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# TECHNOLOGY TRANSFER AND NATIONAL SECURITY ISSUES
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The transfer of technology from the West to the East has been an issue of serious debate since the introduction of detente in the 1970s. Recent disclosures by the Central Intelligence Agency (CIA) indicate that the Soviet and East European intelligence services have been so successful in acquiring U.S. technology that there now exists a significant threat to the national security of the United States. The CIA speculates that the Soviets and East Europeans will increase their efforts for legal and illegal acquisition of U.S. technology in several areas:

o Computers -- systems designs, concepts, hardware and software

o Microelectronics -- complete industrial processes and equipment for Soviet military requirements

o Lasers -- optical, pulsed power and other laser-related components for laser weapons

o Radars -- air defense radars for missile systems

The Reagan Administration has proposed a package of countermeasures to curtail the flow of military-related technology. This includes: strengthening U.S. export controls, increasing efforts against foreign industrial espionage, expanding the list of "military critical technologies" which should not be exported, and influencing the academic community to reduce Soviet access to U.S. research through the free exchange of information.

This Info Pack provides unclassified, background information and analysis of the politico-military impact of technology transfers on the United States and the NATO allies. It contains proposals by the Reagan Administration to redress the problems posed to the national security by the loss of U.S. technology to the Soviet Union.

Congressional Reference
Division

# Soviet Acquisition of Western Technology

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# Soviet Acquisition of Western Technology

### Introduction

The United States and its Allies traditionally have relied on the technological superiority of their weapons to preserve a credible counterforce to the quantitative superiority of the Warsaw Pact. But that technical superiority is eroding as the Soviet Union and its Allies introduce more and more sophisticated weaponry—weapons that all too often are manufactured with the direct help of Western technology.[1] Stopping the Soviets' extensive acquisition of military-related Western technology—in ways that are both effective and appropriate in our open society—is one of the most complex and urgent issues facing the Free World today.

This report describes the Soviet program to acquire US and Western technology, the acquisition mechanisms used, the spectrum of Western acquisitions that have contributed to Soviet military might, the projected Soviet priority needs for Western technology, and the problems of effectively stemming the transfer of Western technology that could someday find application in weapons used to threaten the West.

### Soviet Acquisition of Western Technology: A National-Level Program

Since at least the 1930s, the Soviet Union has devoted vast amounts of its financial and manpower resources to the acquisition of Western technology that would enhance its military power and improve the efficiency of its military manufacturing technology. Today this Soviet effort is massive, well planned, and well managed—a national-level program approved at the highest party and governmental levels.

[1] While there are numerous interpretations of "technology" for weapons, it is defined in this report as the application of scientific knowledge, technical information, know-how, critical materials, keystone manufacturing and test equipment, and end products which are essential to the research and development as well as the series manufacture of modern high-quality weapons and military equipment. Western technology is defined as that technology developed by the Free World.

This program accords top priority to the military and military-related industry, and major attention is also given to the civilian sectors of Soviet industry that support military production.

The Soviets and their Warsaw Pact allies have obtained vast amounts of militarily significant Western technology and equipment through legal and illegal means. They have succeeded in acquiring the most advanced Western technology by using, in part, their scientific and technological agreements with the West to facilitate access to the new technologies that are emerging from the Free World's applied scientific research efforts; by spending their scarce hard currency to illegally purchase controlled equipment, as well as to legally purchase uncontrolled advanced Western technologies having military-industrial applications; and by tasking their intelligence services to acquire illegally those US and Western technologies that are classified and export controlled.

The Soviets have been very successful in acquiring Western technology by blending acquisitions legally and illegally acquired by different government organizations. The Soviet intelligence services—the Soviet Committee for State Security (KGB) and the Chief Intelligence Directorate of the Soviet General Staff (GRU)—have the primary responsibility for collecting Western classified, export-controlled, and proprietary technology, using both clandestine and overt collection methods. They in turn make extensive use of many of the East European Intelligence Services (see inset, p. 2); for their efforts in acquiring Western technology, these countries are paid in part with Soviet military equipment and weapons.

Clandestine acquisition of the West's most advanced military-related equipment and know-how by the KGB and GRU is a major and growing problem.

*East European Intelligence Services Acquire Technologies for the Soviet Union*

*In the late 1970s a former East European intelligence officer revealed organizational and targeting details related to Soviet-directed acquisitions of Western technology by East European intelligence services, particularly military-industrial manufacturing-related technologies that were given the highest priority for collection by at least one East European intelligence service. Many technologies were acquired through dummy firms established in Western Europe that were successful in securing some of the most advanced technologies in the West, including computer, microelectronic, nuclear, and chemical technologies.*

*In microelectronics, for example, many US firms were targeted through their affiliates in Western Europe; scientists, technicians, and commercial representatives also were successfully recruited to provide information during their trips to Europe. Although most of the military and defense-industrial information acquired by East European intelligence services went to the Soviets, much of it was used by the East Europeans themselves to benefit their military and civilian industries. The computer, microelectronic, and photographic areas were priority targets. The East European countries benefited considerably from microelectronic acquisitions, and could not have achieved the present level of development in their computer industry without illegal acquisitions of Western technology.*

These intelligence organizations have been so successful at acquiring Western technology that the manpower levels they allocate to this effort have increased significantly since the 1970s to the point where there are now several thousand technology collection officers at work. These personnel, under various covers ranging from diplomats to journalists to trade officials, are assigned throughout the world.

Soviet foreign trade organizations, or enterprises, although quasi-independent entities, are partially subordinated to the Ministry of Foreign Trade, and their activities are closely coordinated by this Ministry. They have major responsibilities for both legal and illegal acquisitions and purchases; they work closely with the KGB and GRU in arranging trade diversions. East European trade companies assist them in clandestine and illegal acquisition operations.

Official Soviet and East European science and technology (S&T) organizations also play a major role in both open and clandestine acquisition of Western technology. The Soviet State Committee for Science and Technology (GKNT) is the key player in arranging government-to-government science and technology agreements to facilitate access to and the acquisition of established as well as new technologies, including those just emerging from Western universities, laboratories, and high-technology firms. It is the GKNT that oversees the allocation of scarce Soviet hard currency for the legal purchase by various Soviet organizations of selected Western technology for Soviet military purposes. If the GKNT is unable to acquire the necessary technology by open or legal means, it tasks Soviet intelligence to clandestinely acquire the technology.

It is the well-organized and well-coordinated use of all these organizations that has made the Soviet program to acquire Western technology so successful. As a result, the Soviets have acquired militarily significant technologies and critically important industrial Western technologies that have benefited every major Soviet industry engaged in the research, development, and production of weapon systems.

**Soviet Mechanisms for Acquiring Western Technology**

Soviet acquisition mechanisms include: *legal means* through open literature, through legal trade channels, and through student scientific and technological exchanges and conferences; *illegal means* through trade channels that evade US and Western (i.e. CoCom)[2] export controls, including acquisitions by their intelligence services through recruited agents and industrial

[2] The Coordinating Committee (CoCom) was established in 1949 to serve as the forum for Western efforts to develop a system of strategic export controls. It is composed of the United States, the United Kingdom, Turkey, Portugal, Norway, the Netherlands, Luxembourg, Japan, Italy, Greece, France, the Federal Republic of Germany, Denmark, Canada, and Belgium.

espionage. While a large volume of technology is acquired by nonintelligence personnel, the overwhelming majority of what the United States considers to be militarily significant technology acquired by and for the Soviets was obtained by the Soviet intelligence services and their surrogates among the East European intelligence services. However, legal acquisitions by other Soviet organizations are important since it is often the combination of legally and illegally acquired technologies that gives the Soviets the complete military or industrial capability they need.

Because of the priority accorded to the military over the civilian sectors of the Soviet economy, Western dual-use technology—i.e., technology with both military and civilian applications—almost always finds its way first into military industries, and subsequently into the civilian sectors of industries that support military production. Thus, Soviet assurances that legally purchased dual-use technology will be used solely for civilian applications can seldom be accepted at face value.

Legal acquisitions generally have their greatest impact on the Soviets' broad industrial base, and thus affect military technology on a relatively long-term basis. The Soviet Kama Truck Plant, for example, was built over some seven years with massive imports of more than $1.5 billion worth of US and West European automotive production equipment and technology. Large numbers of military-specification trucks produced there in 1981 are now being used by Soviet forces in Afghanistan and by Soviet military units in Eastern Europe opposite NATO forces. Similarly, large Soviet purchases of printed circuit board technology and numerically controlled machine tools from the West already have benefited military manufacturing sectors.

The Soviets give priority to those purchases that meet the direct needs of the Soviet military-industrial complex by paying for them in hard currency. Over the past 10 years, the Soviets legally and illegally purchased large quantities of Western high-technology microelectronics equipment that has enabled them to build their own military microelectronics industry in a short time. This acquired capability in microelectronics is the critical basis for the present wide-ranging enhancements of Soviet military systems and for their continuing sophistication.

Acquisitions through illegal trade channels often have both industrial and military applications, and thus are important in the near term. Illegal acquisitions of technology fall into two general categories, both of which are extremely difficult to detect and monitor. One is the diversion of controlled technology from legitimate trade channels to proscribed destinations. This is done through US and foreign firms that are willing to engage in profitable impropriety; through agents-in-place in US or foreign firms or foreign subsidiaries of US firms; through Soviet- and East European—owned firms locally chartered in the West; and through foreign purchasing agents (including arms dealers). For instance, to evade the US embargo on microelectronic technology exports to the Soviet Union, the Soviets and their surrogates have set up dummy corporations in the West that purchase sophisticated microelectronics manufacturing equipment. This equipment is then shipped and reshipped, sometimes with the knowledge of individuals in the companies, to disguise its ultimate destination—the Soviet Union or Eastern Europe. Both the Soviet and Warsaw Pact intelligence services are in the mainstream of this illegal technology trade flow. The other type of diversion is an in-place diversion, in which legally acquired technology and equipment—in the computer area, for example—are put to military end uses not authorized in export license applications.

The acquisitions that most directly affect Soviet military development have come from intelligence collection and related illegal trade diversions. Soviet Bloc intelligence services have concentrated their effort in the United States, Western Europe, and Japan. These services target defense contractors and high-technology firms working on advanced technology (both classified and unclassified), foreign firms and subsidiaries of US firms abroad, and international organizations with access to advanced and/or proprietary technology, including access to computer data base networks throughout the world.

**Table 1**

**Major Fields of Technology of Interest to Soviet and East European Visitors to the United States**

| | | |
|---|---|---|
| **Computers** | Architecture<br>Automatic Control<br>CAD (Computer-Aided Design)<br>Cybernetics/Artificial Intelligence<br>Data Bases<br>Image Processing Design<br>Image Processing/Retrieval | Memories<br>N/C (Numerically Controlled) Units<br>Networks<br>Pattern Recognition<br>Programming<br>Robots<br>Software |
| **Materials** | Amorphous<br>CAD<br>Composites<br>Cryogenics<br>Deformation | Metallurgy<br>N/C Machine Tools<br>Powder Metals<br>Superconductors<br>Testing/NDT (Non-Destructive) |
| **Semiconductors** | CAD<br>Circuits<br>Defects<br>Devices | Design<br>Ion Implantation<br>Production Technology<br>SAW (Surface Acoustic Wave) Devices |
| **Communications, Navigation, and Control** | Antennas<br>Microwave/Millimeter Waves<br>Radio Wave Propagation | Satellite Communications<br>Signal Processing<br>Telecommunications |
| **Vehicular/Transportation** | Marine Systems | Shipbuilding |
| **Laser and Optics** | Fiber Optics<br>Gas Lasers | Optics<br>Tunable Lasers |
| **Nuclear Physics** | Cryogenics<br>Fusion<br>Materials<br>MHD (Magnetohydrodynamics) | Reactors<br>Structural Designs<br>Superconductors |
| **Microbiology** | Genetic Engineering | |

Both legal and illegal acquisitions of US and Western technology and equipment are coordinated with information obtained through the complex network of international governmental scientific and technical agreements and exchanges that the USSR maintains with the advanced industrial nations. These include know-how, equipment, and computer data base collection activities of Soviet scientists and engineers who participate in academic, commercial, and official S&T exchanges. Visiting Soviet and East European technical and student delegations to the United States generally consist of expert scientists, many of whom are connected with classified work in their home countries. Such was the case with the Soviet scientist who managed to get assigned to fuel-air explosives work. When he finished his US study programs, he almost certainly returned to the USSR to work on related weapons. Other Soviet and East European scientists have come to the United States to work in the aerohydrodynamic, cryogenic, optic, laser, computer, magnetic bubble computer memory, nuclear, microelectronic, and structural and electronic material areas. Given the military importance of these fields to the Soviet Union, it appears likely that a high percentage of these scientists will work on military-related programs in these areas after they return home.

