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Competition in Soviet Weapon Research and Development

A Research Paper

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A Research Paper

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SOV 88-10008X
February 1988

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Competition in Soviet Weapon Research and Development

Key Judgments

Information available as of 1 October 1987 was used in this report.

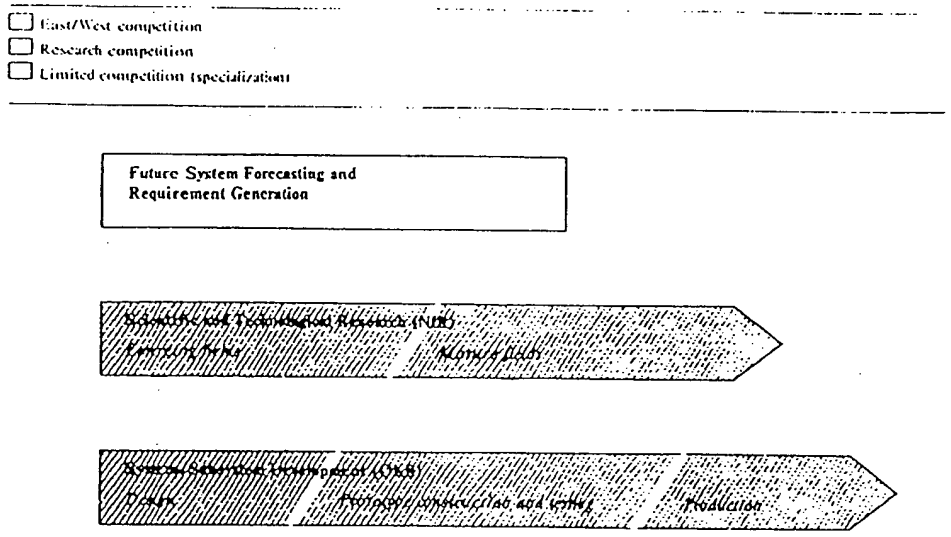
Competition plays an important role in Soviet weapons research and development (R&D), but varies in type and intensity during the process. We find that the Soviets primarily compete against Western military hardware and technology. There is almost no Western-style competition; that is, alternative designs are not produced as prototypes for evaluation before the final design selection (see figure 1).

Competition with the West is an essential element of Soviet forecasting, the first phase of their weapon-acquisition process. In forecasting, the Soviets use Western hardware and technology to help define performance levels for their own future systems. They then continue to compare the projected performance of these systems with that of their Western counterparts throughout the acquisition process. Extensive programs are aimed at overtly and covertly acquiring US and Western military designs, technology, and hardware, both to aid in this comparison and to improve the Soviet ability to compete with the West. Because of the strong Soviet dependence on Western technology and design, the United States and its allies can significantly inhibit the Soviet military R&D process by conducting "black" or at least classified weapon development programs.

After the forecasting phase, the Soviets initiate scientific research to develop the required technologies for a particular weapon type. For emerging technologies, some competition between scientists and between research institutes takes place. Although personal aspects of these rivalries are officially condemned, such competition does foster alternative approaches to technology development. For more mature technologies, a lead institute is appointed to oversee development of the technology and its application, and competition tapers off. Recently, for critical technology fields the Soviets have formed special groups called interbranch scientific technical complexes (MNTKs), which are run by lead institutes. Formation of the MNTKs will increase specialization and further limit competition.

During the system development phase, more than one design bureau is sometimes assigned to work on the initial design for a new system, but such competition is limited to the earliest (paperwork) stages of development. Design bureaus typically do not create full-scale prototypes to determine which design bureau should be awarded the development effort. Soviet requirements for organizational specialization have virtually eliminated such competition. Vestiges of Western-type competition in system development, however, are occasionally still apparent in the aircraft industry.

Figure 1
Competition in the Research and Development Process



NOTE: Competition exists in all three phases of the Soviet weapon-acquisition process, but the nature and extent of competition change from one phase to another. Competition with Western military systems is very important to the Soviets and takes place throughout the process. In the first phase – forecasting and requirement generation – the Soviets compete exclusively with Western weapon systems. In the later phases – NIR and OKR – competition with the West continues. Only in NIR, in emerging research, is there any significant competition among Soviet S&T research organizations.
Time generally increases to the right on this chart, but the scale is not necessarily linear. Research into an emerging S&T field can take decades – considerably longer than the normal cycle for developing a weapon system.

Unless there is a radical change in the Soviet economic system, we believe it is highly unlikely that, during the next few years, the Soviets will increase the extent of competition that takes place during weapon R&D. The factors that constrained the growth of such competition—centralized control of the procurement process, commitment to full employment, and the requirements for organizational specialization—will continue to inhibit competition. The policy changes recommended by General Secretary Gorbachev's restructuring effort may ultimately result in changes in military R&D. We believe that the military and the defense industries will resist for as long as possible, however.

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Scope Note

Competition in the USSR, although different from competition in the United States, does exist, and it affects the development and characteristics of Soviet weapons. This paper examines "Soviet-style" competition within the Soviet weapon development process and discusses the effects of that competition. Beyond that, the paper examines the factors that inhibit the sort of competition that occurs in the West and discusses the prospects for change in the Soviet competitive proces:

Competition in Soviet Weapon Research and Development

Introduction

The Soviets recognize the value of competition in their ongoing attempts to accelerate the use of new scientific and technological developments in industrial production. In a 1985 *Pravda* article, academician V. Trapeznikov admitted that interorganizational and international competition provides a built-in, powerful stimulus for achieving scientific and technological progress in the capitalist system. Trapeznikov indicated that in the USSR the stimulus of competition is in effect at present only in the defense industry. "As a result, the technology and quality of output of our defense industry turn out to be higher than in the civilian sector."

