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INTRODUCTION

The Soviet military-industrial complex, like its American counterpart, is a decisive factor in current world strategy and influences the processes that determine world peace. A sound understanding of its functioning is basic for the political analyst. Unfortunately, information on the Soviet military-industrial complex is limited primarily to analyses of Soviet military output and the military industry's input. The military industry itself, its internal structure and its mechanisms are in many respects a "black box," to borrow a term from cybernetics. The objective of this paper is to reveal the contents of that black box.

The Soviet military-industrial complex has been studied by a number of Western researchers. One of them, Egbert Jahn, has questioned the very existence of the complex as an individual structural sector that exerts an independent effect on the political and economic life of the Soviet Union. This paper does not deal with this aspect of the problem, and employs the term "military-industrial complex" purely to describe the set of military-industrial ministries, without touching on its role in the country's political life. A consideration of that complex, however, naturally gives rise to the question whether the mechanism governing the Soviet military industry differs from the mechanism governing Soviet industry in the civilian sector.

Estimates about the Soviet military industry can be made either on the basis of its output, which to some extent becomes known in the West during military conflicts, or from various indirect data obtained from an analysis of official information. At the same time, it must be noted that output alone serves as only a slight indicator of the efficiency and organization of the Soviet military industry; the same output, quantitatively and qualitatively, can be obtained by applying either capital-intensive production equipment and organization methods, or obsolete labor-intensive equipment and strict quality control. Thus the quality of the products, which is high in Soviet military industry, actually tells us very little of the organization of the industry itself.

STRUCTURE OF THE SOVIET MILITARY-INDUSTRIAL COMPLEX

Several publications have appeared in the West on the structure of the Soviet military-industrial complex. One of the earliest was written in 1970 by Andrew Sheren, who catalogues eight ministries, a number that tallies with what the present author knows. Sheren, however, erroneously believes that the space program is subordinate to the Ministry of Machine Building. His description also omits an important link, the Military-Industrial Committee (VPK), which coordinates the various activities of the military-industrial complex. David Holloway, on the other hand, writing in 1974, mentions the VPK and presents some information on its staff. Yet neither these publications nor that of Vernon Aspaturian (see References) provide any basic information on the mechanism by which the Soviet military-industrial complex functions. Holloway, Aspaturian and Jahn focus their studies mainly on the connection between military equipment (without distinguishing it from production equipment) and political decisions.

According to this author's information, the following Soviet industrial ministries are classified as exercising "defense" functions :

1. Ministry of "Medium" Machine Building, in charge of all problems linked with the use of atomic energy for military purposes;
2. Ministry of "General" Machine Building, in charge of missile and space equipment;
3. Ministry of Defense Industry, in charge of conventional weapons;
4. Ministry of Machine Building, in charge of ammunition;
5. Ministry of Ship Building, whose program includes the navy;
6-7. Ministry of Radio and Electronics Industries, which supplies the army with specialized electronics equipment, e.g., radar, military-computer techniques, etc.;
8. Ministry of Aircraft Industry.

These ministries are controlled directly by the VPK and produce finished military products. However, large quantities of important military equipment are also produced by so-called civilian ministries: the Ministries of Motor Industry (military motor transport, armored vehicles, amphibious vehicles, etc.), of Electrical Engineering Industry (military electrical equipment), of Chemical Industry (chemical warfare agents, fuel), Instrument Building (military precision instruments), and others. In fact, nearly all industrial

sectors of the Soviet economy are involved in the production of goods used by the military, including local industry and light industries such as shoes, textiles, etc. All production equipment for the military industry is supplied to the "defense" ministries by the "civilian" industrial ministries. Virtually all research and educational institutions, as well as the Academy of Sciences, handle secret military and military-industrial programs.

On the other hand, many "defense" ministries also have extensive programs for producing civilian products as well. For example, the output of the Ministry of "General" Machine Building includes streetcars designed for provincial towns, *Biryusa* refrigerators, harvesting combines, pleasure boats, and so forth. It is very difficult to estimate the share of civilian output, for its gross value is determined by the unique mechanism of Soviet pricing and gives no clue as to its real cost.

All this forms a vast military-industrial complex that undoubtedly dominates the Soviet economy. Parallels have been drawn between this complex and the military industry of the Comecon (Committee of Economic Cooperation) countries. Such comparisons, however, are misleading, as several differences exist. For example, the Comecon countries maintain no special military-industrial ministries; instead, military departments exist within every industrial ministry. This arrangement apparently serves to prevent the formation of a full-fledged military-industrial complex, which would surely play a more independent political role vis-à-vis the Soviet Union. Thus the USSR is not interested in developing the military industry of the Comecon countries, which it considers an annex of its own, or even a competitor. Plants producing only armaments are disappearing from the Comecon countries, so that civilian production becomes predominant in their programs. This does not apply to most Soviet military plants, even though practically every one of them produces a range of civilian products.

The geographic distribution of the plants that form the Soviet military-industrial complex is extremely irregular. Virtually the entire Soviet military industry is concentrated in Russia, the Ukraine and, to a lesser degree, in Byelorussia. Nearly every republic can boast an occasional plant that nominally belongs to the military-industrial ministries, but they produce only secondary parts or production units (e.g., a Riga factory that produces individual electro-mechanical units for military communications equipment, and a Vilnus factory producing electrical equipment for military use). Two major exceptions are the large Chkalov aircraft plant in Tashkent, which produces heavy bombers and transport planes, and the Tbilisi aircraft plant, which manufactures light planes. Both were established during World War Two in the wake of the evacuation of military plants from western and central parts of the USSR. The workers in these two plants are predominantly

Russians. This irregular geographic distribution is apparently dictated by mistrust of the local population and the desire to keep them away from state secrets, especially in the Baltic areas. Elsewhere, the lack of local skilled personnel is an additional, and perhaps decisive, factor.