From the beginning, Soviet candidates in various academic and scientific exchange programs have nearly always proposed research activities involving technologies in areas that have direct military applications and in which the Soviets are technologically deficient. Table 1 provides a list of the key high-technology fields that Soviet and East European visitors come to the United States to study, research, or discuss, many of which are on the US Militarily Critical Technology List today. In each of the past two years, more than a third of the 50 program proposals offered under the Graduate Student/Young Faculty Program of the International Research and Exchanges Board (IREX) has been completely unacceptable in terms of prospective technology loss, and many other programs needed to be modified or have access constrained before the exchanges could be allowed.

The Soviets correctly view the United States and several other Western countries as a continuing source of important and openly available scientific and technical information, which they take every opportunity to obtain access to. Some of the unclassified documents so acquired are previously classified materials which had been downgraded to unclassified through US procedures providing for automatic declassification after a stipulated period. When collected on a massive scale and centrally processed by the Soviets, this information becomes significant because it is collectively used by Soviet weapons designers and weapons countermeasure experts.

The Soviets also regularly attend high-technology trade shows, and attempt to visit commercial firms in the West, particularly small and medium-sized firms that are active in developing new technologies. These apparent trade promotion efforts often mask Soviet attempts to acquire emerging Western technological know-how before its military uses have been identified and government security controls have been applied. Emerging technologies are particularly vulnerable to foreign collection efforts of this type.

Soviet intelligence continues to place a high priority on the collection of S&T information on genetic engineering and futuristic weapons such as lasers and particle beam weapons. The Soviets have been stepping up their efforts to acquire new and emerging technologies such as very-high-speed integrated-circuit (VHSIC) and very-large-scale integration (VLSI) technology from Western universities and commercial laboratories for both military and commercial applications.

Over the past few years there has been an increased use of Soviet- and East European–owned firms locally chartered in the United States and abroad to exploit Western-controlled and military-related technology. There are more than twenty Soviet- and East European–owned firms in the United States, and near the end of the 1970s there were more than 300 similar firms in Western Europe. In addition to the United States, heavy concentrations are in the United Kingdom, Sweden, the Netherlands, Italy, the Federal Republic of Germany, France, Canada, Belgium, and Austria. These firms are avenues for Soviet acquisition of advanced Western technologies, as was shown when the US engineer arrested in late 1981 was charged with selling US secret documents to an East European intelligence officer employed by a Polish-owned firm chartered in Illinois (see inset, p. 6). Furthermore, firms chartered in the United States can legally purchase controlled US technology and study it without actually violating US export controls unless they attempt to export the equipment or related technical data from the United States without a license.

**Soviet Acquisitions and Benefits**

Today's recognition of the crucial role of Western technology in the development and production of Soviet weapon systems and related military equipment is not unique. Soviet dependence on Western technology was visible and clear-cut in the years immediately after World War II, when the Soviets stole Western nuclear secrets leading to their development of a nuclear weapon capability, and copied a US bomber in its entirety leading to production of their TU-4. To achieve major improvements in their military capability quickly, they exploited captured scientists and industrial plants and resorted to a combination of espionage, stealing, and copying Western systems.

Since that early period of near-complete reliance in the 1950s, the Soviets' dependence on Western technology to develop their weapons has decreased. Nevertheless, despite several decades of Soviet priorities focused on science, technology, and weapon systems, the Soviets, because of their inability to be innovative

*US Radar Expert Passes Over 20 Significant Classified Reports on Future US Weapon Systems to Intelligence Agent*

*William H. Bell, a radar project engineer for a high-technology US defense firm was recruited by an intelligence officer who operated under cover as a vice president of the Polish firm called Polamco. This firm is a subsidiary of the Polish Government Corporation and is incorporated in Illinois and Delaware. It began as an importer/exporter of machinery, parts and tools and as a consultant to firms exporting these products to Poland. The recruitment began as a simple friendship between neighbors with mutual sporting interests, grew quickly to include their families, then to proving Bell's credentials by showing a classified document to the agent, and then to passing microfilm copies of classified reports at meeting places in the US, Switzerland, and Austria. Mr. Bell was in financial straits and was easily influenced by the cash proffered—a total of $110,000 over a three-year period. In all, over 20 highly classified reports on advanced future US weapon systems or their components were passed to the Polish Intelligence Service and probably eventually to the Soviet Intelligence Service.*

*Among the classified reports, those of prime importance to the West included: the F-15 look-down-shoot-down radar system, the quiet radar system for the B1 and Stealth bombers, an all-weather radar system for tanks, an experimental radar system for the US Navy, the Phoenix air-to-air missile, a shipborne surveillance radar, the Patriot surface-to-air missile, a towed-array submarine sonar system, a new air-to-air missile, the improved HAWK surface-to-air missile, and a NATO air-defense system. The information in these documents put in jeopardy existing weapons and advanced future weapon systems of the United States and its Allies. The acquisition of this information will save the Polish and Soviet Governments hundreds of millions of dollars in R&D efforts by permitting them to implement proven designs developed by the United States and by fielding operational counterpart systems in a much shorter time period. Specifications on current and future US weapon systems will enable them to develop defensive countermeasure systems.*

and effectively apply new technology to weapons developments, still depend on Western technology and equipment to develop and manufacture some of their advanced weapon systems more quickly.

Today, Soviet military designers carefully choose the Western designs, engineering approaches, and equipment most appropriate to their deficiencies and needs. These needs are still substantial and pervade almost every area of weapons technology and related manufacturing equipment. Table 2 lists classes of Western technology acquired by the Soviets and East Europeans and illustrates the wide range of Soviet military technology needs. In the following paragraphs of this section, Soviet Bloc acquisitions have been grouped according to their likely applications: strategic systems, aircraft systems, naval systems, and tactical systems. Also cited are acquisitions in the microelectronic and computer areas that have broad application to military and industrial programs. In certain of these areas, notably the development of microelectronics, the Soviets would have been incapable of achieving their present technical level without the acquisition of Western technology. In other areas, acquisitions have allowed the Soviets to reduce the indigenous effort they would otherwise have had to expend.

The Soviets' strategic weapons program has benefited substantially from the acquisition of Western technology. The striking similarities between the US Minuteman silo and the Soviet SS-13 silo very likely resulted from acquisition of US documents and expedited deployment of this, the first Soviet solid-propellant ICBM. The Soviets' ballistic missile systems in particular have, over the past decade, demonstrated qualitative improvements that probably would not have been achieved without Western acquisitions of ballistic missile guidance and control technology. The most striking example of this is the marked improvement in accuracy of the latest generation of Soviet ICBMs—an improvement which, given the level of relevant Soviet technologies a decade ago, appears almost certainly to have been speeded by the acquisition of Western technology. Their improved accuracy has been achieved through the exploitation and development of good-quality guidance components—such

Table 2

**Selected Soviet and East European Legal and Illegal Acquisitions From the West Affecting Key Areas of Soviet Military Technology**

| Key Technology Area | Notable Success |
|---|---|
| Computers | Purchases and acquisitions of complete systems designs, concepts, hardware and software, including a wide variety of Western general purpose computers and minicomputers, for military applications. |
| Microelectronics | Complete industrial processes and semiconductor manufacturing equipment capable of meeting all Soviet military requirements, if acquisitions were combined. |
| Signal Processing | Acquisitions of processing equipment and know-how. |
| Manufacturing | Acquisitions of automated and precision manufacturing equipment for electronics, materials, and optical and future laser weapons technology; acquisition of information on manufacturing technology related to weapons, ammunition, and aircraft parts including turbine blades, computers, and electronic components; acquisition of machine tools for cutting large gears for ship propulsion systems. |
| Communications | Acquisitions of low-power, low-noise, high-sensitivity receivers. |
| Lasers | Acquisitions of optical, pulsed power source, and other laser-related components, including special optical mirrors and mirror technology suitable for future laser weapons. |
| Guidance and Navigation | Acquisitions of marine and other navigation receivers, advanced inertial-guidance components, including miniature and laser gyros; acquisitions of missile guidance subsystems; acquisitions of precision machinery for ball bearing production for missile and other applications; acquisition of missile test range instrumentation systems and documentation and precision cinetheodolites for collecting data critical to postflight ballistic missile analysis. |
| Structural Materials | Purchases and acquisitions of Western titanium alloys, welding equipment, and furnaces for producing titanium plate of large size applicable to submarine construction. |
| Propulsion | Missile technology; some ground propulsion technology (diesels, turbines, and rotaries); purchases and acquisitions of advanced jet engine fabrication technology and jet engine design information. |
| Acoustical Sensors | Acquisitions of underwater navigation and direction-finding equipment. |
| Electro-optical Sensors | Acquisition of information on satellite technology, laser rangefinders, and underwater low-light-level television cameras and systems for remote operation. |
| Radars | Acquisitions and exploitations of air defense radars and antenna designs for missile systems. |

as gyroscopes and accelerometers. The quality of these instruments, in turn, depends to a considerable degree on the quality of the small, precision, high-speed bearings used.

Through the 1950s and into the 1960s, the Soviet precision bearing industry lagged significantly behind that of the West. However, through legal trade purchases in the 1970s, the Soviet Union acquired US precision grinding machines for the production of small, high-precision bearings. Similar grinding machines, having lower production-rate capabilities, were available from several foreign countries. Only a few of these machines, either US or foreign, would have been sufficient to supply Soviet missile designers with all the quality bearings they needed. These purchases provided the Soviets with the capability to manufacture precision bearings in large volume sooner than would have been likely through indigenous development. The Soviets probably could have used indigenous grinding machines and produced the required quality of bearings over a long period by having an abnormally high rejection rate.

While some of the Soviet acquisition in the aircraft area appears directed toward the development of countermeasures against Western systems, the Soviets appear to target data on Western aircraft primarily to acquire the technology. Furthermore, while the Soviets have acquired a large amount of hardware and data from planes downed or captured in Vietnam and elsewhere, they continue to attempt to acquire the most advanced technologies through both legal and illegal transactions with the West. Assimilation of

Western technology has been of great benefit to both their military and commercial aircraft development programs—to the extent that aircraft from certain Soviet military design bureaus are to a significant degree copies of aircraft of Western design. Soviet military aircraft designers have "ordered" documents on Western aircraft and gotten them within a few months, including plans and drawings for the US C-5A giant transport aircraft early in its development cycle; these plans, although dated now, have contributed to current Soviet development of a new strategic military cargo plane. Designers were in particular need of data on US technological advances, but more importantly, they needed information on aerospace manufacturing techniques.

Soviet aircraft designers have been interested in US military transports and wide-body jets and probably have managed to accelerate the development programs for their IL-76 Candid and IL-86 transports. The IL-86 looks much like the Boeing 747 and the IL-76 resembles the C-141. Neither system is an identical copy.

The IL-76 also is used by the Soviets as the platform for their new AWACS (Airborne Warning And Control System), which is expected to be operational in the mid-1980s. This system will provide the Soviets with a major improvement in attacking low-flying missiles and bombers. The Soviet AWACS is strikingly similar in many ways to the US AWACS, and is a major improvement over their old AWACS.

The Soviets' acquisition effort in the naval systems area reflects well the two major factors that motivate their requirements: the acquisition of technology not readily available to them—yet critical to their programs—and the acquisition of equipment which, while producible in the Soviet Union, allows them to divert resources to more pressing naval programs. The Soviets appear to have concentrated their acquisitions in areas related to aircraft carriers, deep sea diving capabilities, sensor systems for antisubmarine warfare and navigation, and ship maintenance facilities. In the maintenance area, two huge floating drydocks purchased from the West for civilian use by the Soviets have been diverted to military use. Drydocks are critical for both routine and fast repair of ships damaged in warfare. In 1978, when the Soviets took possession of one of the drydocks, they diverted it to the Pacific Naval Fleet. The other was sent to the Northern Fleet in 1981.

These drydocks are so large that they can carry several naval ships. More importantly, they are the only drydock facilities in either of the two major Soviet fleet areas—Northern or Pacific—capable of servicing the new Kiev-class V/STOL aircraft carriers. Soviet advanced submarines carrying ballistic missiles, Soviet Kiev aircraft carriers, and Soviet destroyers were among the first ships repaired in these drydocks. It is important to note that the drydocks themselves are so large that no Soviet shipyard would have been capable of accommodating their construction without major facility modifications, associated capital expenditures, and interruptions in present weapons programs. Their importance will be even more pronounced when the Soviets construct the still-larger carriers (for high-performance aircraft) projected for the 1990s. The Soviets even have acquired Western aircraft carrier catapult equipment and documentation for this larger carrier; catapult technology, though relatively common in the West, is outside the Soviet experience.

Within the past few years, the USSR also has contracted for or purchased foreign-built oceanographic survey ships equipped with some of the most modern Western-manufactured equipment. In place of US equipment that was embargoed, other Western equipment has been installed on the ships. This modernization of what is the world's largest oceanographic fleet with Western technology will help support the development of Soviet weapon system programs and antisubmarine systems against the West.

