SOVIET WEAPONS ACQUISITION IN A PERIOD OF NEW ECONOMIC POLICIES

Arthur J. Alexander

October 1988

P-7489

The RAND Corporation, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138

I. INTRODUCTION: CIVIL AND MILITARY R&D AND REFORM

This paper considers the future performance of the Soviet weapons acquisition sector under the conditions of Gorbachev's policies as they have been revealed thus far, and as they may develop in the future. I focus on technological change in the Soviet weapons R&D sector, and on the systemic influences operating throughout the weapons acquisition process. My approach reviews the main impediments to Soviet innovation in general, the means by which the military sector has avoided or mitigated the effects of many of these impediments, and finally the ways that present and possible future policies may change civilian and defense industries' relative capabilities in promoting technical change.

The chief elements that influence innovative behavior in the Soviet Union (and elsewhere) include values, policies, and the four properties of any economic system described by Berliner: prices, decision rules, incentives, and organizational arrangements.[1] Berliner focuses on the four economic properties, but since it is their differences in the civil and military sectors that generate the sharply divergent outcomes that we have seen in the past fifty years, we look to the sources of these differences: values and policies.

II. INNOVATION IN THE CIVIL SECTOR

The standard litany describing the problems of Soviet civil innovation contains the following elements. The decision rules that the ruling elite would like the managers in the system to use in choosing among alternative courses of action are inconsistent with the incentives faced by these managers. In particular, the leaders would prefer more innovation, new and more productive products, reduced costs, better use of internally generated research and development, better cooperation among research, design, and production organizations--in short, greater adherence to growth on the so-called intensive path, rather than on the customary extensive route that is based on ever-greater use of resources. Enterprise managers, who are the final implementers of

[1] Joseph S. Berliner, *The Innovation Decision in Soviet Industry*, MIT Press, 1976, Chap. 1.

innovation in the products they produce, face an unbalanced array of factors when they consider whether to innovate: high risks to innovation with small and uncertain returns; little penalty for failure to innovate; and a fairly well guaranteed return from following a conservative, no-change strategy. Rational evaluation of the balance produces a powerful incentive to eschew technological change, despite official rhetoric and formal decision rules that insist on innovation. In order to understand the different circumstances faced by the defense-industry manager, and possible future trends, it is necessary to establish the causes for this unequal set of forces impinging on the civil sector manager.

Supply Uncertainties

R&D and the implementation of innovation always involve risks of the unknowable future where affairs are, by design, intended to deviate from contemporary circumstances. But for the Soviet innovator, the economic system produces additional risks. Probably the most important such risk arises from the supply of inputs. Weakness of the inter-enterprise supply system has been a major shortcoming of the Soviet economy since the 1930s. Uncertainty over supply is the major problem facing managers, and for innovating managers or directors of research institutes the problems are magnified. A great deal of management effort is devoted to developing reliable relations with suppliers, tracking down late or missing supplies, sending dispatchers to problem enterprises, and dealing with local Party and government organs in attempts to obtain support in these activities. Once a known set of suppliers, components, and materials has been identified and incorporated into an enterprise's plans and operations, a manager is very reluctant to disrupt these arrangements.

Supply problems arise from faulty planning procedu over-centralization of planning and allocation, complexity of the economy with its tens of thousands of enterprises and millions of commodities, but mainly from the tautness of the planning system.[2] Tautness is another name for excess demand, which arises from the attempts of

[2]These points follow Berliner, pp. 70-72.

planners to motivate workers and managers to produce more by stimulating effort throughout the hierarchical management system. When tautness is combined with an incentive system that primarily rewards the meeting of output targets, a permanent seller's market is produced, one of whose outcomes is a state of constant shortage. Despite repeated attempts since the 1960s to replace output targets with more complex indices of plan fulfillment--including profit-like measures--short-term output continues to dominate the reward structure for a simple and powerful reason: the outputs of one organization are the inputs of others; in a planned economy of the Soviet type, the authorities cannot tolerate schemes that could disrupt the vast number of bureaucratically contrived connections among organizations without contemplating a chaotic breakdown of the production system.[3] Thus, supply uncertainties have been an abiding feature of the Soviet economy; they are produced by a control system that abhors organizational autonomy and flexibility, and that penalizes managers who dare to follow the official decision rules and attempt to innovate.