SPECIFIC FEATURES OF THE SOVIET MILITARY INDUSTRY

The Soviet military industry has several unique features that distinguish it from civilian industry. Some of them are advantages, others are shortcomings: they ensure usually higher-quality production than in civilian industry, but they contribute to the inefficiency and even backwardness that mark so much of the military industry.

Market Mechanism

The most prominent feature of the Soviet military industry is its market nature, which resembles Western industry much more closely than its civilian counterpart. In the military industry the consumer is the absolute, dominant factor in relations between the supplier and consumer. The Defense Ministry issues orders to the development bureaus responsible for design and controls the quality of military equipment through its military representatives at plants, from the earliest stages of development of new equipment through completion

Guidelines for the inspection of military equipment are formulated under the supervision of a specialized, centralized body of the Defense Ministry and are subject to its approval. All military equipment must meet general requirements which are incorporated into every new set of guidelines. No such procedure exists in civilian industry.

A State Inspection Committee, generally headed by a representative of the above-mentioned body of the Defense Ministry, inspects the prototypes of military equipment and ensures that all items covered by the guidelines are thoroughly tested. A state committee of this kind generally includes many people, sometimes several dozens or even hundreds, depending on the nature of the product.

At the same time, a state committee for the inspection of prototypes in civilian industry is usually small, is not governed by strict regulations, and does not thoroughly check compliance with guidelines. Moreover, its membership is generally determined by the supplier, who can exclude undesirable opponents or compensate for their presence by the inclusion of known allies. There are no specific regulations as to how these committees should be constituted and, for this reason, they often approve faulty equipment.

Another feature distinguishing military from civilian industry is the method of inspection of current production. In civilian industry, as in the military, quality control is effected by the Department for Quality Control

(OTK). According to existing regulations, the head of the OTK in civilian plants is subordinate only to his "parent" ministry and enjoys a relatively independent position in the plant he is inspecting. However, if OTK rejection of a product threatens to jeopardize the production schedules of the plant, the OTK generally submits to pressure exerted by the plant manager and accepts defective products. Since the OTK inspectors receive their wages from the ministry to which the plant is attached, pressure can be exerted on them relatively easily — promises of bonuses, intimidation, etc. Thus the inspectors can be persuaded, as they often are, to conditionally accept faulty products, particularly toward the end of a given month, since stopping production to correct the fault would disrupt the predetermined schedule. Such conditional acceptance requires the plant management to undertake to eliminate the defect by the beginning of the next month.

In the military industry, however, OTK inspection is followed by a second inspection, carried out by military representatives called *Vojenpredy*. The latter are permanently attached to the plant and are entirely independent of its management and "parent" ministry. Their wages are paid directly by the Defense Ministry, and they have no connection with the bonus system of the plant or its ministry. Invested with veto power, the *Vojenpredy* have instructions to inspect production in strict accordance with the guidelines, which are particularly thorough and strict for the manufacture of military products. No replacement of materials is permitted, even in cases where such replacement would not harm production. The military representatives give no consideration to production schedules. Any laxity in inspection on the part of the military representatives is severely punishable if discovered by the Defense Ministry.

The existence of a second inspection system in the military industry greatly increases production costs, especially in the manufacture of large equipment where rejection can bear significant consequences.

The interface between the development bureau and production in the military industry differs substantially from that in civilian industry. In the latter, new products are developed by the plant's development bureau, by independent development bureaus not having production facilities of their own, and by research institutes in the relevant branch. No strict ties bind the plant to its own development bureau; in principle, every plant can manufacture products that have been designed outside it, although it prefers to manufacture products developed by its own development bureau, which is encouraged by financial as well as social incentives. A constant struggle exists between the development bureau and the independent research institute that has no production facilities of its own for the introduction of their respective developments into industry — a problem that does not exist in

the West. In the USSR, however, this becomes a serious restraint on technological progress, for products designed in research institutes and independent development bureaus are often not introduced into production at all. Generally, the services of independent research institutes and development bureaus are employed only by new and weak plants which have no designers of their own. As soon as such personnel are trained, they begin to display a tendency toward independence.

In the military industry, however, all plants are strictly distributed among various development bureaus, although the same plant may manufacture products developed by several designers. Thus, for example, in the aircraft industry every development bureau provides services for several plants in different parts of the country. One of them, a pilot plant, operates directly on the development bureau premises; others are responsible for serial production.

A plant can be transferred from the authority of one military-industrial development bureau to another only by top-level decision. The development bureaus in military industry fully dominate production, while civilian industrial plants can substantially change the products, sometimes even disregard the opinion of the designers, in the interests of production. In military industry the sundry documentation that the development bureau hands down to the producer assumes the force of law. There can be no unilateral change in the documentation on the part of the plant, and the development bureau generally remains adamant against proposed changes. This has its shortcomings, as designers' mistakes often exact their toll from production and greatly raise the cost of products.

The designers in military development bureaus do not adhere to state standards and demand the use of parts which often differ from the ones provided for in standards. Different systems of standards can even be operative at the same plant. In civilian industry, however, a product would be immediately rejected by the producer if non-standard parts were stipulated where standard ones could be used.

Priority

An essential factor affecting the quality of military production is the fact that the military industry receives only materials of the highest quality and may use parts which have been banned by special regulation for civilian production. The military industry also has greater funds for the acquisition of new equipment, although fundamentally it is not equipped better than some of the civilian industrial sectors. For example, plants involved in agricultural machine building are furnished with first-class equipment, since the mechanization of agriculture is considered a high-priority national task.

This is true also of the watch and clock industry, the optical industry, and the bicycle industry, among others. The military industry also has higher wage funds, which enable it to use more labor per unit of output. At the same time, however, the greater accessibility of funds for equipment and labor does not necessarily work to its advantage, as identical results can often be obtained from better production organization and more efficient use of equipment. Indeed, the number of machine-tools in the USSR is several times higher than that in the U.S., while the gross output of Soviet machine building is considerably lower than that of the U.S., indicative of the poor utilization of equipment in the USSR.