Although the Soviets have a strong indigenous technology base that could support the development of much of their tactical weapons systems, this does not prevent them from maintaining an ambitious program for acquiring and benefiting from Western technology in this area. In some cases, their acquisitions satisfy deficiencies in Soviet technology; smart weapons technology and electro-optical technology are examples of

Table 3

**Microelectronic Equipment and Technology Legally and Illegally Acquired by the Soviet Bloc**

| Equipment or Technology | Comments |
|---|---|
| Process Technology for Microelectronic Wafer Preparation | The Soviets have acquired hundreds of specific pieces of equipment related to wafer preparation, including expitaxial growth furnaces, crystal pullers, rinsers/dryers, slicers, and lapping and polishing units. |
| Process Technology for Producing Circuit Masks | Many acquisitions in this area include computer-aided design software, pattern generators and compilers, digital plotters, photorepeaters, contact printers, mask comparators, electron-beam generators, and ion milling equipment. |
| Equipment for Device Fabrication | Many hundreds of acquisitions in this area have provided the Soviets with mask aligners, diffusion furnaces, ion implanters, coaters, etchers, and photochemical process lines. |
| Assembly and Test Equipment | Hundreds of items of Western equipment, including scribers, bonders, probe testers, and final test equipment have been acquired by the Soviets. |

this. Signal and information-processing technology, particularly for Soviet air defense systems, is another. More often, however, technology is exploited to speed up a developmental program or to improve upon original Western designs in an expeditious manner. The Soviets appear to have concentrated their tactical systems acquisitions on Western tank, antitank, and air defense-related technology and equipment in order to derive concepts and know-how to benefit their weapons programs and to design countermeasures to the Western systems. The Soviet SA-7 heat-seeking, shoulder-fired antiaircraft missile contains many features of the US Redeye missile. Such acquisitions have enabled the Soviets to obtain advanced tactical weapon capabilities sooner than otherwise would have been possible.

Western equipment and technology have played a very important, if not crucial, role in the advancement of Soviet microelectronic production capabilities. This advancement comes as a result of over 10 years of successful acquisitions—through illegal, including clandestine, means—of hundreds of pieces of Western microelectronic equipment worth hundreds of millions of dollars to equip their military-related manufacturing facilities. These acquisitions have permitted the Soviets to systematically build a modern microelectronics industry which will be the critical basis for enhancing the sophistication of future Soviet military systems for decades. The acquired equipment and know-how, if combined, could meet 100 percent of the Soviets' high-quality microelectronic needs for military purposes, or 50 percent of all their microelectronic needs.

Table 3 identifies the microelectronic production-related equipment that has been acquired by the Soviet Bloc. These acquisitions have been grouped into areas related to the four steps required to produce a microchip: wafer preparation, circuit-mask making, device fabrication, and assembly and testing.

Soviet computer technology has long been limited by fabrication and production technology problems and by difficulties in software development. Since 1969 the USSR and East European countries have been developing a family of general purpose computers known as the Ryad series. These computers, which make up virtually the total Soviet and East European effort in large general purpose computers, have been and will continue to be used in a wide variety of civil and military applications. Western technology has been important to development of the Ryad series by providing proven design directions both at the system and component levels. The architectural designs of the

Ryad computers, for example, are patterned after those of the highly successful mass produced IBM 360 and 370 series, computers that are used in a wide range of applications and are highly serviceable in the field.

With this approach, the Soviets and East Europeans eliminated many of the risks involved in undertaking the development and production of a new series of general purpose computers, and saved considerable amounts of manpower and time. Since the early 1970s the Soviets and East Europeans have legally purchased more than 3,000 minicomputers, some of which are now being used in military-related organizations. Furthermore, they are also developing minicomputers that are direct copies of Western models. Soviet and East European development of computer systems has been aided by all available means—legal and illegal, including clandestine—for acquiring the needed technical know-how.

Thus, the Soviets and their Warsaw Pact allies have derived significant military gains from their acquisitions of Western technology, particularly in the strategic, aircraft, naval, tactical, microelectronics, and computer areas. This multifaceted Soviet acquisitions program has allowed the Soviets to:

- Save hundreds of millions of dollars in R&D costs, and years in R&D development lead time (see inset).
- Modernize critical sectors of their military industry and reduce engineering risks by following or copying proven Western designs, thereby limiting the rise in their military production costs.
- Achieve greater weapons performance than if they had to rely solely on their own technology.
- Incorporate countermeasures to Western weapons early in the development of their own weapon programs.

These gains are evident in all areas of military weapons systems. While difficult to quantify, it is clear that the Western military expenditures needed to overcome or defend against the military capabilities derived by the acquisition of Western technology far outweigh the West's earnings from the legal sales to the Soviets of its equipment and technology.

*Soviet Intelligence Officer Reveals Technology Acquisition Saved Soviet Military Hundreds of Millions of Rubles*

*A former Soviet intelligence officer revealed that information on Western military-related technology acquired by the Soviet intelligence services saved the Soviet military industry hundreds of millions of rubles. The acquisition of Western technology operationally was assigned the highest priority for collection by local residencies in key West European countries because of the relatively easy access to much US and Western technology in Europe and the praise being received by the services for their acquisition efforts.*

*These acquisitions were directed by the military manufacturing industries under the Council of Ministers, and there was intense competition between the intelligence services to acquire Western technology needed for weapons development programs. Of particular need by Soviet weapons designers has been the acquisition of knowledge on special materials, notably the weaving of carbon filaments in a three dimensional configuration which the services were tasked to acquire. The end products from this 3-D carbon-carbon weaving technology are useful for ablative heat shields for high velocity reentry vehicles (the warhead part of ICBMs and SLBMs) and for other portions of rocket motors for large missiles. The Soviet acquisition of some of this technology is likely to enable them to eventually gain a capability for increased military options against the West—a capability that otherwise would have taken them several additional years to develop themselves. The intelligence services also worked closely with scientists from the Soviet military manufacturing industries and even planned joint operations against Western Trade and Equipment Fairs in order to acquire needed Western technology.*

**Outlook for the 1980s**

The Soviets' military R&D and weapon test-and-evaluation efforts are continuing at a rapid pace. Several hundred development projects for weapons systems and major system elements are now under way, and it is expected that through the 1980s the number of new or modified advanced Soviet weapon systems emerging from these projects into production and deployment will remain at the high levels of the last two decades—some 200 weapon systems per decade.

Soviet military manufacturing capacity increased by a significant 80 percent during the 1960s and 1970s, and new plant expansion now under way at one-fourth of their key weapons manufacturing facilities will add considerably to their capabilities. These new facilities will be ready to produce weapons in the next four to 10 years. Plant expansion is in the following areas: ground warfare vehicles, including new tanks; aviation, including facilities for a new B-1-type bomber and a new long-range military transport aircraft having strategic airlift capabilities; naval shipbuilding, including submarines for ballistic missiles and cruise missiles, as well as full-size aircraft carriers for high-performance aircraft capable of competing with the United States in global operations; and electronic and microelectronic manufacturing facilities throughout the USSR. The development and production of new Soviet weapons at these facilities is sure to be more complex and costly than during the 1970s.

All of this military development and plant expansion activity, however, is taking place at a time when the Soviet economy has reached its lowest level of growth since World War II. Soviet annual GNP growth may well be limited to an average of 1 to 2 percent by the mid-1980s. Stagnation in industrial sectors that are key to both the civilian and the military sectors will make it increasingly difficult for the Soviets to satisfy the needs of both. Thus, Soviet leaders will have to make tough choices among defense, investment, and consumption; the competition among rival claimants for resources will become intense. Under these conditions, it may be impossible for the Soviets to maintain current growth in military production without hurting the civilian economy.

Despite these economic difficulties, there are no signs that the Soviets are shifting resources away from the military sector or slowing down development of weapon systems that will be entering the production stage by mid-decade. New generations of Warsaw Pact weapons will require selected critical component and modern manufacturing technologies. It is in these areas that Soviet illegal acquisitions of Western technology, complemented by legal acquisitions, are more likely to be concentrated over the next five to 10 years.

Among the more important technologies are microelectronics, computers, and signal processing. Microelectronics will play a very significant role in advances in computers and signal processing, and all of these technologies will be important in developing advanced Soviet missile, aircraft, naval, and tactical weapon systems, and associated detection systems. Additional projected Soviet technological needs related to such systems are presented in the appendix.

As the result of both tactical and strategic force modernizations, Soviet and Warsaw Pact military manufacturers are increasingly pressed by large-scale production requirements and the related need to control manufacturing and materials costs. Thus, particularly critical for the 1980s are Soviet needs to improve their manufacturing capability. To a large extent, the level of manufacturing technology in Soviet plants determines the Soviets' capability to move new technology from R&D into military application. Manufacturing technologies play a significant role not only in the development of advanced component technologies, such as microelectronics and computers, but also in the actual production of modern military systems.

Future Soviet and Warsaw Pact acquisition efforts—including acquisitions by their intelligence services—are likely to concentrate on the sources of such component and manufacturing technologies, including:

- Defense contractors in the United States, Western Europe, and Japan who are the repositories of military development and manufacturing technologies.

- General producers of military-related auxiliary manufacturing equipment in the United States, Western Europe, and Japan.

- Small and medium-size firms and research centers that develop advanced component technology and designs, including advanced civil technologies with future military applications.

The combination of past Soviet acquisition practices and projected Soviet military needs indicates that the United States and its Allies are likely to experience serious counterintelligence and related industrial security and export control problems over the next five to 10 years.

The task of stopping Soviet Bloc intelligence operations aimed at Western military and industrial technologies already poses a formidable counterintelligence problem, both in the United States and abroad. But that task is likely to become even more difficult in the future as several trends identified in the 1970s continue into the 1980s:

- First, since the early 1970s, the Soviets and their surrogates among the East Europeans have been increasingly using their national intelligence services to acquire Western civilian technologies—for example, automobile, energy, chemicals, and even consumer electronics.

- Second, since the mid-1970s, Soviet and East European intelligence services have been emphasizing the collection of manufacturing-related technology, in addition to weapons technology.

- Third, since the late 1970s, there has been increased emphasis by these intelligence services on the acquisition of new Western technologies emerging from universities and research centers.

The combined effect of these trends is a heavy focus by Soviet Bloc intelligence on the commercial sectors in the West—sectors that are not normally protected from hostile intelligence services. In addition, the security provided by commercial firms is no match for the human penetration operations of such foreign intelligence services. But the most alarming aspect of this commercial focus by Soviet Bloc intelligence services is that as a result of these operations the Soviets have gained, and continue to gain, access to those advanced technologies that are likely to be used by the West in its own future weapons systems.

The Soviet intelligence effort against Western defense contractor firms poses a serious problem in itself. With more than 11,000 such firms in the United States and hundreds of subsidiaries abroad, US counterintelligence efforts are stretched thin. Protection of US firms abroad from hostile intelligence threats is the responsibility of host governments, but they too are feeling the burden of well-orchestrated Soviet Bloc efforts. The Soviet intelligence threat and the illegal trade problem appear to be severe in Japan. It appears that Western industrial security—both defense and commercial—will be severely tested by the Soviet intelligence services and their surrogates among the East European intelligence services during the 1980s.

Western industrial nations also can expect increased Soviet Bloc intelligence activities directed at the acquisition of their key industrial technologies. Western export controls are presently being updated and broadened; the CoCom allies have recently agreed to strengthen controls and to enhance their enforcement. Moreover, serious hard currency shortages, along with generally increased restrictions on Soviet S&T visitors to the United States, will make the Soviets even more dependent on intelligence and other illegal efforts to acquire the goods and equipment they will need.

The massive, well-planned, and well-coordinated Soviet program to acquire Western technology through combined legal and illegal means poses a serious and growing threat to the mutual security interests of the United States and its Allies. In response, the West will need to organize more effectively than it has in the past to protect its military, industrial, commercial, and scientific communities.

# Appendix

## Projected Soviet Technological Needs and Acquisition Targets Through the 1980s

Given the dynamic nature of their collection program, it is expected that the Soviets will continue their attempts to acquire a broad range of Western technologies. Certain areas, however, represent priority collection targets for them; these areas are critical to the Soviets' enhancement of their weapons capability.

Over the past decade, the Soviets' most pronounced improvements in strategic weaponry have been in the development of a MIRV ballistic missile capability and a significant improvement in the accuracy of their ICBMs. The former capability was made possible largely through the introduction of onboard digital computers and the latter through the improvement in the quality of the missile guidance systems and the procedures used to calibrate them. Technology acquisitions from the West contributed significantly to these improved capabilities.

The Soviets probably will continue to make their highest priority the acquisition of Western microelectronics and computer technology for in-flight guidance computers. This acquisition effort will be motivated by a desire to overcome reliability problems and also to provide the on-board processing capability required for the development of new guidance options with the potential for extremely high accuracies.

The Soviets will also give top priority to acquiring information on the latest generation of US-inertial components upon which the MX ICBM and the Trident SLBM guidance systems are based. Despite the past accuracy improvements of Soviet ICBMs, these two US systems incorporate technologies beyond present Soviet technological capabilities. Moreover, their SLBM accuracies are significantly behind those of US systems. In addition to information on hardware, the Soviets are expected to seek calibration software algorithms which, as the guidance instruments themselves reach their practical performance limit, would allow for continued improvement in weapon system accuracy.