Other recent Soviet press reports have also stressed the desirability of increased competition in the machine-building sector, which includes the nine defense industrial ministries.[1] In a 1986 *Izvestiya* interview, I. S. Silayev, Deputy Chairman of the Council of Ministers and Chief of the Machine Building Bureau, stated that a limited competitive system exists, but more competition should be arranged where organizational specialization permits. Silayev believes that competition is especially necessary in those fields in which the Soviet Union lags world standards, because the Soviets "always have a competitor—foreign firms."

A wide variety of Soviet civilian and military organizations are involved in the research and development (R&D) of weapon systems or subsystems; therefore, it is virtually impossible to separate the economic or political factors that pertain to only military or only civilian production. Although military systems are developed more efficiently because of continual oversight by the Ministry of Defense, the same state standards that regulate the development of military systems apply to the development of any Soviet hardware. These standards, coupled with the increasing emphasis on accelerating the development of new technologies and their introduction into production, further blur the distinction between civilian or military developments. Thus, we believe that bureaucratic changes in the management of civilian industry ultimately could affect the way that weapon systems are created.

This paper identifies the types of competition that can occur during Soviet weapon research and development, shows where such competition takes place, and assesses the prospects for increasing the level of competition in Soviet weapon procurement.

Competition and the R&D Process

Neither the Soviets' defense industrial base nor the overall economy is currently set up to accommodate "Western-style" competition. Indeed, a very different type of competition, "socialist competition," has long been a fundamental tenet of Marxian dialectics. Socialist competition is an esoteric concept in which workers and their organizations are enjoined to meet preplanned production objectives. There are no losers. It is the obligation of the individual worker or facility to achieve its goals, but if those goals are not met, the organization still exists and still has the same charter.

The Soviets have many of the same R&D goals as the United States. In recent years the Soviet leadership increasingly has demanded that high-quality products incorporating advanced technology be produced in a cost-effective manner. Soviet R&D planners attempt to meet these goals by mandating requirements through a centrally controlled R&D apparatus. In the United States, on the other hand, capitalism, profit

[1] These nine ministries are the Ministries of the Aviation, Communications Equipment, Defense, Electronics, Radio, and Shipbuilding Industries, as well as Machine Building, General Machine Building, and Medium Machine Building.

Competition in the West

Competitive development plays an important part in the US weapon acquisition process. This competition can generally be characterized as a process in which a variety of organizations develop their own concepts for a weapon system, the different approaches are compared (frequently by building and testing prototypes), and the most satisfactory solution ideally wins. However, there must be an existing industrial base to support effective competition. A number of relatively evenly matched organizations must be available and willing to do a particular type of work. They must have sufficient capacity to handle an increased workload, and an efficient, motivated work force. In a genuine competition, there must be losers. This potential for failure is a primary incentive to compete effectively in the West. When there are only a few organizations capable of competing on a problem, as is typical of the US defense industrial base, it is particularly important to sustain the losers so they can compete the next time, while rewarding the winners sufficiently to maintain their motivation.

A number of related factors inherent in US-style competition provide motivation to the competitors:

- *The prospect of economic gain.*
- *The prospect of economic losses if they do not compete.*
- *Becoming or remaining an industry leader in a technological area in order to compete effectively in the future.*
- *Beating the competition by incorporating advanced technological capabilities.*
- *Optimizing profits while producing high-quality products.*
- *Providing products that are cost effective for the customer.*

motives, and political considerations spur US defense contractors to compete for weapon development programs.

The phases of the Soviet acquisition process (see appendix) are marked by competition of different types and intensity. Intense competition with the West (particularly against the technical parameters of Western weapon systems) takes place at the beginning of the R&D process, when future systems are forecast and requirements are generated. During the initial research into new technologies, competitive activities are exemplified by rivalries between Soviet scientists and between their respective research institutes. These rivalries occur during the scientific research work (NIR) phase of the weapon acquisition process and are especially prevalent in emerging technological fields. In the third phase, experimental design work (OKR), competition is minimal. It exists to a limited degree among design bureaus in the aircraft industry. In most other areas, Soviet design bureaus are specialized, and competition between them is infrequent or nonexistent.

Forecasting: Competition With the West

Soviet interest in meeting or exceeding the world standard in a particular weapon type is not new. Historical examples can be found readily, particularly in biographies of Soviet weapon designers. Other examples include an article in a 1970 edition of *Equipment and Armaments*, which stated: "If we created a gun designed to destroy only the enemy's existing means of attack and defense, then we had not fulfilled our task of always looking ahead." Another article in the same edition claimed that during World War II the F-22 gun was equal to the best guns of that time. Soviet production standards "were invariably influenced by the quality of equivalent Western products. The question, 'How does the product compare with its Western equivalent?' was ever present.

Requirements for Future Systems. Competition with Western systems begins as part of the five-year planning process, when the Soviets attempt to forecast requirements for their future military systems and technologies. Forecasting is conducted as part of their long-range planning for weapons that will be developed 10 to 15 years hence. Forecasts are developed by scientific research institutes (NIIs) subordinate to the main and central directorates of the Ministry of Defense, with help from institutes within the Academy of Sciences and the defense industrial ministries. A major goal of such forecasting is the identification

Tactical-Technical Characteristics

The Soviet Military Encyclopedic Dictionary *describes TTKhs* (taktiko-tekhnicheskiye kharakteristiki) *as "the aggregate of quantitative characteristics of a model or piece of military equipment organized in accordance with a designated scheme, which determine its properties." The TTKhs are the mission-important characteristics of a system. For example, the principal TTKhs for armored vehicles are weight, armor protection, armament, engine capacity, speed, ammunition load, air transportability, range, and so forth. Some TTKhs are relevant to all types of military hardware, regardless of function. These include reliability, survivability, and resistance to interference*

The Soviets also address a foreign threat system in terms of its performance characteristics. On the basis of their estimates of future Western threats, they forecast the performance characteristics of their own future systems. Soviet sources link threat forecasting, their own system forecasting, and the importance of TTKhs. They have stated: "The resolutions of the questions of developing a new type of weapon require a forecast of the enemy's weapons and military equipment," and "The question of whether there is a need to produce a new weapon is inseparably linked with the determination of its tactical-technical characteristics

of tactical-technical characteristics (TTKhs), which define the performance characteristics the Soviets hope to achieve for future Soviet weapon systems. The forecast is also a means of identifying prospective technologies that should be developed or acquired for future generations of weapons.