Secrecy

Even if the market mechanism of the Soviet military industry and the priority it enjoys over civilian industry grant it definite advantages over the civilian sector, a stifling atmosphere of secrecy dooms it to inefficiency and even backwardness. It complicates communications within the Soviet military industrial complex, as this communication is organized not by military-industrial ministries but by the KGB, which classifies all information into five categories: "open," "confidential," "secret," "top secret," and "top-top secret." There is no single criterion that determines the classification of information, so that information of the same rank may be attributed with entirely different values in different sectors and different plants. Every person working in the military industry has the right of access to information of a particular classification. This right of access *(dopusk)* is officially issued by a centralized KGB service to a new employee when he is taken on the staff. His access grading can be changed while he is employed in a given enterprise in accordance with the recommendations of the management. The employee must sign a commitment not to disseminate state secrets — including the very fact that he works for the military industry — and not to enter into any relations whatsoever with any foreigners without prior permission.

Many plants maintain libraries which are open to their personnel. These contain relevant books, journals, sectoral publications, and some material which has been classified "confidential" and which ordinarily may not be taken from the premises. All material classified "secret," "top secret" or "top-top secret" is kept in the archive of the KGB department in charge of the plant's security and is available to plant personnel only to the end of the working day. All materials are numbered, and the personnel to whom they are issued must adhere to all the rules of library procedures. For example, the reader may not leave such literature lying on a table in the library if he leaves the room for any length of time. If, in a special case, he is permitted to take it from the archive to his place of work, it must be carried

in a special file or hidden on his person; at all times, such material must be in a safe, locked place.

In a military plant, notes on the day's work are entered in special notebooks — some open, some secret. All secret entries must be made in ledgers kept in the KGB department. Every page is numbered and cannot be arbitrarily destroyed. Entries are made only by authorized personnel — either the same person every day or several people who jointly share responsibility for a specific project. Every office dealing with secret information has two typing pools, one open, one secret. Secret material, such as that in the secret work notebooks, is retyped in the secret typing pool; all other matter is typed in the open one.

All these regulations hamper work and often lead to absurd situations. For example, in 1969 an international machine-tool exhibition was held in Paris and attended by representatives of the Soviet military-industrial complex. A major report was written in a military-industrial institute on the exhibition. When retyped in the open typing pool, the report numbered several hundred typewritten pages. After the report had already been typed, it was suddenly learned that a government order issued shortly before declared all reports on foreign trips made by Soviet experts to be "secret". The institute's KGB department insisted on rewriting the entire report, by hand, into a notebook, which was then to be retyped in the secret typing pool. Following intervention by the administration and negotiations with the KGB department, which lasted several days, the KGB department finally made a concession and only demanded that the back of every page of the already typed report bear a number and "secret" stamp, which implied that the report had been typed in the secret typing pool.

Secrecy requirements mandate that the real names of military products may not appear in writing, even those stored in the KGB department, and that they should not be pronounced anywhere, even at closed meetings. Generally the word "product" or some such code description is used for this purpose, although violations of this demand are not uncommon.

Employment in a certain plant or office does not entitle an employee to visit departments other than his own without a specific purpose. At aircraft and missile factories, for example, "top secret" right of access is required to visit most shops, while "top-top secret" right of access is needed to visit assembly shops, which are therefore provided with an additional, special guard. The general intent is that the employees of one department be unaware of what employees in other departments are doing — a situation that often leads to misunderstandings and overlapping in the same office. The same considerations dictate that there be no open meetings in military industrial organizations, participants in all meetings being limited to the official

lists only. The presentation of scientific theses is similarly restricted. Needless to say, anyone intending to visit an outside secret installation must obtain an official assignment to that effect from his office.

The information services in a military-industrial ministry are far more numerous, but far less effective, than in civilian industry. The duties of the information services include the dissemination of Soviet as well as foreign publications to the libraries of military-industrial organizations. Yet employees of military industry receive far less information on foreign as compared to Soviet technology than do employees of civilian industries. This is due to the general isolation of the military industry and the abnormal situation created by secrecy, and the lower qualifications and general intellectual level of employees in military industry, very few of whom know foreign languages. In fact, a reading knowledge of a foreign language is a rare achievement for employees of a military-industrial institute. A department comprising several hundred people may include only a few who are able to read English, and then only with difficulty. In a comparable civilian industrial institute, on the other hand, a large number of employees will know English well enough to read technical literature (although very few may be able to speak it). And in the Academy of Sciences, practically all scientists are able to read foreign technical literature without the help of a translator, and many even know two or more foreign languages. (Most of them also do free-lance work for the Institute of Scientific and Technical Information of the Academy of Sciences, which provides them with additional income and current information.)

Thus personnel in military industries must rely overwhelmingly on the services of translators in order to learn about innovations publicized in Western technical literature. The average income of such translators is very low: in 1975 the average income of a translator in a research institute was 120-150 rubles a month, far below the wages drawn by translators of fiction or political literature. Qualified translators are therefore not attracted to work in military industry, and the places are often filled by incompetent employees who have neither a sound knowledge of the foreign language nor a solid understanding of the specific technical field in which they are working. Yet even such inept translations as are produced by these translators are valued by employees who have no other access to foreign texts. These difficulties in getting first-hand information on foreign technical innovations make it necessary to seek such information in secondary sources, such as books or articles by Soviet scientists, who generally are sufficiently qualified to understand foreign literature. This, however, causes a major information lag.