Western solid rocket propulsion technology also will be a high-priority Soviet acquisition target in the 1980s. While the Soviets have vast experience with the liquid-propellant systems which represent the bulk of their ballistic missile force, they are shifting their emphasis to solid propulsion systems, which have practical advantages over liquid systems in a variety of applications. At the same time, the Soviets have had only limited success with the progress of their solid-propulsion program. They probably will pursue the acquisition of information on solid-propellant production procedures, and propellant grain design, motor case, and rocket nozzle technologies.

The Soviets' ABM R&D effort has continued apace since the 1960s. As a result, they have gained considerable expertise in the development of large fixed-site radars for early warning, tracking, and engagement, and their interceptor technology has also improved substantially over the years. Areas remain, however, in which the Soviets will still seek and would benefit from sophisticated Western ABM technology. These include signal processing for detection, discrimination, target assignment, and sensor technology, particularly in the long-wave infrared portion of the electromagnetic spectrum applicable toward improving their launch detection capability.

Priority Soviet targets in the aircraft area will include Western materials technology, particularly composite materials to allow weight-efficient designs. The Soviets would also benefit from the acquisition of certain engine technologies, in particular those critical to the development of high-bypass turbofans for large strategic airlift type of aircraft. While, in general, Soviet avionics technology appear adequate, the Soviets have yet to demonstrate a capability to deploy reliable, accurate airborne inertial navigation systems for long-range navigation and weapons delivery. Thus, while long used in the West, these systems are still prime candidates for acquisition.

Very high priority probably will be given to the acquisition of computer-aided aircraft design technology, an area in which the Soviets are clearly impressed by US progress. In general, they also will continue to benefit from the acquisition of efficient aircraft production technology from the West to reduce costs.

While the Soviets have a strong indigenous air defense radar and missile technology, their general lag in microelectronics and microprocessing will direct them to attempt wherever possible in the West the acquisition of advanced signal-processing hardware and software.

The Soviets will continue to emphasize the acquisition of naval-related technologies applicable to improving their antisubmarine warfare capabilities, an area in which much Western technology is superior to theirs. Thus, a significant effort to acquire acoustic sensor technology can be expected, in particular that technology applicable to the development of large towed acoustic arrays that would assist the localization of Western submarines in open waters. They probably will also target the acquisition of Western signal-processing hardware and software required to fully exploit the detection capabilities of these sensors.

Another critical problem area to which the Soviets will direct acquisition is that of submarine quieting. Here also the Soviets lag the West significantly. As a result, not only are their submarines more vulnerable to detection, but the self-generated noise reduces the effectiveness of their own acoustic sensors.

An area in which the Soviets have historically lagged behind the West is precision submarine navigation—in particular, in the development of submarine inertial navigation systems. The need for improvements here will become more pressing as the Soviets develop long-range cruise missiles for land attack which require precise knowledge of launch location.

The Soviets also will continue to target technologies related to the design and construction of large aircraft carriers (for high-performance aircraft) to reduce the likelihood of poor design choices that would arise in what is for them an entirely new type of construction program.

Much of the Soviet acquisition effort in the area of tactical weapons is likely to be targeted against seeker and sensor technology for tactical missiles and precision-guided munitions. The Soviets will apply considerable effort in particular to acquiring advanced Western electro-optical technology including that related to antitank weapons. As in other weapons areas, the signal processing and microelectronics technologies supporting tactical weapon systems will also be priority acquisition targets. Technical documentation on entire weapon systems, if obtained, will be used to develop countermeasures.

In the microelectronics area the USSR is now at the stage of implementing its LSI (large-scale integration) technology to high-volume production. Despite the large acquisitions of Western technology and production equipment over the past 10 years which have brought them to the LSI level, additional acquisitions from the West are needed for the more sophisticated weapons projects of the future. Ever-increasing needs for higher precision Western equipment will extend at least through the 1980s.

In addition, the Soviets will require considerable expansion of their microelectronic material base to support continued expansion of integrated-circuit production. In this regard, the USSR is seeking Western help to build two or three poly-silicon plants that will more than double current Soviet capacity for military applications. Also, with increasing advances in the technology, the USSR already will be seeking additional Western assistance in key complementary technologies such as packaging and printed circuit board production.

The USSR is expected to focus its future acquisitions efforts on the emerging technologies related to very-high-speed integrated circuits (VHSIC) and very-large-scale integration (VLSI). It is important to note that, while VHSIC is thought of as a military development program, and VLSI as a civilian technology, there is little difference between the two as far as Soviet production needs are concerned. The same materials, production, and test equipment will be used to produce both. In both of these technological areas, the USSR has developed effective means for illegally acquiring Western advanced products.

Prime Soviet collection efforts in computer technology through the 1980s are likely to include large-scale scientific computers such as the US-built CRAY-1 Computer. Computers of this class offer significant improvements over Soviet models in weapons-systems design and simulation and in the processing of numerical data for many military applications. Other hardware targets will include: very dense random-access memory chips; high-capacity disk drives and packs; the so-called "superminicomputer" class of machines; and the latest in general purpose computer technology. All of the above targets offer opportunities for significant performance improvements and represent technologies of substantial Soviet lag.

In computer software, the Soviets will continue to attempt to collect IBM programs and programs of other vendors written for these machines because of past Soviet decisions related to copying IBM computers. The large and growing number of IBM-compatible computers in the USSR means that collection activity in this area can be expected to increase. The compelling attraction of computer networks also should spur great Soviet interest in acquiring network-control software and other programs related to networking.

# The High-Tech Secrets Russia Seeks in West

**By fair means and foul, Moscow is helping itself to military technology. A new report by the CIA lists the 10 most wanted items.**

How far has the Soviet Union gone in challenging America's commanding lead in military technology?

Whatever gains the Russians have made—and administration officials say there have been many—the Central Intelligence Agency identifies 10 critical areas where Moscow still lags behind and is making an all-out effort to catch up.

Summarizing a top-secret intelligence study in a report to Congress, the CIA says several thousand technology-collection officers are involved in a "massive, well planned and well coordinated Soviet program to acquire Western technology through combined legal and illegal means."

These are the areas the CIA believes Moscow has pinpointed in its effort to gain an edge on the U.S. and its allies:

**Guidance technology.** Soviet missiles, aircraft and submarines all lack the most advanced guidance systems used by the United States. [illegible] that Soviet missiles are less accurate than the latest U.S. designs, that Russian pilots have more difficulty finding their way and that submarine-launched missiles are inaccurate because sub skippers cannot be sure exactly where they are under the water.

The CIA expects the Soviet Union to give top priority to obtaining details of Western electronic and computer devices used for in-flight guidance of missiles and of inertial-guidance devices used for pinpoint navigation.

**Rocket propulsion.** The Soviets have had trouble mastering solid-propulsion technology. Most of their ballistic-missile force is powered by liquid fuels. Almost all U.S. ballistic missiles use safer, more reliable solid fuels.

The Russians are believed to be trying to obtain a whole range of solid-fuel technology, from techniques for making the fuel to motor design and the shape of the rocket nozzles.

**Missile defense.** Despite years of effort to develop a system to defend itself against missile attack, the Soviet Union is still hampered by lack of sophisticated technology.

The CIA says the Russians need better equipment to detect the launch of hostile missiles, distinguish warheads from decoys, process the information picked up by their radars and assign targets for their defensive missiles. The quickest way to bridge the gap, the intelligence agency concludes, is for Moscow to obtain what it needs, by hook or by crook, from the West.

**Aircraft technology.** Russia lags behind the West in two key areas: Engine technology and lightweight composites used instead of heavier metals in aircraft construction.

Improvements in engine design and use of lightweight materials would enhance the performance of Soviet fighter-bombers. Better engines are especially needed for large planes to carry troops and supplies over long distances.

**Computer-assisted design.** In Soviet aircraft factories, designers still [illegible] plane [illegible] routinely use computers to do most of this work.

The Soviets, says the CIA, "are clearly impressed by U.S. progress" and have probably given very high priority to obtaining this technology.

**Antisubmarine warfare.** In recent years, the U.S. has outpaced the Russians in the ability to detect submarines.

In an effort to close this gap, American intelligence experts expect, the Soviets will focus on trying to obtain the technology that gives the U.S. its decisive edge. A prime target: The kind of listening devices the U.S. Navy tows behind its ships to locate hostile subs in the open seas.

**Submarine quieting.** Soviet submarines are notoriously noisier than the superquiet U.S. subs—so noisy that the clatter is picked up by their own listening devices, drowning out other sounds in the ocean.

Even though Russian designers have sometimes sacrificed quietness to reduce costs and gain greater speed, they now are believed to be going after U.S. technology that can overcome this significant disadvantage.

**Large carriers.** The Soviet surface Navy, by CIA reckoning, is concentrating now on eliminating its one major shortcoming—the lack of large aircraft carriers. While the U.S. has 13 big carriers and is building more, the Soviet Union has only four small carriers designed for antisubmarine warfare.

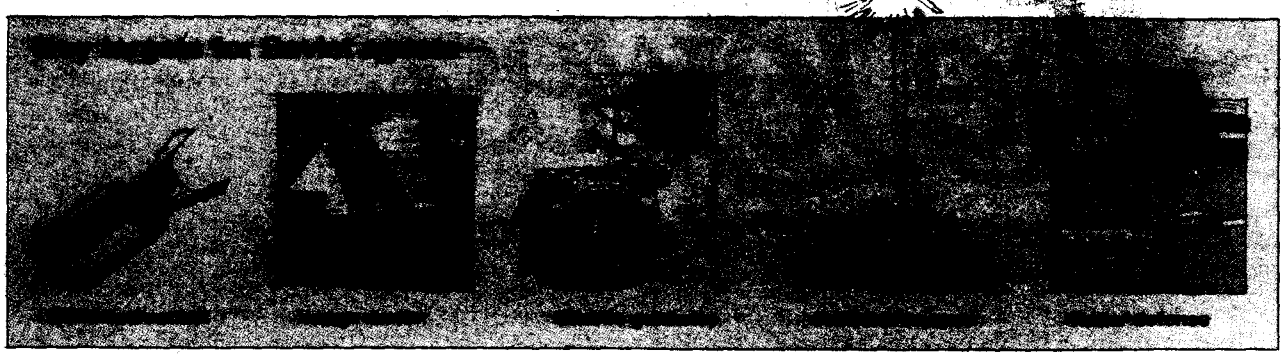
In recent years, the Russians gradually have been putting together the know-how to build big carriers. They are expected to launch their first nuclear-powered flattop sometime later in this decade.

The CIA expects the Soviets to borrow as much from the West as they can to "reduce the likelihood of poor design choices in what is for them an entirely new type of construction program."

**Computer equipment.** Another key target [illegible] to be everything [illegible] sophisticated Western [illegible] making silicon [illegible] connections [illegible]

[illegible] the Soviets, the CIA reports, [illegible] to put much of their effort [illegible] as much as they can about the technology of superaccurate American bombs and rockets that can score direct hits on such difficult targets as moving tanks.

If past successes are any measure, Moscow has a good chance of getting much of the technology it seeks. Preventing that, warns the CIA, "is one of the most complex and urgent issues facing the free world." □



BALTIMORE SUN 31 January 1982 Pg. 1

# Soviet espionage siphons U.S. know-how

By Walter Taylor
Washington Bureau of The Sun

Washington—As a target for espionage, William Holden Bell was textbook perfect.

Then 59 years old and trying to keep pace with a new wife 25 years his junior, he was bitter about a relatively unrewarding career and desperately in need of cash to support a life-style of travel and leisure.

In short, Bell, a radar technology expert for Hughes Aircraft Company, a major U.S. defense contractor, was ripe for the picking. And picked he was.

Before the FBI caught up with him last summer, Bell, in exchange for about $110,000, handed over to Polish government agents classified information regarding some of the West's most closely guarded weapons systems, including the Stealth bomber and several others designed to offset the Warsaw Pact's numerical superiority in Europe.

The Bell case is the stuff of spy drama in an era in which mercenary interests have come to outweigh the political motivations of earlier times. Today, espionage coups can be scored through acquisition of the technology that goes into a child's electronic baseball game, and dummy corporations play as great a role as do secret letter drops and midnight rendezvous.

*First of three articles*

More significant, the case illustrates what law enforcement officials in the United States—including Attorney General William French Smith and FBI Director William H. Webster—see as a change in tactics by the Soviets in a concerted effort to obtain data about American advances in military and industrial technology.

While espionage in the United States certainly is nothing new for the Soviets, the law enforcement officials see the Kremlin turning more than ever to clandestine means of gaining scientific hardware and know-how, since bans on over-the-counter transfers were ordered by Presidents Carter and Reagan.

President Carter ordered a partial ban on technology sales to Moscow after the December, 1979, Soviet invasion of Afghanistan. Last month, President Reagan sought to toughen the embargo following the military crackdown in Poland, which he has said was inspired by the Kremlin.

The Reagan administration's action, federal law enforcement officials believe, is likely to spur the KGB and the GRU, the two Soviet intelligence agencies operating in this country, to ever-greater efforts to obtain secretly and illegally what Moscow once might have acquired openly.