The performance trends of prospective foreign systems are analyzed during the forecasting process. Open sources state that the Soviets are required by law to compare the characteristics of proposed Soviet systems with those of similar foreign counterparts throughout the entire acquisition process. [redacted] as a consequence, obtaining information on the TTKhs of Western weapon systems is a Soviet intelligence priority. Thus, the comparative analysis of the TTKhs of similar Soviet and Western systems is both a critical part of the Soviet weapon development process and an important factor in creating a sense of military competition with the West. For example, [redacted] the planning of requirements for future Soviet submarine-launched ballistic missiles (SLBMs) centered around Soviet assessments of the performance characteristics the United States planned for the Trident-I.

The Soviets' military-technical competition with the West does not mean that their systems will be the technological equals of Western systems or that they will follow similar technological approaches in designing these systems. Rather, forecasting and trend analysis of key TTKhs allow the Soviets to judge the status and prospects of their systems and technologies relative to the West, focus resources for development (including technology theft requirements), and develop new technical approaches or operational concepts that will allow Soviet systems to compete with or counter Western systems.

Collecting Information on Western Systems in Development. The Soviets have created an extensive and elaborate system to acquire information on Western weapon development. [redacted] most every research institute and design bureau maintains a department that translates foreign technical publications. Additional information is freely available in the form of foreign patents, catalogs, films, and exhibit photographs. Specimens of Western equipment and technology are obtained through either overt or covert means for subsequent exploitation. In addition, [redacted] Soviet technicians and scientists involved in joint research projects in non-Communist countries are frequently from defense industrial research institutes.

Our studies of Soviet technology transfer efforts indicate that the Military Industrial Commission (VPK) manages the Soviet program to acquire Western weapon designs and technologies. According to recent analysis, approximately 20 percent of VPK

The ZSU-X: Influenced by the Western Threat

Recently, the Soviets fielded a 30-mm self-propelled antiaircraft artillery (AAA) system that we call the ZSU-X. This system provides an excellent example of how the Soviets use information on Western weapons to establish TTKhs for their own systems. The development of the ZSU-X dates back to the early 1970s. At roughly the same time, the United States began development of the AH-64 Apache helicopter, which was designed to survive attack from the standard 23-mm Soviet cannon. We believe that the Soviets initially intended to develop a new 23-mm AAA system to replace their outdated ZSU-23-4. The US decision to build the Apache may have forced the Soviets to upgrade the gun system to 30 mm, thus changing the TTKhs of the ZSU-X

The external similarity between the ZSU-X and the West German Gepard AAA system exemplifies another aspect of Soviet competition with the West.

[redacted]

requirements are established with the goal of investigating foreign technical capabilities and the directions in which foreign technology is progressing. This information is critical to the Soviets in forecasting the TTKhs their systems must have to respond to the Western threa

[redacted] information on advancing technology came from the following sources:

- Subscriptions to foreign scientific and technical journals.
- Directly from foreign companies or individuals.
- Personnel sent to international expositions.
- Technical exploitation of aircraft that fell into Soviet hands during the Vietnam conflict.
- Soviet research

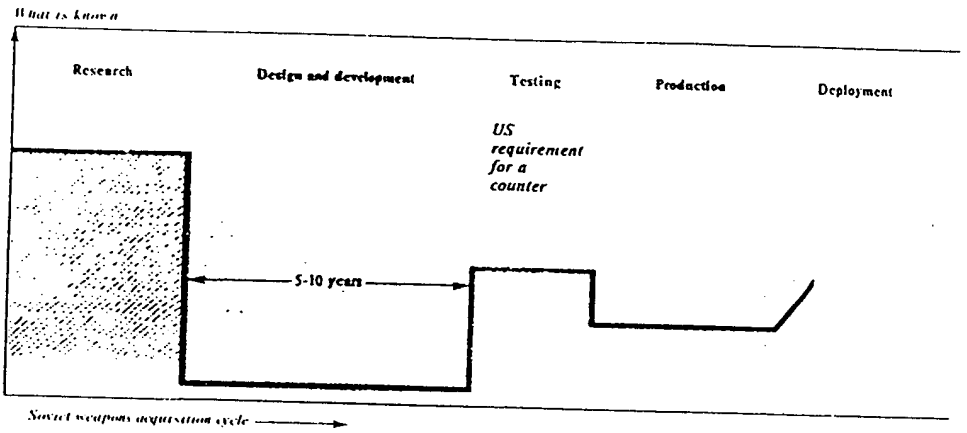
[redacted] believed that requirements for TTKhs for future Soviet weapons were derived as follows: 10 percent from improvements to unsatisfactory equipment; 20 percent from new technological discoveries from Soviet scientific research institutes; and 70 percent from information concerning foreign technology. Although it is not clear that these percentages held true throughout Soviet industry, and although they may have changed over the years, this information still supports the Soviet position that "an individual engaged in R&D should know as much as possible about what 'the opposition' is doing so as to be able to take the necessary steps to stay abreast of the state of the art.