Every military-industrial ministry publishes its own secret monthly. The ministries also issue bulletins indicating which affiliated organizations are testing Western military equipment. But individual publication by employees of a military industry is extremely difficult, over and above the general difficulty of all publishing in the USSR. Every Soviet scientific and technical journal, for example, requires every author to furnish a certificate issued by experts of his own organization vouching that the publication does not reveal any secrets, including patented information, and a note from the author himself guaranteeing that no secrets are contained in his article. In a civilian institute or factory, the prospective author submits his article to a committee of experts (not his direct superiors) which issues its conclusions. In the military industry the same procedure lasts several months. An opinion is first issued by the departmental committee of experts headed by the department chairman, who may reject an article if he feels that it somehow infringes on his personal interests. Only after having received the endorsement of the first committee is the publication passed on to a higher-level committee of experts, which may also reject an article for trivial reasons. This procedure applies not only to articles in journals and manuscripts of books, but also to the texts, and even the resumés, of conference reports, which are also considered "publications." Many a prospective author is discouraged by the jungle of bureaucratic obstacles and therefore prefers to publish his articles in secret editions rather than in the open press. As a result, they are accessible to only a limited number of people. These difficulties lead many dynamic, creative people to leave the military industry, while many others live with a sense of dissatisfaction, indicative of social mechanisms that inevitably lower the general level among those employed in the military industry.

Although everyone given access to secret work must sign a commitment not to establish contacts with foreigners without permission, some such contacts do take place, particularly in the course of Western exhibitions in the USSR, which generally attract a large number of military industry employees, who are allowed to ask technical questions but are categorically prohibited from giving their names or the name of the organization employing them.

An additional source of contacts with foreigners are overseas scientific exhibitions and conferences, which personnel in military industry are sometimes permitted to attend. In 1971, following the defection of A. Fedoseev, a senior military designer, at the Aviation Salon at Le Bourget, France, trips abroad by military-industrial personnel were sharply reduced (it is uncertain how long these restrictions remained in force). The practical value of such trips had at any rate been relatively low, since competent scientists were rarely sent abroad — although management employees frequently took ad-

vantage of such opportunities — and since those sent overseas only rarely had a knowledge of the relevant foreign language.

Perhaps it is by now needless to point out that scientists in civilian industry maintain far closer ties with foreign countries than those in the military industry, especially (though not exclusively) with Eastern Europe. This is one more case in point illustrating the extent to which the overriding stress on secrecy in military industry serves to undermine progress and development in that industry.

PERSONNEL IN SOVIET MILITARY INDUSTRY

At one time, shortly before and after World War Two, employment in a military-industrial installation meant a certain social prestige, as well as preferential treatment by the government in the form of high wages, housing and exemption from military service, even during wars. While it is still generally believed abroad that the military industry is highly prestigious and that it employs the ablest and best-qualified scientists, engineers and technicians, in fact the pervasive effects of government-imposed secrecy have done much to lower the quality of employees and reduce the economic and social status they once enjoyed.

BRAINPOWER

From its beginnings, the Soviet military industry tended to limit the creative initiative of its scientists, especially engineers, because of the strictures of secrecy. At first these limitations were compensated for to some extent by certain privileges, but later, as greater governmental funds were allocated to the civilian sectors of the Soviet economy, the prestige of the military industry began to wane. Greater prestige became attached to teaching in institutions of higher education or working in the Academy of Sciences, two areas where personal achievements were not hidden and where professional reputations could be made. More attractive yet were the possibilities of international contacts and trips abroad, the last being extremely valued in a totalitarian country isolated from the outside world. Such fields of activity were now better paying, and as the work was not secret, additional income could be earned by writing, tutoring, consultations, lectures, etc. Jobs in the military industry, on the other hand, deprived employees of most forms of additional earnings, prevented them from gaining professional renown, and imposed many other restrictions on them, all keenly felt in particular by the more able, dynamic, and hence ambitious, individuals who have grown increasingly reluctant to work for the military industry.

At the same time, however, the average wage in the military industry is higher than in the civilian sector. Someone who is neither especially ambitious nor particularly capable, and therefore unable to take advantage of the outside opportunities available in civilian industry, can gain financially by transferring to the military industry. Thus, for example, an engineer employed in the civilian sector can expect to earn a 20-30 percent higher

salary by joining the military industry. The wage differential can even be as great as 40-50 percent.

There is in fact a steady influx of young specialists into the military industry, mostly graduates of technical institutions, some of which train people exclusively for the military industry. Many students are given the right of access to secret material during their internships at military-industrial plants, which often predetermine future job appointments. Students who apply to the educational institutes and faculties of the military-industrial complex are not necessarily selected on the basis of ability. Once accepted, they are committed to the military industry and do not receive preferential treatment even if they are especially competent. As a result, these educational institutions are not held in high regard by the public, nor do they attract top-level students.

The military industry also hires graduates of other technical institutions and people who have taken correspondence courses or attended external courses. The hiring procedure is strictly impersonal, since applications are processed by the personnel department of some ministry, without preliminary contacts between the prospective employer and the students. Excellent scholastic records are not an important criterion for selection, and a significant number of the ablest workers who begin their careers in the military industry later leave to join civilian institutions. And as noted previously, the higher wages and greater job security of the military industry attract many less-qualified people who have previously begun work in the civilian sector.

The secrecy that envelops the military industry creates favorable opportunities for those who seek to raise their status by earning academic degrees but who could not do so in civilian institutions. The restrictions on publication in the military sector apply to scientific theses as well. Thus all theses are presented for review at closed meetings of the scientific councils. "Open" theses are made available to whoever wishes to examine them; "secret" theses are inaccessible outside the institutions, and even within it accessibility is limited to an abstract of the thesis, only twelve copies of which are printed and distributed by secret mail. Even the author's co-workers are seldom permitted to attend the presentation of the thesis. Such conditions tend to dissuade the more professionally ambitious (and qualified) scientist, but they are attractive to the less competent scientist who wishes to avoid criticism and professional scrutiny. As a result, the average standards of doctoral theses in the military sector are substantionally lower than those coming from civilian institutions.