Some experts, but by no means all, see the acquisition of outside technology as vital to Moscow's hopes of continuing its military competition with the United States and at the same time addressing its own internal economic problems.

If they were not able to utilize Western know-how as a sort of "quick fix," some of these experts believe, the Soviets would confront a continuing series of difficult trade-offs, particularly in allocating precious research and development resources, in trying to meet both their defense and domestic needs.

The West "is virtually subsidizing Soviet military power," says Dr. Miles Costick, who runs the Washington-based Institute for Strategic Trade and occasionally serves as a congressional consultant on East-West trade.

There are some, including a few members of Congress, who believe the extent to which the Kremlin relies on Western technology is greatly exaggerated by a Reagan administration that tends to view most foreign policy questions in East-West terms. This would seem to be a minority view, however.

Representative Jonathan B. Bingham (D, N.Y.), chairman of the House Foreign Affairs subcommittee that oversees U.S. trade policy, asserts flatly that the Reagan administration has overstated the seriousness of the problem to the United States, particularly the contribution the West has made to the Soviets through over-the-counter sales of know-how.

Others, including some top policy-makers in the executive branch, question Washington's ability to choke off such exports, even if such a goal is warranted.

"There is no doubt that Western technology has had some impact," says William A. Root, director of the Office of East-West Trade at the State Department, but "if you take the line that any trade frees resources for military production, that basically is a formula for a total embargo, and this is an idea not being pursued under present circumstances."

These views are balanced not only by hard-liners within the Reagan administration, but also by a number of congressional experts with untarnished liberal credentials.

Senator Joseph R. Biden, Jr. (D, Del.) for example, says Western technology, principally from the United States, has been of "significant benefit" to the Soviets and their Eastern Bloc allies, and he is critical of what he sees as a wavering administration effort to ebb the flow.

"It seems to me the administration loves commerce more than it hates communism," he says, citing a number of large, government-approved sales to the Soviets since Mr. Reagan took office more than a year ago, and a lack of law enforcement success in halting illegal acquisitions of industrial and technical know-how.

Following the military crackdown in Poland, five other influential Democrats, including such liberal spokesmen as Senators Gary Hart of Colorado and Carl Levin of Michigan, both members of the Senate Armed Services Committee, urged Mr. Reagan to halt all technology transfers to the Kremlin, particularly those that would aid the Kremlin's energy programs.

If there are differing views about the consequences of technology transfers to the Soviets, there is general agreement on one thing: It continues, despite publicly expressed concern at both ends of Pennsylvania avenue. By and large, the Kremlin is able to acquire much of what it wants, from the latest in computer chips to radar technology to the latest advancements in space-age weaponry.

"Soviet leaders have learned they have access to Western technology both through legal and illegal channels," Richard N. Perle, assistant secretary of defense for international security policy, says of the seriousness of the problem.

"Under the guise of purchases for benign, civilian objectives, the Soviets have obtained a wide range of equipment critical to their military program. Where they have failed to get what they want openly, they have resorted to a well-coordinated, illegal acquisition program."

Speaking on the threat of Soviet espionage last month, Attorney General Smith told a Los Angeles group that because the United States relies so highly on superior military technology, the current costs to national security through such losses are "incalcuable."

The Bell case, which led last fall to his conviction and that of his Polish confederate, Marian W. Zacharski, on espionage charges, illustrates the kind of sensitive military information that stimulates such contacts as the Polish link to Bell.

The FBI still will not discuss certain details of the case, or describe in detail the extent of the national security breach.

Evidence and testimony at Mr. Zacharski's trial, however, indicated that among the secrets obtained by Polish intelligence (and, U.S. officials assume, by the KGB) was information about the Stealth bomber project; a new, rapid-firing, radar-controlled antiaircraft and antitank gun; a sophisticated antitank missile, and the so-called "look-down, shoot-down" radar of America's most sophisticated fighter plane.

The Stealth bomber is the super-secret aircraft being designed to replace the B-52 and the planned B-1 bombers as the airborne component of this country's nuclear triad. The plane is so named because of its hoped-for invulnerability to Soviet radar detection.

The other weapons systems are elements of NATO's conventional deterrent forces in Europe, and provide the West with technology to counter the massive numerical superiority in tanks, planes and soldiers of the Warsaw Pact nations.

The "look-down, shoot-down" radar, for example, is designed to permit U.S. F-15 fighters to counter enemy aircraft that fly low to the ground to avoid detection by ground-based surveillance systems.

Soviet radar technology is believed to be much less advanced than the American version of "look-

ESPIONAGE...Continued

down, shoot-down," and NATO defense strategy has been based, at least to a degree, on the presumption that Western warplanes could penetrate enemy airspace but that Warsaw Pact fighters and bombers could not penetrate Western airspace.

Mr. Bell, who confessed to his part in the conspiracy and recently was sentenced to eight years in prison, had been cleared by the government for access to secret information when he first went to work for Hughes in 1952.

He had been project manager for Hughes's radar systems group for only about a year when, according to his own testimony in federal court, he began selling national defense secrets. The original "hook" in Mr. Bell's case was a $12,000 down payment on a condominium overlooking the Pacific.

Mr. Bell was enticed into espionage by one of the hundreds of Iron Curtain agents believed by U.S. authorities to be operating in the United States. Many operate under the guise of diplomat, businessman, media or trade representative, or staff member of international organizations.

Estimates of the number of agents from communist countries operating in California alone, the home of about 1,000 American companies doing sensitive defense work, range as high as 100. A particular target of interest is the 30-mile stretch of Northern California between San Jose and Menlo Park known as Silicon Valley, the hub of the microelectronics industry.

There, more than 1,500 companies turn out silicon chip circuitry, much of it with military application and some of it highly prized by the Kremlin.

The FBI is said to have identified as many as 15 members of the bloated, 100-man staff at the Soviet consulate in San Francisco as KGB or GRU agents, and half of the 15 science and technology experts as intelligence agents.

The West's once commanding advantage in microelectronics has been dramatically reduced over the last few years, according to U.S. defense officials, in large part through illegal acquisitions from such places as Silicon Valley.

Communist efforts to divert U.S. military and industrial advances are by no means limited to the old-fashioned cloak-and-dagger tactics employed in the Bell case, however.

Until recently, the Soviet Embassy here was on the regular mailing list for tens of thousands of unclassified Commerce and Defense department reports each year, many of them dealing with high technology. The Reagan administration halted this practice.

The United States also recently halted the practice of permitting Soviet and Eastern Bloc exchange students and visiting scientists to visit and study at some university and research institutions doing sensitive work for the American military.

Moscow continues to pursue U.S.-approved over-the-counter sales of technology, even though most of these sales have been outlawed because of Afghanistan and Poland. In some cases, the Soviets are able to glean valuable information from the sales proposals made by U.S. companies, even if the contracts ultimately are disapproved by the Commerce Department.

Moreover, Kremlin agents, often working under the guise of legitimate businessmen, have been successful in establishing a broad network of companies operating in the United States and elsewhere with the sole purpose of illegally diverting Western technology.

Mr. Zacharski, for instance, was an official of the Polish American Machinery Corporation, an Illinois-based firm 90 percent of which was owned by the Polish government.

It often is perfectly legal for such companies to purchase sophisticated technology in the United States. The trick for the KGB is to circumvent U.S. restrictions against the shipment of the information or hardware to the Eastern Bloc.

In some cases, enterprising—or greedy—Americans, unhappy about what they see as unwarranted constraints on their ability to sell their wares, wittingly or unwittingly ease this problem for the Soviets.

A few years ago, for example, Walter Spawr, a contractor for three of the American military services, decided he was being deprived of a principal market for a product and technique he pioneered—highly polished, water-cooled laser mirrors.

Mr. Spawr, who later was convicted in a federal court, illegally diverted some of his mirrors to the Soviets after an application to sell them openly was turned down.

Most U.S. intelligence and defense experts believe the Soviets could have only one use for the mirrors— development of so-called "death rays," weapons using intense beams of light to destroy military targets on Earth or in space.

In another case, a federal grand jury indicted Volker Nast, a West German businessman, in arranging for the purchase in Baltimore of a $47,000 microwave receiver and attempting to have it smuggled out of the country. The Baltimore firm involved got suspicious and tipped off federal authorities.

*TOMORROW: The legal transfer of technology through commerce.*

BALTIMORE SUN 1 February 1982 Pg. 1

# U.S. technology enhances Soviet weaponry

**By Walter Taylor**
Washington Bureau of The Sun

Washington—If the Soviet Union were to launch a preemptive attack against the United States, it probably would begin with a strike against the 1,050 or so Minutemen and Titan intercontinental ballistic missiles that are the backbone of the American nuclear deterrent.

The messenger of that destruction? Most likely a weapon that many defense experts believe has been greatly enhanced by technology from the United States and other Western countries—the monster SS-18 missile, the largest in the Soviet ICBM arsenal.

Much of this technology was obtained not by Moscow's sizable espionage effort but over the counter. The Soviet Union has been able to obtain Western know-how, and in some cases military hardware, openly in the United States and elsewhere. The Reagan administration—and the Carter administration before it—cracked down, but the flow of technology has not been cut off.

*Second of three articles*

Western expertise—though for the most part not that of the United States—will play a vital part in the construction of the Soviet's trans-Siberian natural gas pipeline, for example.

There is less than total agreement among experts here about the extent

TECHNOLOGY...Continued

to which strategic commerce has aided the Kremlin. The Reagan administration tends to take the view that any technology that aids, even indirectly, the Soviet military-industrial complex constitutes support for a potential adversary.

Some critics of this view, however, believe that the case for clamping down on technology transfer is overstated by the president and his advisers.

There is little question that the 1972 sale—approved by the Nixon administration—of 168 precision ball-bearing grinders by the Bryant Grinder Corporation of Vermont gave the Soviets, if not the total technological wherewithal, at least a significant leg up in development of the multiple warhead capability of the SS-18.

Precision ball bearings are used in the gyroscopes that are the heart of inertial guidance systems. One former government official whose service covers the SS-18 development period says it is not possible to say definitively how much of a leap the U.S. grinders gave the Soviet Union because U.S. intelligence wasn't good enough to say precisely how poor was the Soviet home-ground product.

But, this former official continued, the Soviet purchase of the U.S. grinders was one of the factors that brought the U.S. government to feel it faced for the first time a threat to American intercontinental ballistic missiles (ICBMs).

Moreover, according to Attorney General William French Smith, the United States also may have contributed greatly, albeit unwittingly, to developing the inertial guidance system of the SS-18, vastly improving its accuracy.

Other experts, both inside and outside the government, believe the know-how for the weapon's guidance system was pirated by Soviet scientists studying at the prestigious Massachusetts Institute of Technology during the late 1960s and early 1970s.

It is this new accuracy, coupled with the tremendous destructive force of these big missiles, that causes many to say U.S. ICBMs are vulnerable to a first strike. This vulnerability, in turn, was the reason given for building the new U.S. missile, the MX, and planning its deployment in a vastly expensive and controversial mobile basing mode designed to foil would-be attackers.

In other cases, the Soviet scientists, participating in an officially sanctioned U.S.-Soviet exchange program, were permitted to visit research facilities doing supposedly secret work on the United States' own ICBM program.

This second kind of acquisition, the fruits of concerted Soviet intelligence activity within this country, not only continues today but goes on at a pace that has become more and more alarming to federal law enforcement and counterintelligence officials.

"Obtaining our most recent advances in areas such as microelectronics, computers, lasers, nuclear energy and, of course, military and space technology is the major thrust" of Soviet bloc espionage, according to FBI Director William Webster.

As was the case with the Bryant ball-bearing grinders, it has not always been necessary for Moscow to steal such secrets, however. During the late 1960s and 1970s, the United States and its Western allies sold Soviet bloc nations billions of dollars worth of technology, much of which directly or indirectly helped the Soviets meet military goals.

Although the United States has cut back sharply on such technology transfers since the December, 1979, Soviet invasion of Afghanistan and, more recently, the unfolding events in Poland, sales from other Western countries continue virtually unabated, according to some American experts.

In recent years, moreover, a number of emerging nations, particularly those of Southeast Asia and South America, have joined the competition to sell industrial advancement techniques, many of them with military application, to the Soviets.

This foreign availability has undermined seriously the efforts of the last two administrations in Washington to reduce the seepage of such know-how.

For example, the willingness of Japan to sell comparable equipment prompted the recent decision by the Reagan administration to approve the sale of pipe-laying equipment to Moscow for use on construction of the massive Urengoi-Yamburg pipeline from Siberia to Western Europe.

President Reagan last month suspended the sale in retaliation for the military crackdown in Poland, but thus far there is no indication that Japan intends to follow suit.

It is precisely this type of assistance that many U.S. experts believe permits the Kremlin to devote its full energies to military research, confident that Western nations will provide for domestic concerns.

"The danger," a recent Rand Corporation study concluded, no longer is the "possibility of sudden and disastrous give-aways, but rather that high-technology trade may help the Soviets upgrade over the longer term the traditionally neglected 'civilian' industries that will provide broad, infrastructural support for new weapons systems tomorrow."