One of the enterprise's responses to supply uncertainty has been to attempt to produce as much as possible of one's inputs within the enterprise. And if it is not possible to produce a needed input in the enterprise, an industrial ministry will try to have it produced at least within the ministry. A consequence of such behavior is a proliferation of small-quantity, unspecialized, and inefficient production of countless items by multitudes of plants, leading to high costs, low quality, low rates of technical progress, and--where innovations do occur--low rates of diffusion.

As much as the risks to innovation are magnified for the Soviet manager, the rewards for successful implementation of technological change are stunted--mainly for the reason just alluded to: a reward structure that continues, in the main, to be based on gross output. Despite several attempts to juggle new-product prices to favor innovation and to add output indices based on the number or value of innovations, these modifications have been relatively minor and

[3]This point is put forward by Gur Ofer, "Soviet Economic Growth: 1928-1985," *Journal of Economic Literature*, December 1987, p. 1802.

ineffective. Moreover, as noted by Berliner, producers are protected from the positive pressures to innovate that are generated by competition and the potential entry of new enterprises by the very system of central planning that has produced the negative incentives in the first place--that is, enterprises are assured of customers for their production. Consequently, enterprises face only administrative pressures (rather than economic requirements) to innovate. In summary, we find a set of strong negative incentives for innovation, an absence of large positive rewards, and no compelling economic force arising from the risks of lost markets, profits, and enterprise existence.

Organizational Structure

In addition to the disincentives retarding technological change, the organizational structure also acts to discourage innovation. Soviet economic organizations are marked by large-scale bureaucratization, complexity, hierarchical rigidity, and horizontal boundaries that are often more difficult to bridge than international boundaries between less-than-friendly states. Where technology is fluid and change is rapid, successful innovating organizations require flexible structures, lateral interactions, and organic, non-hierarchical schemes of organization. Soviet economic organizations tend to violate these norms in all dimensions. As one example, Soviet enterprises are lumberingly large. Twenty years ago, only 15 percent of Soviet enterprises employed fewer than 50 people, compared with 85 percent in the United States and 95 percent in Japan. At the other end of the distribution, 24 percent of Soviet establishments had more than 500 employees; in the United States, only 1.4 percent of the firms were as large, and in Japan the figure was a tiny 0.3 percent.[4] In the meantime, Soviet organizations have grown even larger with the merger of enterprises and the creation of production associations in which many enterprises have been joined under a single management. Ironically, the amalgamation of enterprises and research institutes into enormous complexes was intended to correct the organizational boundary problem epidemic in the Soviet economy.

[4]Berliner, p. 33.

Despite the large scale of individual Soviet research and production organizations, the Soviet industrial structure has been characterized by functional specialization. Production enterprises do little R&D; research institutes have little capacity for prototype construction and testing or for pilot plant production. Design and project organizations produce blueprints for products and factories they will never have to produce or manage. Market economies can, for some products and technologies, coordinate these different functions through arms-length market transactions; but for the majority of products, the functions are integrated within single companies where intense personal communications and the movement of people who embody technical knowledge and know-how are more possible than across company boundaries. Even with such integration, however, research-intensive companies in market economies find that the management of the inter-functional flows is a critically important, difficult, and consuming activity. Developing effective links between research, design, development, production, and marketing is difficult under the best of circumstances; under Soviet condition it is grossly ineffective.