The successful development of military equipment is often sufficient basis for the awarding of academic degrees and even promotion to the Academy of Sciences; no scientific or academic theses need be presented. Such recom-

mendations are made by large organizations within the military-industrial complex, the various military industrial ministries, the Defense Ministry, or the Central Committee of the Communist Party (CCCP). Due to the pervasive aura of secrecy, neither the Supreme Certifying Committee (VAK) nor the Academy of Sciences is informed about the nature of the work performed by these people, many of whom are from management and are not scientists themselves. The practice of promoting industrial and scientific managers (from civilian industry as well as from the military sector) to the Academy of Sciences began at the end of the 1920s with the purpose of undermining the old traditions of the scientific world and the relative independence of the Academy. For example, in the thirties, I. Bardin, the director of an iron and steel works, was appointed to the Academy of Sciences and eventually served as its vice president. By World War II, it was a well-established method; among those appointed were V. Dikushin, chief designer of a machine-tool building development bureau, and A. Mikulin, chief designer of aircraft engines. A the end of the 1950s, a large group of designers of space ships and missile weapons — Korolev, Chalomei, Glushko, Kisunko, Raspletin and others — were appointed without question to the Academy of Sciences despite the fact that some of them did not hold Ph.D. degrees and most were not scientists but major managers, responsible to the government for the fulfillment of specific projects. All the people in this group were promoted to the Academy's Department for Technical Sciences, which was later reorganized as the Department for Mechanics and Control Processes. Managers who have been advanced by the military-industrial complex constitute the majority of the membership of this department (a unique situation that does not obtain in other departments) and in time began to influence significantly the decisions of the Academy and its presidium.

Strictures of secrecy also influence the national composition of the personnel in military industry, in which Russians and Ukrainians form the absolute majority. As previously noted, almost no military industry plants are situated in the Baltic states, the Caucasus or Central Asia. Only a few Latvians, Lithuanians and Estonians are employed in the military industry, perhaps also reflecting their own unwillingness to work in that industry.

Hiring Jews for military installations was halted almost completely in 1969, although those already employed were not fired. Many Jews still work in the older branches of the Defense Ministry, such as the aircraft, munitions and weapons industries, but few work in the newer sectors, such as electronics and missile development. Discrimination against Jews, however, is not a phenomenon unique to the military industry, but rather a common occurrence in civilian sectors as well.

In summary, the element of secrecy exerts a decisively negative effect on

technological decision-making in the military industry, sharply lowers its efficiency and discourages the ablest people from working in it. On the other hand, the drain of brainpower from the military industry is in definite measure compensated for by the fact that the industry makes extensive use of the achievements of civilian industries, especially research and development carried out by the institutes of the Academy of Sciences and various other independent institutions.

Labor Force

Employment in the military industry is more attractive for technicians and blue-collar workers than it is for engineers and academics, since there are fewer limitations enforced on the creativity of the former group. Given the freedom of choice of employment, however, skilled workers too seek to leave the military industry. But such freedom of choice is often limited, since in many localities military plans are the only available places of employment. Between 1940 and 1955, voluntary transfer from one place of employment to another was prohibited, a measure that greatly limited freedom of employment. For a number of years after 1955, the government was able to maintain substantial incentives in labor conditions in military as compared to civilian industries. At present, however, the acute demographic crisis among the Russians (and the Slavs in general) in the Soviet Union has affected manpower in all sectors, but especially the military-industrial sector where Russians form the backbone of the labor force, and no governmental measures can compensate for this.

In the initial period following the abrogation of employment limitations, there was an influx of labor to the military industry from the civilian sector. To attract labor, the civilian industry on its part began to raise wages systematically; these wage increases were issued without official sanction or regulation to that effect. For example, wages were artificially raised for piecework employees by boosting skill grades and establishing lower quotas, so that real wages greatly exceeded what such employees would have earned in accordance with officially approved wage scales. The practice of giving skilled workers guaranteed minimum wages became common (a practice that usually required fictitious calculations on the part of the management). Available data indicates enormous average wage increases in the civilian sector in the last twenty years. Even taking inflation into consideration, an increase of nearly 200%, which took place between 1960–67 in a Moscow watch and clock factory, is no small figure. And the trend continues today, with more substantial increases occurring yearly in some sectors.

Among the other reasons work in civilian industry is more attractive are the more lenient conditions they offer in terms of discipline. Many civilian

workers use their work time and equipment to produce articles for the black market. As earnings from such activity can exceed a worker's nominal salary, this practice is widespread. For example, at least until 1965, a group of workers in a Moscow research institute produced special short-wave adapters for standard radio receivers. These enabled the listener to receive broadcasts between 11 and 19 meters, a range not provided for in state standards and absent from Soviet radio receivers produced for the official market. These adapters were easily sold on the black market, since at the time the jamming of Western broadcasts in this range was far less effective than it is today. Similarly, between 1956-58 the workshops of another research institute produced expensive, professional-quality tape recorders; these too were profitably sold on the black market.

Shops such as these are not guarded, and thus the contraband articles can be smuggled out. At military-industrial plants such laxity is unheard of and activities of this sort virtually impossible. (However, it has been reported that guns were available on the black market in Tula.) In combination with the often higher salaries, the opportunities to engage in illicit business in the civilian sector regularly attract many skilled and creative people to civilian industries and small shops.