The report also underscores another point made by experts on trade with the Soviets—that the authorities charged with monitoring technology traffic often are poorly equipped to judge the potential impact of such know-how.

"Sometimes you don't find out what you've done for five years," laments an aide whom Senator Jake Garn (R, Utah) has placed virtually full time on the problem. Senator Garn has sponsored legislation that would set up a new federal agency, the Office of Strategic Trade, to police U.S. sales to the Soviets.

The recent record of transfers is replete with cases where the United States and its allies may have substantially and directly aided the Soviet military through seemingly innocuous sales to Moscow.

Often cited is the sale by Datasaab of Sweden of an air traffic control system, supposedly to aid in monitoring civilian aircraft flying into or from the Moscow airport. The system, containing American electronic components, is said to be capable not only of detecting approaching aircraft (or missiles), but also of accurately projecting the future flight paths of such objects.

The Kama River and Zil truck plants are two classic examples of U.S. technology turned to military use by the Kremlin. For some time, the United States continued to license sales of computer parts for the Zil factory, despite intelligence reports that the plant was turning out missile launchers. The Swindell-Dressler division of Pullman, Inc., supplied three foundries that enhanced Soviet output of military vehicles.

Trucks from this Kama River facility carried Soviet troops into Afghanistan and, if the Kremlin finds it necessary, could serve a similar mission in Poland.

*Tomorrow: The administration grapples with ways to stop technology transfers.*

BALTIMORE SUN 2 February 1982 Pg. 1

# U.S. acts to stem technology flow to Soviet

By Walter Taylor
Washington Bureau of The Sun

Washington—In the summer of 1979, Lawrence J. Brady, then acting director of the Carter administration's Office of Export Administration, became an overnight cause celebre for critics of economic detente with the Soviet Union.

Mr. Brady, appearing as an administration witness, told a congressional oversight committee what skeptics had been maintaining all along: The Nixon-Ford-Carter policy of relatively open trade with the Russians not only had accomplished little toward its goal of moderating the Kremlin's international designs,

*Last of a series*

but in fact was abetting efforts to achieve them.

U.S. safeguards against the diversion of sophisticated technology of potential military use to the Russians had only "marginal utility," asserted Mr. Brady. International efforts by the West, he said, were even worse.

His cathartic testimony may have won him a spot in the hearts of conservatives, but it also meant political purgatory at the hands of the Carter White House. Mr. Brady lost his position in the Commerce Department, and in January, 1980, a month after Soviet troops began rolling into Afghanistan on trucks manufactured at a Ural Mountain foundry outfitted by an American company, he resigned from the government.

Today Mr. Brady is back, as assistant secretary of commerce for trade administration. He is in charge of efforts by the Reagan White House to refashion American and Western export policy in a way that would deprive the Soviets of the steady diet of Western technology they have enjoyed for most of the last decade.

Unlike recent governments, the Reagan administration views the control of trade, particularly in the area of high technology, as a strategic weapon that can deprive the Russians of assistance vitally needed to modernize their military-industrial base.

Technology, Mr. Brady said in a recent interview, "is the one tool, the one hook we've had since World War II . . . that could cause some real strains in the Soviet system."

Along with its efforts to weave a new policy that would emphasize less rather than more commerce with the Soviet Bloc, the Reagan administration has stepped up law enforcement and counterintelligence efforts to reduce the loss of American know-how through illegal transfers and espionage.

The U.S. Customs Service, traditionally geared to prevent material from coming into the country rather than leaving it, recently began a program dubbed "Operation Exodus" designed to scrutinize more closely cargo bound for the East.

The FBI and the Justice Department, for their parts, have embarked on a major campaign to make the public more aware of the espionage peril. Actor Efrem Zimbalist, Jr., star of the old FBI television series, has been doing loose-lips-sink-ships spots on radio and TV in California, where more than 1,000 companies doing sensitive work for the U.S. government are headquartered.

Concern for the problem is by no means limited to the Reagan administration. Senator Sam Nunn (D, Ga.), the senior Democrat on the Permanent Subcommittee on Investigations, has assigned his entire subcommittee staff to an investigation of possible legislative steps to cut off the flow of information to the Soviets, with an eye toward public hearings in April.

Senator Nunn, in an interview, termed the transfer of technology "a very serious problem," and openly questioned the ability of the government, as currently organized, to address it effectively. Without providing specifics, he said a number of legislative remedies were possible at the conclusion of his panel's probe.

So far, authorities acknowledge, the new federal effort on this front has fallen far short of stopping the flow of illegal diversions to the Soviet Union and its Iron Curtain allies, despite a few spectacular successes.

Officials of some enforcement agencies complain of a lack of funds, manpower and, perhaps even more crucial to their efforts, the expertise necessary even to recognize the sophistication or potential value of material finding its way to the Russians.

"How does the average customs inspector recognize the difference between a microchip you can buy at Radio Shack and one that the Soviets can plug into a military computer?" asks one beleaguered federal official involved in efforts to stop the flow.

Moreover, amid the competition of commercial, political and bureaucratic interests both inside and outside the government, there is still less than total unanimity about the need and desirability of a policy of preventing trade with the Russians.

Representative Jonathan B. Bingham (D, N.Y.), chairman of the House Foreign Affairs subcommittee that oversees U.S. trade policy, contends, for example, that the administration has vastly exaggerated the degree to which the Russians depend on the West.

He described as "utter nonsense" the assertion that transfers from the United States have played a significant role in Soviet technological advancement, and charges that administration statements about the seriousness of the problem "verge on the hysterical."

On the academic front, a number of scientists and university administrators, citing the cause of intellectual freedom, have balked at Reagan administration efforts to restrict access to technology during visits to American campuses.

Some academicians also have bristled at suggestions last month by Adm. Bobby Inman, deputy director of the CIA, that American scientists should voluntarily submit their work for possible government censorship in cases where it is to be published.

Some American businessmen also complain, though less openly than they once might have. One who has not tempered his outspokenness is Robert D. Schmidt, vice chairman of Control Data Corporation and an advocate of continued economic detente with the Russians. He complains that Reagan policy merely serves to spur the Kremlin to develop its own technical capability, accomplishing little of strategic value to the West but costing U.S. companies valuable overseas markets.

In general, there is one major area of agreement among experts on the subject within and outside the government. Given recent history, however, this also bodes ominously for U.S. efforts to cut the eastward traffic in Western know-how.

"It is worth bearing in mind that in the total volume of Western high-technology exports to the Soviet Union, the United States is a small player," notes a recent Rand Corporation study, underscoring the point made by others that there is little Washington can do unilaterally.

U.S. experts, notes Thane Gustafson, author of the Rand report and an expert in the field, amount to only about a tenth the level of advanced machinery and equipment sent annu-

TECHNOLOGY...Continued

ally to the Soviets by West Germany, France and Japan alone.

"The chances of gaining such support from other countries for an expanded system of export controls are small and growing smaller, for among the nations conducting high-technology trade with the Soviet Union one finds not only NATO allies (whose reluctance to apply stiffer export controls is of long standing), but also countries like Australia and Switzerland, which are unlikely to cooperate at all."

A similar report by the congressional Office of Technology Assessment, which focused specifically on the role of Western nations in development of Soviet energy resources, reached like conclusions.

The lack of support for President Reagan's trade sanctions against the Soviets in the ongoing Polish crisis, and two years ago in the wake of the Afghanistan invasion, would seem to support such pessimism.

In its first major initiative in this area, the Reagan administration, following up on discussions begun among allied leaders last summer at the Ottawa economic summit, sought allied support for precisely these kinds of restrictions in early January.

Representatives of COCOM, an organization of NATO countries created to control exports to the Communist bloc, agreed, at Washington's urging, to tighten the list of embargoed technology, particularly in the field of computer know-how, to the Russians.

Since the deliberations of the group are secret, it remains difficult to determine how this agreement will play out in terms of strengthening sales restrictions. The North Atlantic Treaty Organization members made clear, for example, that they planned to go ahead with sales to Moscow to aid in the construction of a trans-Siberian natural gas pipeline to Europe.

The 3,500-mile pipeline, which would supply Soviet gas to Western Europe, is strongly opposed by the Reagan administration out of concern that it will make countries such as West Germany and France dependent on the Kremlin, and thus susceptible to political blackmail. Mr. Reagan, as part of his program of sanctions against Moscow after the military crackdown in Poland, ordered a total U.S. ban on any technology that would aid the Soviets to develop their energy resources.

The pipeline issue highlights the differing perspectives in the West on the technology question even after the recent events in Poland.

The director of East-West trade at the State Department, William A. Root, acknowledged in an interview that there continues to be no consensus among the allies on precisely what they should seek to deny the Soviets.

"The concept is not at issue," he said. "It is the question of what constitutes aid that remains under debate."

Some experts question whether COCOM is any longer a useful vehicle for creating barriers to technology loss. One such specialist, a bank representative who asked not to be identified, noted that most of the participating Western nations do not even include military experts in their COCOM delegations.

"How the hell can they decide whether something will contribute to the Soviet military if they don't know anything about the military?" he asks.

Administration officials, citing an increase in government rejections of proposed U.S. sales to the Soviets even before the Polish crackdown, say the United States is prepared to go it alone if the allies don't cooperate.

One senior Pentagon official, Under Secretary of Defense Fred Ikle, has said that if it comes to this, the United States might have no choice but to try to restrict U.S. technology transfers even to allied nations.

"We have to establish a boundary beyond which we will not permit sensitive technology to travel," Mr. Ikle told the Reuters news agency. "We would like to have this boundary include not just our allies but our friends and other countries that we cooperate with."

But, he warned, Washington would stop selling its technology to friendly nations if they let it slip into Soviet hands.

# National security vs. academic freedom

## Administration wants to stem outflow of 'high tech'; will research suffer?

By Brad Knickerbocker
Staff correspondent of The Christian Science Monitor

Washington

The Reagan administration is moving steadily to stop the flow of military related technology to the Soviet Union. At the same time, scientists and academics are just as steadily resisting what they see as heavy-handed infringements on research and the free exchange of information.

This debate between "national security" and "academic freedom" has at times been tense. But there are indications that both sides want to see the controversy resolved voluntarily rather than by government fiat.

In congressional testimony this week, the CIA's deputy director, Adm. Bobby Inman, conceded that some of his earlier pronouncements on the subject had been inflammatory. He pointed out that government intelligence officials and private researchers have worked out an agreement on guarding information dealing with cryptography (the making and breaking of codes).

At the same hearing, National Academy of Sciences president Frank Press noted that the Defense Department "has agreed to support and cooperate" in a year-long study on the export of technology. A panel of distinguished scientists, academicians, and business leaders, many of whom have served in high government posts, would conduct the study.

"This is unquestionably a sensitive and complex problem," Assistant Commerce Secretary Lawrence Brady told the lawmakers. "We are striving to restrict the transfers of technology that impair our national security while not unduly burdening scientific research."

The key words in Mr. Brady's comment are "impair" and "unduly." They are highly subjective. But the administration has defined them to its satisfaction and is taking steps to stem what Admiral Inman describes as an "enormous outflow." Among them:

- The administration last week withdrew its financial support for the International Institute for Applied Systems Analysis in Austria, which has 17 member nations from NATO and the Warsaw Pact. US officials cited "Soviet abuse" of the scientific information exchanged there.
- The Defense Department is seeking a new security classification covering technological and scientific information. Such information could more easily be kept secret under the administration proposal. In a recent letter to national security adviser William Clark, Frank Press of the National Academy of Sciences warned that this could cause many universities to stop work in these areas "and thus deny to the Defense Department this important basic research resource."
- The administration has stopped sending the Soviet Embassy unclassified Commerce and Defense Department reports on high technology matters. It also has stepped up enforcement efforts under the Export Administration Act.

"As academic institutions have become increasingly involved in research for industrial applications, more technology becomes potentially subject to the regulations," Assistant Commerce Secretary Brady said. "We focus on preventing the transfer of scientific research involving nonpublic data that is related to industrial processes and could endanger US security."