Limiting Technology Transfer Opportunities. Dependence on Western technology to forecast requirements for their own future weapons creates a vulnerability for the Soviets. An increase in classified and "black" US programs could slow the Soviet development of similar systems or countermeasures. It is much more difficult to combat an unfamiliar and unexpected system than one that is fully understood. If the Soviets cannot easily obtain information on US weapon development programs, they will be forced to plan their future systems from a worst case perspective of the Western threat. In addition, the use of deception could trigger expensive Soviet R&D responses to nonexistent US weapon development efforts. Thus, denial of information on US weapons R&D could increase Soviet costs in terms of time, money, and development resource

The Soviets are aware of the benefits they accrue by being able to develop new weapon systems without exposing them to the West (see figure 2). According to one open-source statement:

> The creation of a new weapon, secretly nurtured in scientific research institutes and design bureaus, can abruptly change the relation between forces within a short period of time. The surprise factor not only affects the enemy's morale but also deprives him of the possibility of fielding a timely countervailing response.

Figure 2
Secrecy: A Potential Soviet Advantage



NOTE: The Soviets consider all weapon development programs to be closely held state secrets. Before weapons are decided upon, the Soviets publish basic scientific findings in order to be players in international science. Thus, we often can obtain some information on basic research (the amount varying with the specific field). Once system design and development begin, however, the Soviets effectively clamp down on the information flow, and we generally can obtain only limited information on the direction that the development is taking. Often a Soviet weapon is in testing before the United States has sufficient information to start designing a counter. Theoretically, the Soviets hope to have entire weapon systems nearly deployed before the West can begin to develop systems to equal or counter them.

This understanding of the benefits of secrecy is an extension of the general Soviet philosophy toward weapon development programs. That is, all elements of Soviet weapon programs—including their existence, technology, participants, and timing—are closely held state secrets. Because they can obtain vast amounts of information on US programs, the Soviets can mount propaganda campaigns aimed at halting or delaying US weapon development programs while secretly developing their own counterpart systems. One recent example of such an attempt is the Soviet propaganda campaign against the US Strategic Defense Initiative, even as the Soviets were developing many of the same technologies themselves.

Research: Competition Mainly in the Early Stages

When a requirement for a new weapon system that will incorporate new or emerging technologies has been formulated, those technologies must be developed quickly and cost effectively. This technology

development is a highly structured process. The initial development of new technologies with potential applications for the military can take place at research institutes either within the defense industrial and civilian ministries or within the Academy of Sciences. Because a broad range of organizations can be involved in the development of new or emerging technologies, a potentially competitive environment can result. That is, if a desired goal may be reached by different and competing research directions, the Soviets sometimes follow through on several of the most feasible—first to accomplish the development of the desired technology, and later to find ways to economically implement it. This technology development can include the construction of more than one "feasibility demonstrator." Competition among research institutes takes place at this stage—the scientific research work (NIR) phase of the weapon acquisition process.

Rivalry Among Research Institutes. Rivalries in a number of emerging fields have been noted between senior scientists and between research institutes. Although these rivalries are frequently condemned by the Soviet leadership as ineffective and as efforts toward empire building, they are direct reflections of competitive technology development. In a number of cases, the rivalries are both personal and professional. We see them reflected [redacted] Table 1 lists examples of research areas where competition in technology development has been noted among various Soviet scientists and research institute

It is difficult to quantify the extent of the competition in technology development within the Soviet Union. Because information is limited on actual NIR programs in emerging fields of technology, data on the continuing existence of such rivalries promote the idea that similar "competitive" technology development probably takes place between institutes where such rivalries are not apparent. Sometimes scientists openly refer to their competition with other scientists and their institutes. At other times, the clearest indicator is that only one of several institutes researching a particular field is able to obtain large amounts of resources, finances, or personnel. Also, research at several different institutes sometimes seems to be oriented toward the same goal suggesting that the institutes are in competitio

Creation of Lead Institutes. When an emerging technology has matured—proved successful—the Soviets establish a lead institute in that field, normally within an industrial ministry (see table 2). This lead institute is responsible for overseeing further development of the technology, any derivative research, and the assimilation of the new technology into industrial production. The lead institute controls the future application of its technological specialty, at least within its own ministry

The creation of such lead institutes is a reflection of the Soviet proclivity toward organizational specialization. Once the lead institute has been established, the level of competition quickly diminishes. A Soviet book on the aviation industry clarifies the concept of specialization as it occurs during scientific research work.

> Scientific research institutes specialize in kinds of aviation sciences and aviation equipment. In the first instance the NII's serve the sector and in the second instance, a specific subsector or only a portion thereof. The Central Aerohydrodynamics Institute *imeni* Zhukovskiy (TsAGI), which works on problems of the development of aviation, aerodynamics and strength of aircraft, is the lead research center. The Central Institute of Aircraft Engine Building (TsIAM) is the lead institute in the field of problems of aviation engine construction development. Other institutes specialize in the exploration of new aviation materials and alloys, standardization of aviation equipment, flight dynamics and flight testing, organization and methods of production, economics and management of the sector, the designing of enterprises, and so on. Some research is performed by the country's aviation higher educational institutions

Efforts To Speed Critical Technologies. General Secretary Gorbachev, in a move toward increased organizational specialization in R&D, has created new groups to speed the development of critical technologies. Since December 1985, the USSR Council of Ministers has created 24 of these groups—Interbranch Scientific Technical Complexes (MNTKs). Although not all of these MNTKs are directly concerned with military applications, many of the technologies they were created to develop are

Table 1
Examples of Competition in Soviet Technological Research [a]

Research area	Competitors
Space research	V. Barsukov—Vernadskiy Geochemistry and Analytical Chemistry Institute *versus* R. Sagdeyev—Space Research Institute
Stellarator fusion energy devices	O. S. Pavlichenko—Kharkov Physico-Technical Institute *versus* I. S. Shpigel—Moscow Institute of General Physics
Lasers	Yu. S. Protasov—Bauman Technical Institute, Moscow *versus* V. S. Zuyev—Physics Institute *imeni* P. N. Lebedev (FIAN)
Lasers	N. G. Basov, Director, FIAN *versus* A. M. Prokhorov, Director, General Physics Institute (IOFAN)
Industrial lasers	V. Yu. Baranov—Atomic Energy Institute *imeni* Kurchatov (IAE) *versus* G. A. Abilsiitov, Director, Scientific Research Center for Technological Lasers (NITsTLAN), Troitsk