Essentially, then, the drain of manpower from the military to the civilian sector is similar to the drain of brainpower. Workers who are tradition-bound or tied to a place of residence, especially the less skilled and less dynamic among them, still prefer the job security offered by the military industry. But on the whole, chronic manpower shortages of both skilled and unskilled labor plague the military industry as they do the civilian sector. In both sectors, in fact, blue-collar industrial jobs are increasingly unpopular among younger people, despite the wages, because jobs such as machine-tool operation carry very little status. For the young people of the USSR, desirable occupations are service jobs, especially those requiring technical skills, such as appliance repair, or personal services, such as selling consumer goods or driving taxis or chauffeuring officials — work that allows for direct contact with the client and thus opens the way to additional financial opportunities. In this respect, all jobs connected with tourists and foreigners are particularly coveted.

Workers tend to choose the jobs that carry higher status even if they are lower paid. For example, in the Kiev aircraft plant, young workers refused to work as "millers," even though they were offered high wages, preferring instead to operate numerical-control milling machines at lower wages because they were then called the "electronics maintenance staff."

At one time, workers in the military industry were enticed by the opportunity of obtaining housing, a benefit which has recently disappeared. In fact,

today in Moscow, which is a major military industrial center, it is easier to get housing or "registration" (ensuring eventual housing) for civilian employees, particularly in the construction and service sectors, than for military personnel. In addition, fringe benefits, such as medical services and rest homes, are frequently better in civilian industry.

TECHNOLOGICAL PROGRESS IN THE SOVIET MILITARY INDUSTRY

Although relatively little is known about it, the nature of technological progress in the USSR differs substantially from that in the West. The mechanisms governing technological progress in the civilian and the military industries in the USSR are essentially the same, although the element of secrecy and the greater accessibility of funds in the military sector do result in some distinctions.

Logically, the development of military equipment should be expected to depend on foreign equipment and technology far less than would the development of consumer goods. In the USSR, however, this is not the case; the military industry relies greatly on imported equipment and especially foreign know-how. The reason for this dependence can be traced to the different attitudes towards secrecy held by the Soviet and Western military industries.

One account may illustrate these divergent attitudes: In the course of a 1966 visit to the United States, Professor A. Letov, a senior scientist in the Soviet space program, was permitted to be present at a discussion of the NASA budget for the next fifteen years. When he reported this later in the Soviet Union, his colleagues greeted the story with unbelieving laughter, as all aspects of the Soviet space program, including budget allocations, are top-top secret. By being allowed to learn details of the NASA budget, Letov had essentially been granted a great deal of information on the entire technical policy guiding the American space program and missile technology development.

In addition to information about Western military technology gathered directly (or indirectly) by the giant system of Soviet intelligence, an enormous amount of top secret (by Soviet standards) data is freely published in Western technical literature. In fact, such publications print everything military officials and weapons designers need to know about modern armaments and strategies, from basic concepts to the details of lead-times for specific military products. In conditions where research and development has become a mass phenomenon, as in the Soviet Union, there is little difficulty in putting technical concepts into practice. At the present level of Soviet technology and science, the military industry can concentrate much of its available investment capital and brainpower in research and development, even if it means exerting a strain on the Soviet budget. The main challenge in development is choosing the "concepts," the verbal definitions

of the basic technological innovations. This task falls to the chief designer of a specific project; and he is often able to draw such concepts from information published in the West, sometimes even implementing them before their implementation in the West, since conceptual and technological data often appear in Western technical literature long before their practical realization.

The process of "borrowing" Western military technology began with the creation of the nuclear bomb; the information obtained from the West by Soviet intelligence played the major role in Soviet nuclear development, although this does not, of course, imply that the Soviet Union's implementation of "borrowed" theoretical concepts should be belittled. Yet one could make a strong case for the argument that no fundamentally new concepts have emerged recently in Soviet military technology; instead, Western innovations have been implemented with minor design changes introduced according to the dictates of Soviet military strategy. For all the success the USSR has had in implementing Western concepts, the quality of Soviet military equipment, although high, seldom excels the Western military equipment produced by implementing the same technological innovations.

SPILLOVER BETWEEN THE MILITARY AND CIVILIAN INDUSTRIES

As far as the spillover of military technology per se into the civilian sector is concerned, one can state with confidence that it barely exists. The dissemination of such innovations is strictly prohibited, and the secrecy that pervades the Soviet military industry serves to prevent infringements of this prohibition. Technological advances that are not strictly military in nature are eventually permitted to filter into the civilian sector, but this process takes so long that it is easier and more profitable for civilian industry to draw on foreign sources for new information.

The severity with which the Soviet government views infringements on the ban on military "leaks" can be illustrated by an incident that took place in 1959. In June of that year, the All-Union National Achievements Exhibition (VDNKH) was held. In keeping with custom, the opening of the exhibition was attended by government representatives, including Nikita Khrushchev and virtually the entire leadership. At a radio-electronics pavillion, Khrushchev was shown a new radar device capable of locating large shoals of fish, and was informed that it was actually secret military equipment adapted for use by the civilian fishing fleet. Khrushchev immediately had the exhibit removed from the pavillion and sent for Y. Maksarev, then chairman of the State Committee for Science and Technology, who was responsible for the opening of the exhibition and hence for the breach of security. Maksarev hid from Khrushchev for two hours until he was discovered; in the presence of the other government members, Khrushchev berated him and insulted him coarsely. Although the offending exhibit turned out to have been a completely obsolete radar device long since discarded by the army, and the whole incident was in fact an intrigue against Maksarev (a member of the old Stalinist elite dissatisfied with Khrushchev), the pretext of a possible breach of security sufficed to have Maksarev demoted to the chairmanship of the Committee for Inventions, where he served until recently.

This episode underscores the impossibility of civilian utilization of materials developed for the military. In principle, a civilian organization can obtain a catalogue of new materials, parts and devices used or developed by the military, but must have special approval — which is never granted — to obtain the articles themselves. What exchange of production technology know-how does exist between the civilian and the military sectors is generally

one-directional, from the civilian to the military. Since civilian products are freely publicized through technical literature and conferences, they can be easily inspected, and used, by the military industry. Thus, for example, laser technology was introduced first in civilian industry; low-capacity lasers developed in the Academy of Sciences were used in 1965 for boring minute holes for various industrial uses, and only later was laser technology applied to military use.