Not only are the functions associated with the research, development, and production of new technologies and products located in separate organizations, often they are in totally different sectors of the economy. The research institutes of the Academy of Sciences are the premier scientific organizations of the Soviet Union; these lie wholly outside the production sphere managed by the industrial ministries. Even when a research institute is within the same ministry as a production plant, the different incentives acting on managers of the different organizations produce only weak forces for the interactions and personal energies required to develop an innovation and transfer it successfully to a producing organization. Moreover, the forces of demand are so blunted that there is often little incentive to produce even a successfully implemented innovation.

Contracts for R&D

The Soviet government has put forward several policies intended to reduce the deleterious effects of organizational boundaries. Contracts were introduced and promoted in the later 1960s as vital links between research users and performers. Research institutes in industrial ministries and in the Academy of Sciences were informed that their budget support was to be reduced or held steady. Growth would have to be sought through contracts with industry. Thus, the correct incentives were provided to the research community to pay attention to the needs of users. The use of contracts has had mixed success, often depending (as in market economies) on the branch of industry and type of production process or product. Also important was the entrepreneurial spirit of research directors, the encouragement given by higher-level authorities, and the availability of research contract funds in production enterprises. The Siberian branch of the Soviet Academy of Sciences and the Ukranian Academy have gone the farthest in industrial participation--so far, in fact, that complaints were made by the mid-1970s that scientific institutes were being diverted from the basic goals of advancing science. All in all, the policy of promoting contractual relationships can be scored as a success in establishing links across functionally differentiated organizations, although the endemic problems of weak incentives for innovation on the part of the producer remain, and the difficulty of writing and enforcing contracts for R&D are even more severe than the problems of contractual relations wholly within the production sphere.

Production Associations

A different approach to dealing with the fragmentation problem was the creation of science-production associations (NPO) beginning in the late 1960s. A decree of September 1968 called for several types of research, development, and production associations throughout industry, agriculture, transport, construction, and other branches and specialties; the NPO was thus only one of the variety of new organizational types, all of which were intended to bring together under

a single management the variety of functions required to improve production processes, products, work organization, product development, and R&D. The greatest interest in forming NPOs was in the research-intensive industrial ministries.[5]

The NPOs, with a research institute (or design bureau) as the lead organization and its director as the manager of the entire complex, are intended to act as a technical center for a whole branch of industry. The other, or ordinary, types of production association, which also include R&D establishments--but as subordinate organizations--are more inward focused with the research institutes serving only the needs of the association.

The operations of the variety of industrial association have not been without substantial problems. The question of whether NPOs should have their own production facilities, for example, was vigorously debated. In fact, most had at least pilot-plant capabilities and many had considerable production capacity. However, ministries planned the production sections of NPOs as though they were normal enterprises, creating the usual impediments to innovation. When production capabilities were eliminated from the association, the usual technology-transfer difficulties across organizational boundaries remained, although somewhat attenuated. The ordinary production association appears to have gone further toward integrating the different functions, although they, even more than NPOs, are subject to the usual web of disincentives. Moreover, the formal organizational structure of the associations masks some serious boundary problems that continue to plague association managers; the elimination of organizational boundaries through the amalgamation of several kinds of organizations into a single association has often not been accomplished within the presumably unified association. In a great many instances, after 10 or 15 years of operations, full, integrated operations have not prevailed over the jealously guarded prerogatives of the original managers. The

[5]The development of science-production associations is described by Julian Cooper, "Innovation for Innovation in Soviet Industry," in R. Amann and J. Cooper (eds.), *Industrial Innovation in the Soviet Union*, Yale University Press, 1982, pp. 456-463.

original organizations often continued to act as unitary enterprises, maintaining their traditional links to superior organs, and even continuing to be issued separate plans by the planning agencies. Nevertheless, despite the imperfections of the policy, some progress has been made in reducing one kind of barrier to innovation by lowering the boundaries between functionally separate organizations.