[a] Competition in technology development can take the form of rivalries between different research institutes and their leading scientists striving to have their particular research approach accepted as the best or most likely to succeed, attempts to obtain larger percentages of funding or other resources, or quests for personal aggrandizement achieved through recognition as the preeminent researcher in a particular area.

critical to future systems. Several of the lead organizations in the new MNTKs have previously been involved in military-related technology developments, and one lead organization is subordinate to the Ministry of the Defense Industry.

The formation of these groups reflects a Soviet effort to reform the method by which new technologies are developed, but the MNTKs will inhibit rather than foster competition. Each MNTK is to include scientific research institutes, engineering and design facilities, and experimental production enterprises. Each will be responsible for coordinating all work in its field throughout the country. Some MNTKs are headed by Academy of Sciences institutes, while others are led by industrial institutes, depending on product specialty. Table 3 lists the 24 existing MNTKs with their specialty areas and lead organizations. The important thing to recognize is that this type of organizational structure will limit the number of research approaches that will be examined, thus reducing the level of competition and increasing the level of research specialization.

According to a January 1986 *Izvestiya* article, these MNTKs have five basic functions:

- Conduct and coordinate basic and applied research and design, as well as experimental and technological work, for the development of highly effective types of equipment, processes, and materials.
- Build experimental prototypes and perfect them for series production jointly with ministries and agencies.

Table 2
Examples of Lead Institutes and Their Areas of Specialization [a]

Ministry	Institute	Area of Specialization
Aviation Industry	Central Aerohydrodynamics Institute (TsAGI)	Aerodynamic vehicles
	Central Scientific Institute of Aviation Engine Building (TsIAM)	Aircraft engines
Defense Industry	Central Scientific Research Institute for Materials (TsNIIM)	Metallurgy
	Central NII of Automation and Hydraulics (TsNIIAG)	Automation and hydraulics
Shipbuilding Industry	Central NII of Electrical Equipment (TsNII Elektropribor)	Navigation equipment
	Central NII 49 (part of NPO Granit)	Ship control systems

[a] When a technological field has matured to the stage that the Soviets are satisfied they are pursuing the appropriate avenue of research, a lead institute is often established. This effectively stifles further competition. The lead institute will be responsible for further development and application of its area of specialization. For example, the Central Scientific Institute of Aviation Engine Building is responsible for conducting applied research into new types of aviation engines. The results of TsIAM's research will then be applied by the design bureaus that do actual aircraft engine development.

- Draft scientific-technical programs for key economic problems, and also draft five-year and annual plans of R&D.

- Assist ministries and agencies in the efficient utilization and further improvement of the equipment, processes, and materials that the complexes develop.

- Conduct and coordinate R&D on tasks of the comprehensive program of scientific-technical progress in countries belonging to the Council for Mutual Economic Assistance up to the year 2000.

According to the Soviet press, the MNTKs are not yet operating effectively. They may be yet another level of bureaucracy. Each MNTK will be led by an existing institute that specializes in the appropriate technology and that will have some authority over the allocation of research funds in its area of responsibility. This gives rise to the question of whether the MNTK lead institutes will support only their own line of investigation into technology development. The MNTKs seem likely to stifle the competition that existed before their formation. If so, these new complexes may backfire on the Soviets by limiting the technological approaches that will be investigated.

Development: Specialization Predominates

During the system development phase, competition occurs only to a limited degree. It usually is abbreviated and takes place only in the early (paperwork) phases of system design. An example from the Ministry of the Machine Tool and Tool Building Industry [1] clarifies this matter. [redacted] when a new machine tool was needed, two or three design bureaus were asked to submit plans, which were used

[1] This Ministry is not one of the nine Soviet defense industrial ministries, but it is governed by the same state standards for hardware development. Thus, this reflection of the operation and paperwork involved in civilian industry can have a direct correlation to those for military development.

Secret

Table 3
Soviet MNTKs: Specialties and Lead Organizations [a]