Production equipment in civilian industry is equal to or often better than that used in the military sector. In fact, the most advanced Soviet plants are in the civilian sector, such as those to which foreign visitors are admitted. The "Red Proletarian" machine-tool plant, the Likhachev Motor Works, the Gorky Motor Works, factories involved in heavy and engineering machine-building, tractor plants, clock and watch factories, photographic equipment producers — these and other showcase plants and high-priority industries indeed operate on a relatively high technological level. Very high government-imposed specifications are attached to the goods produced in these industries, hence the plants must use industrial equipment as sophisticated as that used by the military. They can quickly replace their outdated or worn-out machine tools because the fact that they export their products entitles them to purchase top-quality imported equipment with certain currency deductions in their favor. Such plants, the vanguard of Soviet industry, share their expertise with the military industry. Almost all new management methods are first introduced at these plants, and it is at them that new production techniques are publicized, as it is forbidden to publicize such innovations when they occur in the military industry.

For the most part, Western researchers erroneously continue to ascribe a superior level of production management and technology to the Soviet military industry. They assume that the main source of progress in Soviet civilian industry is the gradual transfer of expertise from the Soviet military industry. Robert Campbell, for example, thoroughly analyzes Soviet technical literature and tries to find parallels in the American model, in which production management methods developed in the military-industrial sector do later spill over to civilian industry. He disregards the fact that in an analysis of the progress of Soviet production technology it is not enough to consider only the interface between the Soviet military and civilian industries; in fact, the primary focus should be on the relationship between Soviet and Western technology, as established through technical literature.

Campbell assumes, though without adequate proof, that the USSR is guided by the same principles in its management of its military industry as is the United States. He further assumes that the USSR is successful in meeting these standards of management, particularly when compared with the

known inefficiency of the Soviet economy, including its civilian industry. He then questions to what degree the USSR is able to use the production management know-how of the military industry to improve the operation of civilian industry.

Campbell conjectures that the "systems concept," quality control programs, reliability assurance and "network" methods can be considered examples of successful utilizations; he is unaware that the official Soviet technical literature that he quotes fails to state where these methods originated. He concludes that if Soviet military industry is successful, modern production management must operate in it. It then follows that if these management methods appear in civilian industry, their only source can be the military industry. He misses the fact that the new methods that emerge in civilian industry are borrowed from concepts found in Western technical literature and that, moreover, are introduced only later into the military industry.

Campbell correctly notes that the Saratov zero-defects system of production closely resembles the quality control method developed in the United States at the Martin space missile firm. A book on this subject published in the USSR in 1966 contains some of the same material as one that came out in the United States in the same year. Campbell seems to consider this a simple coincidence, but it is more probable that the Soviet author was able to publish his book almost simultaneously with the American writer because he had learned about the new method from American technical journals.

The place of the Academy of Sciences in the Soviet military-industrial complex deserves a special note, as the ties between this civilian body and the military take many forms. Most of the Academy's laboratories are engaged in open fundamental research in various fields, creating the theoretical premises for both civilian and military technical projects. Each institution within the Academy also maintains a secret military-oriented department.

Many scientists at the Academy have the right of access to secret work and in varying degrees participate in secret projects, for the most part as consultants. Such work, however, does not limit them as it does direct employees of the military industry, and they are freer to establish international contacts, visit foreign states and participate in international conferences, as their links with the military are not obligatory ones. Thus they can combine the advantages of working in an open institution with the advantages of ties (often merely superficial) with the giant military-industrial complex.

RESEARCH AND DEVELOPMENT PROGRAMS IN THE SOVIET MILITARY INDUSTRY

As distinct from civilian production, all new types of strategic military equipment are produced in the USSR on the basis of current (special) decrees of the Council of Ministers of the USSR, which may run counter to formerly approved state plans. These decrees can be signed at any time and, unlike the state plans, are not limited to specific calendar dates. Essentially, these decrees represent the approval of contracts between the Defense Ministry and development bureaus responsible for certain types of military equipment. They provide the lead-times of the prototypes, terms for coupling to serial production, mention all the essential subcontractors, and establish precise schedules for them. Every section of the decree always indicates the person responsible for that section, and establishes the budget allotted for the given work. The approval of the Council of Ministers of the USSR is necessary for every such contract, as there are no other legal measures which install some sense of responsibility for the execution of a contract issued to industry. In any case, simply an order of the Defense Industry is insufficient for that purpose.

Every such decree of the Council of Ministers is first approved by the Central Committee of the CPSU, but there is no information as to precisely how this approval is obtained (probably not in writing, at any rate). In all likelihood, initial approval depends on a Central Committee instructor who supervises the industrial sector concerned.

The successful development of new prototypes of military equipment is encouraged by material and social incentives. The persons responsible for a project may be promoted, awarded an academic degree, receive State or Lenin Prizes or some other government award. On the other hand, delay of the order or failure to fulfill it completely threatens them with demotion, and in some cases even with the ruin of their careers.

The chief designer of a military industry development bureau is generally responsible for the program as a whole, both the segment of the work under his direct supervision and the segments allocated to subcontractors. Since schedules are extremely tight, the chief designer seeks to use his influence to obtain as long a time allocation as possible for the project when the decree of the Council of Ministers is being drawn up. If the chief designer enjoys authority with the government (as did, for example, S. Korolev), he is

sometimes able to establish a more or less realistic schedule. If the chief designer has no such influence, or when strong political pressure is applied, or he fears competition from other chief designers, he may find himself in an untenable position. To avoid the risk of being blamed for having failed to meet the schedule, he takes steps in advance to ensure that he can justify himself if things should go wrong. For example, he may deliberately engage a weak subcontractor to whom the blame can be shifted should the project fail. Such subcontractors are most frequently the production facilities of the various military-industrial ministries. In such cases, the development bureaus and their plants hand down extremely difficult problems to the production technology institutes, their sole purpose being to enable them to justify themselves in the event of a break-down in the schedule of an important government program. All necessary work is actually carried out in their own facilities, the institutes being merely a juridical body bearing responsibility for the given project. The plant, naturally, seeks to allot as much funding as possible to the production technology institute in order to make the project seem important to the ministry, and deliberate deceit is sometimes used.