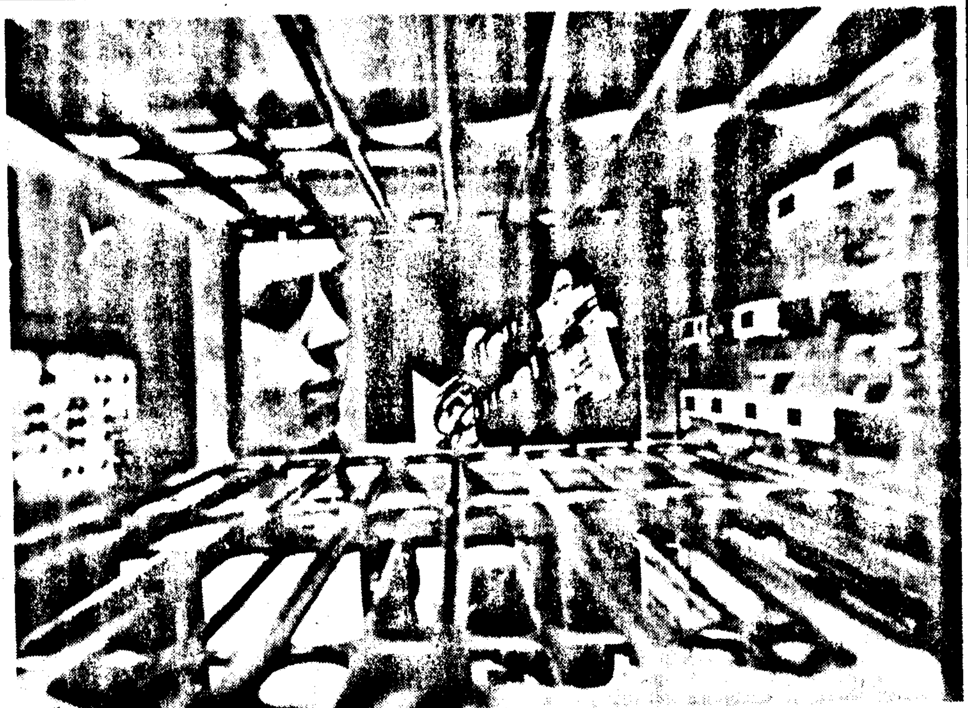
- The Defense Department is adding to its list of "militarily critical technologies," which covers more than 600 items in such categories as computers, lasers, metals and alloys, and telecommunications. This list covers "technologies whose acquisition by potential adversaries would be detrimental to national security," and is used by the Commerce Department in deciding whether to license exports.

The government-scientific community debate is increasingly being reflected on Capitol Hill. Rep. George Brown (D) of California calls the administration's policies "short-sighted," and notes that "some of our closest allies" not only provide much scientific information to the Soviet Union but engage in "occasional industrial espionage" against the United States.

Sen. Jake Garn (R) of Utah, on the other hand, has introduced legislation that would establish a new Office of Strategic Trade. The House is considering a bill giving the Secretary of Defense greater power to regulate the disclosure of certain technological information.

There is general acknowledgment that the line between "pure" research and industrial or military technology is becoming less distinct. Many experts feel that Soviet intercontinental ballistic missile guidance systems may have benefited from freely available US technology.

"With few exceptions, the development of high technology, whatever the source, has military impact," says George Millburn, the Pentagon's man in charge of research and advanced technology.



Bell Labs photo

Experimental lightwave transmitter — the kind of technology that may need protecting, says administration

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(excerpt from)

# Technology and East-West Trade

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# CHAPTER VI

# Technology Transfer: Definition and Measurement

**Discussions of the economic consequences of trade in technology for both the United States and the Communist world have been hampered by conceptual and practical difficulties in gathering and interpreting data. There is no universally accepted definition of "technology," and in many critical instances, useful data is simply unavailable. Any attempt to assess the economic importance of this trade must therefore include a discussion of the nature of technology and technology transfer and the ways in which they can be measured.**

## DEFINITIONS

Technology must be differentiated from science on one hand and from products on the other. Science is the pursuit of knowledge, whereas technology is the specific application of knowledge to the production of goods and services. Science flows freely across international boundaries, and even if it were possible to effectively control this flow, the prospect of doing so raises at the very least grave Constitutional questions. Some control of technology, however, is both desirable and necessary in the interests of national security because of the military or strategic capabilities it may provide.

The distinction between technology and products is more troublesome. If technology is broadly defined to mean the knowledge necessary to design, create, or implement a process; the process itself; or any services related to the process, the problem of how to treat the resulting product remains. Often this will be a "technology intensive" product, one that might be said to "embody" technology or from which the technology may be extracted through a process known as "reverse engineering"—the deduction of the techniques of manufacture from examination of the product itself. Often too technology-intensive products have military applications that cause them to pose as severe a problem to national security as the design and manufacturing know-how that went into them.

For commercial purposes, "technology" usually refers either to equipment and processes that transform raw materials into goods and services, to the training that accompany these, or to final products like computers that embody high technology. But there is little agreement, in the United States or abroad, as to exactly which products and process should be included in these categories. There are, furthermore, problems of measurement within each category. The cost of equipment or of the licenses for rights to processes, for instance, may not necessarily reflect the value to the buyer in terms of the quality, output, innovativeness, and profitability of the final product. The value of a purchase, which includes the skills of the workplace—the training required to operate machines, to achieve practical familiarity with the theoretical aspects of equipment, and to become able to adapt and extend the operation of the equipment—is difficult to quantify. Finally, there is disagreement over which products qualify as "high technology items.

To these empirical problems must be added the difficulties engendered by the fact that a number of both commercial and noncommercial vehicles exist through which technology of potential economic value is exported to the East. Commercial vehicles of technology transfer include turnkey factories (i.e., a factory built in the recipient country by a foreign firm, which is turned over to the recipient only when it is ready to "turn the key" and start production); licensing (with and without training programs); joint ventures; technical exchanges; training in high-technology areas; sale of processing equipment; provision of engineering documentation and technical data; consulting; proposals (documented and undocumented); and sale of products that embody technology. Noncommercial vehicles include visits in both directions of students, scientists, and businessmen or managers; the use of unclassified published technical data and patents; the reverse engineering of single machines or components; and clandestine activities. All of the latter modes of technology transfer cost negligible amounts of hard currency and, for the most part, have been beyond Government control. Communist states have made the most of these techniques, although they are by no means unique in this regard. These channels of technology transfer have historically been and will continue to be of great importance to market and nonmarket nations alike.

# PROBLEMS OF MEASUREMENT

## COMMERCIAL TRADE IN TECHNOLOGY

The most common forms of commercial technology transfer are the direct sale of products embodying high technology and various forms of industrial cooperation agreements.

### High-Technology Products

The U.S. Department of Commerce recently attempted to isolate trade in high technology through the examination of exports in selected categories of the Standard International Trade Classification (SITC). This classification scheme summarizes trade information for approximately 10,000 different items by organizing it into commodity groupings. The Commerce study selected 25 categories of products which, it contends, contain all those goods that reflect best practice in critical technology sectors—machinery and transport equipment and professional, scientific, and controlling instruments (see table 14). This effort is by far the most precise and comprehensive attempt to use trade statistics to measure technology transfers.

There are problems with the Commerce list, however. Aside from quarrels over what constitutes a "high technology" good, no list based on trade data can be sufficiently detailed to precisely distinguish between levels of technology. This could be accomplished only through a case-by-case examination of individual exports in light of an accepted set of criteria defining "high technology." The Commerce Department classifications are therefore overly inclusive; they "catch" items which do not in fact embody "high" technology, if by that is meant state-of-the-art or items unobtainable in the East. This means that calculations of high-technology trade based on these categories are inflated. Second, techniques used to value and describe exports at point of origin in the United States cannot reflect the contribution of third nations. U.S. technology embodied in products originating from American subsidiaries in Europe or Japan appears in the trade statistics of these countries and


*Photo credit: Bureau of East-West Trade, U.S. Department of Commerce*

**U.S.-U.S.S.R. technology transfer through the mechanism of trade fairs**

**Table 14.—High-Technology Items**

| SITC | Description |
|---|---|
| 71142 | Jet and gas turbines for aircraft |
| 7117 | Nuclear reactors |
| 7142 | Calculating machines (including electronic computers) |
| 7143 | Statistical machines (punch card or tape) |
| 71492 | Parts of office machinery (including computer parts) |
| 7151 | Machine tools for metal |
| 71852 | Glassworking machinery |
| 7192 | Pumps and centrifuges |
| 71952 | Machine tools for wood, plastic, etc. |
| 71954 | Parts and accessories for machine tools |
| 71992 | Cocks, valves, etc. |
| 7249 | Telecommunications equipment (except TC & radio receivers) |
| 72911 | Primary batteries and cells |
| 7293 | Tubes, transistors, photocells, etc. |
| 72952 | Electrical measuring and control instruments |
| 7297 | Electron and proton accelerators |
| 7299 | Electrical machinery, n.e.s. (including electromagnets, traffic control equipment, signaling apparatus, etc.) |
| 7341 | Aircraft, heavier than air |
| 73492 | Aircraft parts |
| 7351 | Warships |
| 73592 | Special purpose vessels (including submersible vessels) |
| 8611 | Optical elements |
| 8613 | Optical instruments |
| 86161 | Image projectors (might include holograph projectors) |
| 8619 | Measuring and control instruments, n.e.s. |

SOURCE: *Quantification of Western Exports of High Technology Products to Communist Countries*, prepared by John Young, Industry and Trade Administration, Office of East-West Policy and Planning, U.S. Department of Commerce, Project No. D-41.

not in those of the United States. Finally, customs valuations are determined by the price of the sale. Price does not necessarily reflect the full market value of the commodity, however; some firms deliberately underprice an initial sale in order to break into Eastern markets.

With these reservations, and in the absence of alternative superior measures, the Commerce system has been used in chapter III to analyze U.S. and industrialized world exports of high-technology products to the Communist nations.

## Industrial Cooperation Agreements

Industrial cooperation agreements have become increasingly common in East-West trade. In its most general sense, the term refers to a broad charter extending over a number of years to conduct commercial relations between a Western firm and a centrally planned economy. Industrial cooperation includes a wide variety of possible relationships, ranging from the sale of licenses and patents to coproduction agreements and turnkey plant sales. The comprehensive list incorporated into table 15 summarizes the basic mechanisms and techniques utilized in these ventures. These frequently involve relationships between trading partners which extend beyond simple sales of goods and services, to continuous and close contacts between trading partners, training, and technical assistance programs. It can be expected that these agreements lead to considerable communication of technical know-how congruent with sales of plant and capital equipment.

Activities in this area are extremely difficult to measure. Cooperation agreements are often complex and their values particularly difficult to establish because many East-West transactions involve countertrade rather than cash (see chapter III).

Countertrade is particularly attractive to Eastern nations with scarce hard-currency resources and a need to foster exports to the West. But while its importance in Communist countries is becoming increasingly apparent, little data on such agreements exist. The U.S. Department of Commerce estimates that in Poland, 40 to 50 percent of electrical products and machinery exports to the West in the 1980's will be part of countertrade agreements; and 38 percent of Soviet trade turnover between 1976 and 1980 will be generated through countertrade.[1] There are no comprehensive studies of the full range of countertrade transactions, although the Organization for Economic Cooperation and Development (OECD) has studied individual categories of contracts.[2]

[1]See U.S. Department of Commerce, *East-West Countertrade Practices: An Introductory Guide for Business*, Industry and Trade Administration, August 1978.

[2]Organization for Economic Cooperation and Development, *Countertrade Practices in East-West Economic Relations*, Paris, Mar. 23, 1978.

**Table 15.—Types of Contractual Arrangements Included in Different Definitions of East-West Industrial Cooperation**

1. Sale of equipment for complete production systems, or turnkey plant sales (usually including technical assistance).
2. Licensing of patents, copyrights, and production know-how.
3. Franchising of trademarks and marketing know-how.
4. Licensing or franchising with provision for market sharing and quality control.
5. Cooperative sourcing: long-term agreement for purchases and sales between partners, especially in the form of exchanges of industrial raw materials and intermediate products.
6. Subcontracting: contractual agreement for provision of production services, for a short term and on the basis of existing capabilities.
7. Sale of plant, equipment, and/or technology (1-3 above) with provision for complete or partial payment in resulting or related products.
8. Production contractings: contractual agreement for production on a continuing basis, to partner specifications, of intermediate or final goods to be incorporated into the partner's product or to be marketed by him. In contrast to subcontracting, production-contracting usually is on the basis of a partially transferred production capability, in the form of capital equipment and/or technology (on basis of a license or technical assistance contract).
9. Coproduction: mutual agreement to narrow specialization and exchange components so that each partner may produce and market the same end product in his respective market area. Usually on the basis of some shared technology.
10. Product specialization: mutual agreement to narrow the range of end products produced by each partner and then to exchange them so that each commands a full line in his respective market area. In contrast to cooperative sourcing, product specialization involves adjustment in existing product lines.
11. Comarketing: agreement to divide market areas for some product(s) and/or to assume responsibilities for marketing and servicing each other's product(s) in respective areas. Joint marketing in third markets may be included.
12. Project cooperation: joint tendering for development projects in third countries.
13. Joint research and development: joint planning, and the coordinated implementation of R&D programs, with provision for joint commercial rights to all product or process technology developed under the agreement.
14. Any of the above in the framework of a specially formed mixed company or joint venture between the partner firms (on the basis of joint equity participation, profit and risk-sharing, joint management).

SOURCE: Office of Technology Assessment.

Table 16 summarizes one of the most recent attempts to classify types of cooperation agreements by frequency. It shows that in 1976 coproduction based on the principle of specialization accounted for more than 38 percent of East-West agreements. This kind of transaction involves the transfer of an entire production activity to a new location, usually in Eastern Europe. After coproduction, the next most common agreements were turnkey plant sales and the sale of licenses.