	Specialty	Lead Organization
Paton	Welding and metallurgy	Paton Electric Welding Institute, Ukrainian Academy of Sciences
Svetovod	Fiber optics	Institute of Radio Engineering and Electronics, USSR Academy of Sciences
Biogen	Biological engineering	Shemyakin Bioorganic Chemistry Institute, USSR Academy of Sciences
Nadezhnost Mashin	Machine reliability	Blagonravov Machine Science Institute, USSR Academy of Sciences
Lazernaya Tekhnologiya	Laser technology	Scientific Research Center for Industrial Lasers (NITsLANL Academy of Sciences and Ministry of the Electrical Equipment Industry
Personal'nyye EVM	Personal computers	Problems of Information Science, USSR Academy of Sciences
Robot	Automated control systems	Experimental Scientific Research Institute of Metal Cutting Machine Tools, Ministry of the Machine and Tool Building Industry
Membrany	Membrane technology for separating gases from liquids	All-Union Scientific Research Institute of Synthetic Resin, Ministry of the Chemical Industry
Nefteotdacha	Oil recovery	All-Union Oil and Gas Scientific Research Institute, Ministry of the Petroleum Industry
Rotor	Rotary conveyor lines	Design Bureau for Automatic Lines, Ministry of the Defense Industry
Metallurgmash	Metallurgical machinery	Scientific Production Association VNIIMETMASH, Ministry of Heavy Machine Building
Katalizator	Catalysis	Catalysis Institute, USSR Academy of Sciences, Novosibirsk
Poroshkovaya Metallurgiya	Powder metallurgy	Institute of Problems of Material Science, Ukrainian Academy of Sciences
Antikor	Anticorrosion	Institute of Corrosion and Protection of Metals, GKNT
Mekhanobr	Advanced crushing and pulverizing equipment	All-Union Scientific Research and Design Institute of Mechanical Processing of Materials
Termosintez	Synthesis of neoorganic compounds	Institute of Applied Mechanics and Mathematics and Moscow Institute of Chemical Physics
Radiatsiya	Irradiation	An unidentified institute of the Siberian Department, USSR Academy of Sciences
Mikrofotoelektronika	Miniaturized optoelectronic detectors	An unidentified institute of the Siberian Department, USSR Academy of Sciences
Impulsnyye Mashiny	Pulsed-power machines	An unidentified institute of the Siberian Department, USSR Academy of Sciences
Avtomatika	Computer-aided automation	An unidentified institute of the Siberian Department, USSR Academy of Sciences
Mikrokhirurgiya Glaz	Eye microsurgery	Moscow Scientific Research Institute of Eye Microsurgery, Ministry of Health
Energosberezheniye	Energy conservation	Unknown
Nauchnyye Pribory	Scientific instruments	Leningrad Scientific-Technical Association, USSR Academy of Sciences
Geos	Geological, geochemical, and geophysical information	Nuclear Geophysics and Geochemical Scientific Research Institute, USSR Ministry of Geology

[a] To date, the USSR Council of Ministers has established 24 MNTKs. Each MNTK is responsible for coordinating the development of a particular critical area of technology. A lead institute has been designated for each MNTK. This lead institute will oversee the direction, timing, and resource allocations for any research under way in its specific area of responsibility. By selecting a lead institute for each of these critical technology fields, the Soviets are limiting the scope of research, increasing specialization, and restricting competition.

to develop the technical assignment. The plans were to be submitted within 90 days and the winning design bureau was then to be chosen within 10 days. [ ] because the design bureaus frequently had more important projects than they could comfortably handle, they preferred to lose the bid.

Competition in the 1940s and 1950s. During World War II and into the 1950s, the Soviet design bureaus competed to develop specific weapon systems. Aircraft designer A. S. Yakovlev revealed that "it was widely practiced to give the very same task to two or three design organizations." The work on the aircraft would be conducted nearly in parallel, and the results of the state testing of two proposed machines would then be examined. The IL-28 bomber and the MI-1 helicopter reportedly resulted from this type of design competitio

Limited Competition in the Aircraft Industry [

[ ] preliminary design tasking for a new aircraft is distributed by the Ministry of the Aviation Industry (MAP) to several design bureaus, which then compete to create the best design. The competition lasts until the detailed design is developed. This winning design is still only on paper and is developed within a few months of the requirement date. The selection of both the competitors and, ultimately, the winner takes into account the current workload of the design bureau and whether officials of the bureau believe they can fulfill the requirement

[ ] competition sometimes takes place if existing Soviet engine designs are considered unsuitable for a proposed aircraft. When this happens, the MAP engine special design bureaus (OKBs) are asked to provide paper studies for suitable design. The design project is then awarded to one or more OKBs, detailed design work proceeds, and a full-scale mockup may be built. Once further approval is obtained, prototypes can be built and tested. The engine design is fixed once the prototype has successfully passed state testing

This type of engine competition probably took place between the Solov'yev and Kuznetsov OKBs for the TU-204, a civil aircraft now under development. According to a 1986 *Izvestiya* interview with aircraft designer A. A. Tupolev, the TU-204 will use two new low-noise, fuel-efficient engines designed by Solov'yev's OKB [ ] export versions of the TU-204 will be equipped with Kuznetsov engines. This may be true, because the Soviets strive to avoid wasted effort in any development project. Thus, the Soviets use novel technological approaches presented in a losing proposal in the winning design, and they may use less effective models for export systems

Factors Limiting Competitive Weapon Development

Three factors limit competition in the Soviet weapon development process: centralized control, full employment, and organizational specialization. Although Soviet officials are currently calling for increased competition, we do not believe that these factors can be overcome

Centralized Control

The highly bureaucratic Soviet military procurement process has operated smoothly without competition between design bureaus largely because of the Soviet system of centralized control. The Ministry of Defense directs the development and production of military systems, including their incorporation of scientific and technological advances. This ministry also oversees an extensive quality control effort, generally conducted by the teams of military representatives at the R&D and production facilities. In the West, competitive factors would normally work to ensure product quality and integrity. In Soviet military

* According to Soviets at the 1981 Paris Air Show, officials at a design bureau would not want to win a design "competition" if they were already busy on other projects. They believed it would be a "headache" for them to be assigned to a new project, especially because a core of personnel had to be maintained at the bureau throughout the life cycle of every system to resolve any problems.

R&D, the extensive oversight of the acquisition process is an alternative to competition and guarantees the quality of the product.

Full Employment

Employment is considered a basic right of a Soviet citizen, and full employment is a point of pride for the Soviet state. We believe the average worker would strongly resist increased competition in Soviet industry because of the risk of losing his job. Recently, however, some Soviet leaders have admitted that unemployment may be a necessary outgrowth of Gorbachev's restructuring effort.

Organizational Specialization

The GKNT's Role as Leader. Soviet moves toward specialization began in 1966, when a Council of Ministers' decree tasked the State Committee of Science and Technology (GKNT) to determine the main directions of development of science and technology within the civilian sector. The GKNT was given the right to hold competitions to solve the most important scientific and technical problems. At the same time, it curtailed scientific research and experimental design work that was unjustifiably duplicative or without theoretical and practical significance. There is no explicit evidence that the GKNT has the same overall authority within the defense sector. It appears that the VPK is the primary organization responsible for military R&D policy. However, the GKNT has been involved in defense-related matters such as the VPK technology transfer efforts and has also overseen the development of a number of technologies applicable to military programs.