For instance, the development bureau for heavy ballistic missiles of the Ministry of General Machine Building defined and succeeded in having passed a Council of Ministers decree that did not even mention the subcontractor who was to provide the industrial equipment for manufacturing the bodies of the ballistic missiles (heavy machine-tools, which are in short supply). Given the conditions of Soviet industry, the development and manufacture of such machine-tools takes several years, while the date set for the completion of the prototype jeopardized the program from the very start. It was further endangered because the overemployed heavy machine-tool building plants refuse to accept any orders without a special decree of the Council of Ministers, similar to those issued for the production of strategic or other important equipment.

In the end, the main production technology institute of the Ministry of General Machine Building, which never designed such machine-tools before, was charged with their development — a maneuver deliberately designed to push the responsibility for the failed schedule onto it. The proposal to order these particular machine-tools abroad — which was realistic — was vetoed, for these would have been delivered in time, which ran counter to the interests of the plant. Most curious in the episode is the fact that the institute accepted the role of the scapegoat assigned to it.

Generally, the chief designers of the Ministry of General Machine Building maintain that the ministry's production facilities lag behind; this is their main justification for a schedule that has not been met. Actually, they always try to be fully independent in respect to production technology, but are in-

terested in pushing onto its production technology institute an enormous volume of work that cannot possibly be carried out, and that they really do not need at all, in order to lay blame on that institute should that need arise. This tactic is possible, however, only if the management voluntarily agrees to it. Essentially, no real sanctions are applied, for if they were, even only once, no management would agree to assume so dangerous a role.

Thus in response to pressure from the government and the Defense Ministry, various coalitions have formed in the military industry, enabling them to survive even in the most unfavorable conditions. When definite projects are provided for in the Council of Ministers decree, they are included by the ministry in the plan of the research institute and become the main program. However, they form only a part of the total research and development program handled by that research institute.

Other programs are initiated either by the research institute itself or by the various plants attached to its ministry. Any staff member of a research institute can initiate some project if he is able to convince his direct superiors of its usefulness, and personal initiative can play a very significant role. In such cases, the choice of a new project is determined by the employee himself. His motivation can stem from any of several factors: (a) the possibility of handling a project that could become the subject of his doctoral thesis; (b) the chance of being awarded a major bonus; (c) the opportunity of raising his status; (d) the opportunity to expand the team, laboratory, department, etc., as a result of the project. Any head of a lower-level group is able to take such initiative through official channels. He can try to convince the management of his own plant, but may also contact another plant independently and prompt it to sign a contract on the given project with the institute. Frequently the production engineer or shop management of the plant can become the level at which the institute staff member conducts negotiations instrumental in the decision. Management approval is followed by a contract signed by the plant and sent for signature to the institute, or vice versa. The cost involved is determined by agreement between the two parties; only then is a fictitious cost calculation drawn up, its main purpose being to justify the cost fixed in advance.

Research institutes and the plants themselves are often interested in exaggerating the cost, for similar reasons. One is the ambition of the plant personnel who seek to raise their status through the fulfillment of that contract. Secondly, the plant often seeks to use as much of the funds allotted to it for contractual jobs as possible to avoid cut-backs for reasons of non-utilization of funds. Third, the plant is willing to sign contracts to maintain friendly relations with the institute, or, to be more precise, some engineer of the plant is personally interested in helping some scientist at the institute, for by

entering into such a coalition, both secure the signing of the contract. The contract will stipulate the date of the project's completion; the end result may be either software guidelines or some hardware prototypes. The fulfillment of the project is endorsed by the plant. Since virtually no project is fulfilled on time, if at all, an institute representative visits the plant before the scheduled completion date and tries to persuade the plant management into signing the as yet unfulfilled contract. No other supervisory bodies exist to check him if he manages to make some such arrangement.

CONCLUSIONS

The Soviet military industry competes with the West's military industries for the growing world market for weaponry and other equipment. As a result, it is governed by market mechanisms, which accounts for the relatively high quality of Soviet military products. Nonetheless, the Soviet military industry cannot by any means be considered efficient; it is in fact, primitive and unsophisticated in terms of production methods and development, a situation that can be overcome only by increased investment.

Technical progress in Soviet industry as a whole depends to a high degree on information drawn from Western literature or from intelligence sources. For the military sector, this means that the bulk of its theoretical and conceptual innovations are actually "borrowed" from Western sources and then implemented in the Soviet Union, sometimes even before such implementation in the West. The military industry also relies heavily on the civilian sector, which is more amenable to innovation and progress because the bureaucratic tangles inherent in the military are not nearly so insurmountable in civilian industry. The civilian sector is also less affected by the overwhelming concern for secrecy that dominates the military industry and that has led to a gradual drain of highly skilled scientists, engineers, technicians and blue-collar workers away from the military sector. Progress is further hampered by the fact that research and development programs in the military sector are determined less by actual production needs than by a complex of social mechanisms between the government ministries and the various production facilities.

In short, the Soviet military industry is increasingly dependent on the civilian sector, and especially the research carried out by the Academy of Sciences, in order to stay in competition with the West. The vast and ramified military-industrial complex that has emerged has led to the general militarization of the Soviet economy and the gradual blurring of strictly defined borders between the military and civilian sectors.

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