. and Soviet Depictions That Would Come Under:

U.S. Jurisdiction

Soviet Jurisdiction