At first glance, it appears that the GKNT was given two contradictory responsibilities—both sponsoring and stifling competition. In actuality, these are two separate roles. For scientific or technical problems that have been recognized as being important and requiring speedy resolution (for example, emerging technology research), the GKNT promotes competitive activities between scientific research institutes. Once the proper research approach has been determined, however, the GKNT helps select the lead institute. Then it takes steps to abolish subsequent NIR or OKR competition. Thus, the GKNT (or perhaps the VPK, operating under the same regulations in military production) has played a significant role in decreasing the amount of competitive development in military R&D—particularly in the later phases.

Streamlining the Organizations. In 1968 the CPSU Central Committee and the USSR Council of Ministers issued a joint resolution "On Measures for Increasing the Efficiency of the Work of Scientific Organizations. . . ." Previously there had been no provision for the precise specialization of scientific and design organizations, and competition among them was poorly developed. The resolution outlined measures for developing wide competition in the scientific and technological fields to resolve the most important problems and for preventing the formation of monopolies. Thus, in the late 1960s, the Soviets laid the foundation for today's NIR competition.

The joint resolution also required the amalgamation of small duplicative organizations and the abolishment of ineffective ones. It thus provided the mandate for organizational specialization during both NIR (once the need for competitive approaches to research has ended) and OKR. Furthermore, the resolution provided for the creation of scientific production associations, that is, the consolidation of existing scientific research institutes or design bureaus and production facilities specializing in a specific type of system or subsystem into one bureaucratic entity. The formation of these associations reduced the number of organizations available to compete during NIR or OKR. [redacted] this consolidation took place in the early 1970s. For example, [redacted] indicated that the Rubin organization of the Ministry of the Shipbuilding Industry was formed when Special Design Bureaus 16, 18, and 143 were combined. These design offices were unified for administrative reasons, and the consolidation did not indicate a change in direction because the work of all three design bureaus was continued by Rubin.

When necessary, the Soviets have created entirely new organizations that specialize in the design or production of new types of systems or subsystems. For

example, [redacted] the Design Bureau for the Development of Integrated Circuits was organized specifically to develop new types of integrated circuits. The Soviet rationale for organizational specialization rather than competitive R&D activities was explained [redacted] as an attempt to concentrate large efforts in a particular field in one institute [redacted] this concentration was based on the philosophy that the internal competition among scientists possessing equal capabilities raises the performance level [redacted]

How Specialization Works. A Soviet book on the aviation industry has elucidated the extent of specialization within organizations involved in OKR.

> Experimental design organizations (OKO) specialize in kinds and types of aircraft, their hardware, equipment, and the most standardized connections. The OKO's principal tasks are to draw up substantiated long-term forecasts of the development of aircraft and aircraft parts based on the OKO's specialization; to create new and modify existing aircraft, engines, equipment and systems; to assure a high level of standardization and unification of items being developed; to study and implement the recommendations of series production enterprises and organizations which maintain aircraft, in the area of improving their design, and so on.

[redacted] there was no competition between his institute, the All-Union Institute of Light Alloys (VILS), and the All-Union Institute of Aviation Materials (VIAM), both of which do research on aviation materials technology. [redacted] the two institutes "have different problems, different tasks, and there's no overlap between them. The tasks are allocated separately, they work on different problems, and they don't compete for budgets

The emphasis on specialization has continued into the 1980s. Increasingly over the past 20 years, R&D and production facilities for Soviet weapon systems have become specialized. To the best of our knowledge, all Soviet design bureaus and industrial scientific research institutes are specialized. This does not mean that one design organization does all of the work in a particular weapon class. Usually, further degrees of specialization exist. Differentiations may be in system size, range, mission, means of mobility, or others.

One effect of organizational specialization is that a particular design bureau, scientific research institute, or production facility may be the only organization (or one of a very limited number) that is set up to do a particular type of work. When only one organization exists in a developmental or production field, it is almost impossible to facilitate competition. The following problems arise:

- Who would compete?
- Would another organization be formed solely to allow for an opposing approach?
- Could a newly formed organization effectively compete without the institutional memory of the original facility?
- Would the first organization be split to provide experienced personnel for the new one?

Moving Toward More Competition in the Civilian Sector

Over the past two years a variety of statements and actions by General Secretary Gorbachev and other Soviet leaders have indicated changes in economic strategy that would eventually increase the level of competition in the civilian sector. These changes could eventually have an impact on the military procurement process.

Soviet leaders have been increasing their emphasis on the need to analyze world achievements in order to surpass them in civilian industry. Although this emphasis on meeting or surpassing world standards has long been in effect for Soviet weapon R&D, it is new to civilian industry. L. N. Zaykov, Politburo member and Central Committee Secretary, has stated: "The task has been set of introducing everywhere systems analysis and the forecasting of world achievements." This need to forecast world achievements can be seen

as an attempt to emulate the operation of the military's weapon procurement process, because system forecasting and foreign system trend analysis are important parts of that process. The need for such an analysis was clarified by General Secretary Gorbachev:

> What is the root cause of our problem with the technological level of our machines? It lies first of all in the fact that until now we did not make a systems analysis of the latest world achievements.

N. I. Ryzhkov, Chairman of the USSR Council of Ministers, quantified the goal:

> The task has been set of ensuring that 80 to 95 percent of the main kinds of output conform to world standards in 1990. We are faced, in the final analysis, with not only reaching them everywhere but surpassing them with regard to many kinds of equipment. (S NF)

A portion of Gorbachev's restructuring effort is the new "USSR Law on the State Enterprise (Association)." The need for more competition is expressed in a number of sections of this law. For example, Article 2 states:

> Economic competition between enterprises plays an increasing role in enterprises' activity ... to satisfy most fully consumer demands for efficient, high-quality, and competitive output for the least possible expenditure. ... The state uses planning and widely applies competitive design and production, financial and credit levers, and prices to ensure the fullest development of economic competition between enterprises, limiting their monopoly position as producers of a certain type of output.