**Coproduction.**—Under this kind of agreement, each partner specializes either in the production of certain parts of a finished product, which is then assembled by one or both partners; or in the manufacture of a limited number of articles in the production range, which are exchanged so that each partner can offer a full range of products. The technology is usually provided by one of the partners, but in some cases may be the culmination of joint R&D effort. Generally, coproduction and specialization agreements also include cooperative marketing arrangements. Usually the product bears the trademark of both partners, each of which has exclusivity for the market in its own area but shares the market in other countries. In cooperative agreements with the Soviet Union, the Western partner usually has priority for selling in the industrialized West, and the Soviet Union confines its sales to Warsaw Pact nations and possibly certain developing countries.

The attraction of such agreements for both the Western and Eastern partners is obvious. The Western firm may acquire raw materials and/or labor in the East. The Eastern country expands its repertoire of manufacture, its markets, and often its potential for earning hard currency.

**Turnkey Plants.**—Of all cooperation agreements, turnkey transactions are perhaps the most effective means of technology transfer. Although technology may in many cases be purchased or leased through straightforward transactions in the marketplace, turnkey projects afford the possibility of acquiring whole production systems—from feasibility studies, construction, and training through technical assistance during the initial run-in period. Further, most trans-

**Table 16.—Classification of East-West Industrial Cooperation Agreements by Percent**

| | Total | Supply of license[a] | Delivery of plant | Specialization coproduction | Subcontracting | Joint venturing and other |
|---|---|---|---|---|---|---|
| ***Survey of June 1, 1976*** | | | | | | |
| Bulgaria | 100.0 | 17.1 | 25.7 | 31.4 | 11.4 | 14.4 |
| Czechoslovakia | 100.0 | 27.3 | — | 22.7 | 9.1 | 40.9 |
| East Germany | 100.0 | — | 23.5 | 14.2 | 7.1 | 33.8 |
| Hungary | 100.0 | 29.5 | 16.3 | 32.6 | 9.6 | 12.0 |
| Poland | 100.0 | 21.7 | 24.2 | 32.3 | 6.4 | 15.4 |
| Romania | 100.0 | 19.4 | 25.5 | 14.2 | 7.1 | 33.8 |
| U.S.S.R. | 100.0 | 3.2 | 20.4 | 61.5 | 4.7 | 10.2 |
| ***Total CMEA countries*** | | | | | | |
| 1972 | 100.0 | 28.2 | 11.9 | 37.1 | 7.9 | 14.9 |
| 1975 | 100.0 | 26.1 | 21.7 | 33.3 | 6.8 | 12.1 |
| June 1, 1976 | 100.0 | 17.1 | 20.5 | 38.3 | 7.4 | 16.7 |

CMEA = Council for Mutual Economic Assistance or Comecom.
[a]Supply of license in exchange (in part at least) for products or components.
SOURCE: Economic Commission for Europe, United Nations.

actions guarantee an ongoing relationship with the supplier, opening the possibility of access to developing technology. The continuity of these relationships is universally regarded as the most important single element affecting the success of a technology transfer.

Turnkey projects in their pure form, involving purchase of an entire installation from one firm or one country, are relatively rare—at least in the case of the Soviet Union. Most often, a Communist nation contracts with many Western firms for particular components of a complex, including marketing and subsidiary services. The Soviet Kama River truck plant is a good example. Here, the U.S.S.R. dealt with Western firms in several countries, assembling its own sophisticated mixture of goods and services to fit its own specifications.[3]

**Licenses and Patents.**—The acquisition of technology through licenses accelerates indigenous technological progress and enhances potential export capabilities in the East. According to one estimate, the purchase of a license may cause technological progress in the affected field to leap by 7 to 8 years, compared to only 3 to 5 years with the purchase of know-how and 1 to 2 years for coproduction.[4] Often the acquisition of a license creates requirements for other improvements, more imports, further licenses, and the promotion of exports. Licenses may be paid for in either currency or in products through countertrade arrangements. In Eastern Europe, the latter predominate.[5]

Licensing arrangements are varied, ranging from a straightforward authorization to exploit an individual patent to complex agreements on industrial cooperation. These may provide for the grant of licenses for using patents linked with the importation of certain capital goods; of licenses to use know-how and technical assistance in building turnkey plants or other industrial installations; and of licenses to use trademarks.

It is apparent that the diversity of modes through which technology is transferred and the complex interdependence of activities,which are directly or indirectly involved in the process, make it extremely difficult to accurately measure the value of technology that flows to the East in commercial transac-

[3]See Harlan S. Finer, Howard Gobstein, and George D. Holliday, "KamAZ: U.S. Technology Transfer to the Soviet Union," in Henry R. Nau, ed., *Technology Transfer and U.S. Foreign Policy* (New York: Praeger Publishers, 1976).

[4]See Jozef Wilczynski, "License in the West-East-West Transfer of Technology," *Journal of World Trade Law*, March-April 1977.

[5]*The U.S. Perspective on East-West Industrial Cooperation*, International Development Centre of Indiana University (Bloomington, Ind., 1975).

tions. No extensive statistical analysis of the transfer function in this respect has been made, and available data can support only crude analyses of overall volumes and trends. Any comprehensive assessment of the economic importance of these transactions would require data of a sophistication presently unavailable.

## NONCOMMERCIAL TECHNOLOGY TRANSFER

Open and regular contacts between the scientific and engineering communities of the United States and the Soviet Union have received official encouragement through a number of bilateral agreements. In July 1959, a formal agreement was concluded between the U.S. National Academy of Sciences (NAS) and the Academy of Sciences in the U.S.S.R.; in the same year the International Research and Exchanges Board (IREX) began a program that sent American graduate students and young instructors to the U.S.S.R. In 1972, the U.S./U.S.S.R. Agreement on Cooperation in the Fields of Science and Technology (S&T) was completed, instituting bilateral cooperative programs in a number of scientific fields. The S&T agreement is predicated on the idea of building and maintaining a world scientific community through open channels of communication. More recently, exchanges with the People's Republic of China (PRC) have begun.

The role that such contacts have in transferring American technology with potential commercial value is the subject of considerable disagreement.

Two recent studies of the S&T agreements and the exchanges program by NAS have attempted to assess the value to both sides of the information exchanged in these programs.[6] Both concluded that exchanges with the Soviet Union were worthwhile, although their value to U.S. participants may be limited by American scientists' lack of familiarity with the Soviet Union's unique style of science and engineering and by the lack of Soviet candor regarding weaknesses in many areas of its research. Both programs were plagued by the rigidity of the Soviet bureaucracy (although problems with the U.S. bureaucracy seemed to rank a close second) and by erratic attendance on the Soviet side. In 1978, for example, NAS extended invitations to 44 Soviet scientists; only 4 participated.

A review of the two studies indicates that while the initial contacts provided some useful information about Soviet research (especially in the fields of medicine, weather forecasting, accelerated drug testing, nuclear fusion, magnetohydrodynamics, superconducting magnets, and earthquake prediction), the primary value of the U.S./U.S.S.R. exchanges to America has been one of educating the scientific and engineering community about the nature of the Soviet scientific system:

> Not only do U.S. scientists and engineers have the opportunity of acquiring at first hand new ideas and new perspectives from their Soviet colleagues, they also become more familiar with the relevant Soviet scientific literature and are alerted to particular Soviet scientists and engineers whose future publications likely merit special attention.... [The Soviets] have probably received more technical value in computer topics, in econometrics, and in management science than has the U.S., largely because the U.S. is more advanced in these areas. But the most significant value to the U.S. ... lies in better U.S. understanding of the Soviet planning and management process, and of Soviet status and approaches in economics, management science and computer science.[7] It is nevertheless true that the United States has, on the whole, taught the Soviets more than it has learned from them. The NAS expects the future balance to shift toward greater equality.[8]

[6]National Academy of Sciences, *Review of the U.S./U.S.S.R. Agreement on Cooperation in the Fields of Science and Technology*, National Research Council, May 1977, and *Review of U.S./U.S.S.R. Interacademy Exchanges and Relations*, National Research Council, September 1977.

[7]Ibid., *Agreement on Cooperation*, pp. 7, 43.
[8]Ibid., *Interacademy Exchanges and Relations*, p. 3.

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According to NAS, the risk of inadvertently communicating important technology through scientific exchange is minimal. The Commerce Department's Office of Export Administration regularly briefs U.S. scientists on topics they should not discuss in the exchange programs, and "except in certain narrow and well-delineated fields, problems of technology do not loom large . . . The Soviets have not managed to translate into practice the wealth of American technical data already available to them through the open literature [and as a result] their technology is unlikely to benefit greatly from any further technical data we might disclose except certain specific data which are proprietary or classified."[9]

A different cost/benefit balance may exist in the student exchanges between the United States and the U.S.S.R. These can result in the transfer of technology that is difficult to quantify or even identify. Since about 1972, Soviet "students," who are usually experienced engineers, scientists, and managers of R&D establishments, have concentrated on study programs in the United States in semiconductor technology,

[9] Ibid., *Interacademy Exchanges*, p. 4; *Agreement on Cooperation*, p. 43.

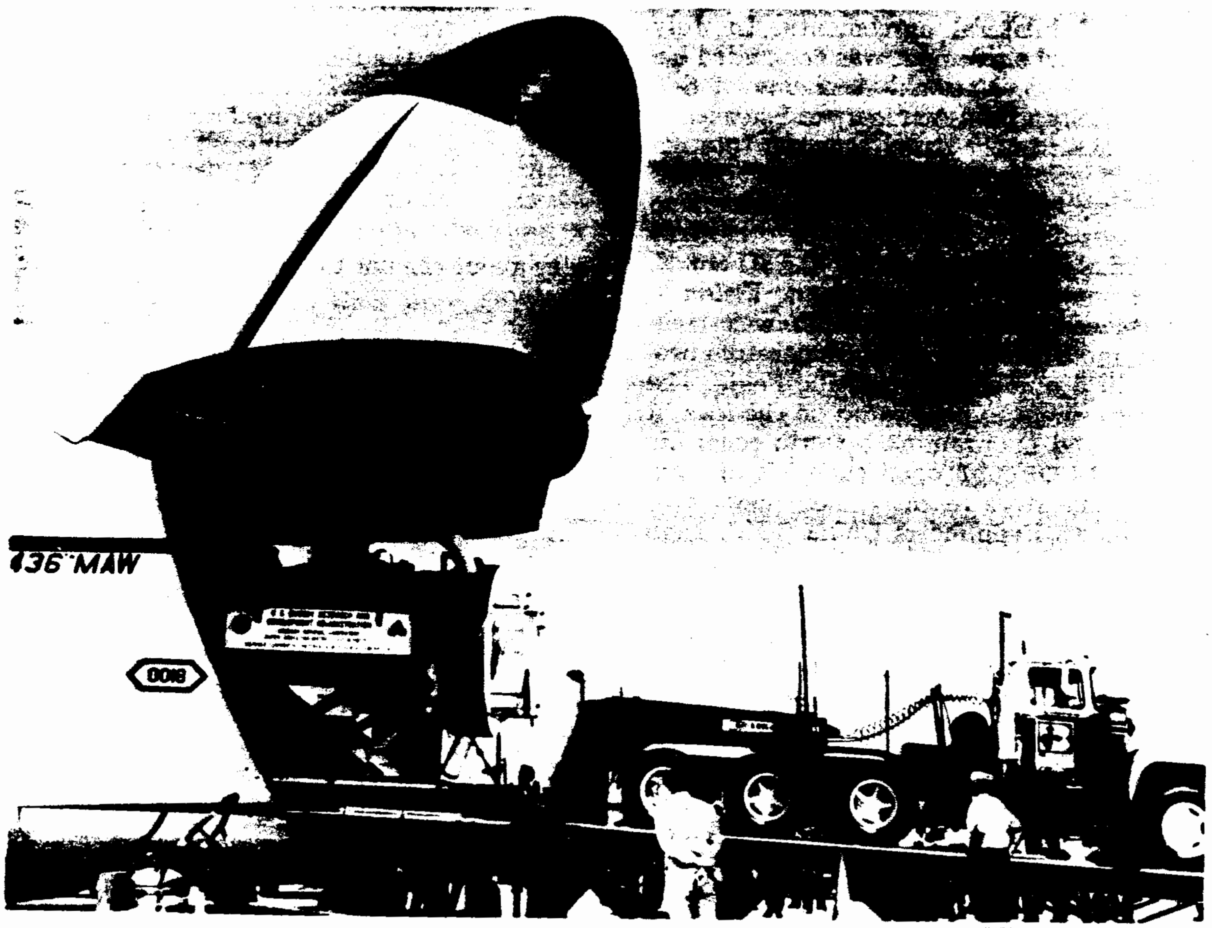


*Photo credit: U.S. Department of Energy*

**American magnetohydrodynamic (MHD) technology arrives in the Soviet Union as part of the U.S./U.S.S.R. Cooperation Program**

computers, and other fields related to problems of applied research. Large numbers of Chinese "scholars" are similarly beginning to appear in the West. Data reflecting the number of such students and the institutions they attend tell little of the nature and amount of the technology they carry back with them. It has been alleged that this information carries potential military significance. As far as can be determined, however, no systematic attempt has ever been made to quantify its value in either military or commercial terms. Any complete assessment of such exchanges must weigh both strategic and potential commercial losses against their political and cultural value.