Article 11 directs: "Enterprises, associations, or organizations that have been successful as a result of scientific and technical competitiveness or have won a competition are given priority in material and moral incentives and increase their profit (revenues)."

The law also directs that an enterprise be closed or reorganized if the need for its continued operation has declined or if it has a long record of losses, becomes insolvent, or cannot operate profitably. When an organization is reorganized or closed, its personnel are to receive two months' notice of the change and will continue to receive their wages while looking for other work, but for not more than three months.

The new law on enterprises can be seen as a major step toward increased organizational competition in the Soviet Union. It is too early to tell how strictly the law will be enforced, however. We believe that both the new law and the recent emphasis on domestic development of technological upgrades are Soviet efforts to improve the quality of civilian output rather than to change defense industrial management policies.

Will the Soviets Increase Military-Technical Competition?

Despite these efforts to increase the degree of competition in the civilian sector, we do not believe that the Soviets will increase the extent of competition in their weapon procurement process in the next few years. We judge that the factors that have limited competition in weapon development since the 1960s (centralized control, full employment, and organizational specialization) will remain in effect. The Soviets have developed a procurement process that works well for them, although there has been at least one recent press article questioning the operation and the quality of output of military technology. They are constantly developing weapon systems with incremental improvements over their predecessors, and they are able to maintain specialists in a particular field while producing large quantities of any particular system. Also, according to Trapeznikov, the defense industries currently meet their goals by producing quality products that incorporate advances in technology. Trapeznikov also indicated that the stimulus of competition (meeting or surpassing world standards) is already in effect in the defense industries.

If there is any change in the degree of competitive activity in the weapon acquisition process, it will probably result from the increasing complexity of the

systems. Weapon systems under development today are more expensive and more complex than their predecessors. Higher levels of technology have been incorporated into limited numbers of systems. Partly because of this, some weapons are now designed for multiple missions. As the need for complex, multimission systems grows, there may be a limited amount of competition among the existing design bureaus. One system may potentially replace two or more specialized systems, and supremacy in that system will be at stake. We believe that if such competition occurred, it would probably continue until one organization achieved superiority. Then the remaining design bureaus would move into new areas of hardware development

We believe that any changes in the amount of competition within the Soviet military R&D base will be gradual and difficult to detect. Previously, when the need for an R&D organization diminished, the organization moved into another field. We would expect that, as technologies develop and exotic types of weapon systems become feasible, existing design bureaus would move into the breach

The Soviets appear reasonably satisfied with the status of their military-technical competition. Specialization has been developed to such an extent that it would be very difficult and prohibitively expensive for the Soviets to create a more competitive environment. In addition, the manpower and funding resources of the Soviet Union are not inexhaustible, and there seems to be little reason to change the status quo. At this point, because the defense industries seem to be operating well by Soviet standards, we do not expect them to undergo any major changes. Thus, we believe they will continue to compete with the West as part of their forecasting effort, to compete in the realm of technological advances as part of their military NIR efforts, and to compete to only a limited extent in their OKR developments

Appendix

Development of Military Technologies and Systems in the USSR

Soviet military technologies and weapon systems are the result of a strictly regulated and highly bureaucratic acquisition process in which a large number of organizations take part. Although the ultimate outcome of this cycle is a weapon system, the players involved are not necessarily subordinate to the military or to the defense industrial ministries. Within the USSR, top-priority programs, such as weapon systems, are authorized by joint decrees of the Central Committee and the Council of Ministers. An important aspect of the joint decree is that it can create a program structure that transcends normal bureaucratic boundaries. Any state asset—that is, any individual or organization in the USSR—deemed important to a program can be assigned a role in it, regardless of that asset's formal affiliation. Thus, the major difference between military and civilian acquisition is not the R&D infrastructure, it is the availability of limited resources and the oversight of the development and production process afforded by the Ministry of Defense.

Among the primary organizations involved in military R&D are:

- *The Ministry of Defense.* Develops technology and system forecasts, generates requirements, provides oversight throughout the development cycle (including quality control), and acts as customer.
- *The Military Industrial Commission (VPK) of the Presidium of the Council of Ministers.* Coordinates the work of the nine defense industrial ministries, monitors weapon programs, enforces schedules, and ensures that technical and performance specifications are met.
- *The State Planning Committee (Gosplan).* Develops national economic plans, ensures that plans are integrated throughout the research, development, and industrial hierarchies, and integrates military industrial plans (including R&D) with the national economic plans.
- *The State Committee for Science and Technology (GKNT).* Coordinates scientific and technical activities, especially in priority areas, plans capital investment for science, approves the creation of new research facilities, manages the dissemination of scientific and technical information, and monitors the funds budgeted for science. The GKNT is primarily responsible for civilian R&D, but many of the programs it oversees focus on the development of new technology, materials, and manufacturing processes that can be and are used to help design and produce sophisticated weapons.
- *Institutes of the Academy of Sciences.* Conduct basic research, frequently at the behest of the Ministry of Defense.
- *Institutes of the Ministry of Higher and Specialized Secondary Education.* Train scientists and engineers for civilian and military industry. At times, students and faculty work on specific military R&D projects under contract.
- *Institutes, design bureaus, and production facilities of the nine defense-industrial ministries.* Conduct applied research, system development, and production of major weapon systems and subsystems.
- *Organizations within the civilian industrial ministries.* Conduct applied research, system development, and production of some weapon systems (such as wheeled armored vehicles) and subsystems (such as propellants).