Goal-Oriented Planning and Program Management

One other policy development in the civil sphere deserves mention, because of both its growing prominence and its links to military sector practices: the use of program planning and management.[6] The program approach places emphasis on a set of goals or technical achievements such as the development of a specific new product or the creation of some production capability. For such programs, planning centers on the achievement of the goals, rather than on an organizational unit such as an enterprise. Many of these programs in the civil sector appear to be related to high-level Party or government objectives and are managed outside the usual methods and organizational frameworks. In some cases, time schedules, resources, and participants are designated in the formal documents authorizing the project. For important, inter-ministry problems, a lead organization may be assigned authority over resources and over other participating organizations. In the most important projects, high-level political backing is used to solve the always-present problems of bottlenecks, unreliable supplies, uncooperative partners, and general disinterest in results. Such approaches have been used for major campaigns such as exploitation of Western Siberian oil and gas reserves, or for more narrowly defined goals such as a ship-building development program.[7] While often effective, program management is not a generalizable practice; its effectiveness depends on the ability to isolate a high-priority goal from the general economic structure; indeed, the high priority and privileged access to supplies and organizational talents can disrupt the plans of others and impose an

[6]Cooper, pp. 478-480.
[7]Cooper, p. 479.

additional burden on the already taxed capabilities of ordinary managers. As Berliner notes, when the source of problems is systemic, the creation of remedies by exceptions only adds complexity and arbitrariness to resource use and decisionmaking.[8] Therefore, to the extent that program planning is effective, it contributes an additional source of barriers to innovation to the unfavored residual claimants of resources, which is an appropriate transition to the defense sector.

III. INNOVATION IN MILITARY INDUSTRY

Soviet military industry escapes from many of the impediments to innovation faced by the civilian production sector through a variety of organizational devices and politically supported management policies. I will focus on the two chief impediments that were described above for civilian industry: supply problems and functional fragmentation brought about by organizational boundaries. But first, it is necessary to dwell for a moment on the incentive question.

Military Incentives

Unlike most of the civil production sector, the Soviet military faces true competition as it considers its real and imagined adversaries circling its borders. The highly skilled and experienced military professionals of the Soviet General Staff formulate weapons acquisition requirements and policies in light of the always-changing nature of the technical level and capabilities of the forces opposing them. Although the Soviet military maintains large forces and receives a commensurately large budget, in the development and acquisition of new weapons, it must act within overall budget constraints--no organization (not even the Soviet military under Stalin or Brezhnev) has access to infinite resources. The combination of real, international competition and a budget constraint generates a phenomenon that is rather rare in the Soviet Union--a buyer with incentives to make optimizing choices that appear to be rational to an outside observer. The importance of this rationality is that it is combined with political authority; this

[8] Berliner, 78.

combination transforms the defense industrial sector into a buyer's market, dominated by consumers. The incentives transmitted to defense industry are therefore consistent with the decision rules of the political leadership. Unlike most other actors in Soviet economic affairs, the defense leaders and the defense industrial managers, in general, actually choose what they *ought* to choose. They are astute buyers. This is not to deny that price distortions and other disequilibria introduce many deviations from strictly optimal behavior, but the military has been given something that others do not have: authority to cope with uncertainty and risk and the ability to escape the customary Soviet preoccupation with the narrowly defined efficiency of producers at the expense of the utility of users. It must be emphasized, though--and we will return to this point later--that competition and constrained choice do not automatically confer special rights, but that political values and policies have transformed the objective conditions into a favorable procurement environment.

Military Industry's Access to Supplies

Military industry is given first priority in its access to materials and the outputs of other enterprises. Beginning with planning at the highest level, the military allocation (as determined by the interplay of politics, economics, and military demands) are satisfied first, with the rest of the economy treated as a residual.[9] In production plans at enterprises, military orders must be completed before the demands for other customers. Capital equipment in short supply goes first to military plants, and then the remainder is allocated to lower priority enterprises. Advanced, high productivity foreign equipment, both bought and stolen, flows in large volume to military producers. Not only supplies and equipment, but also high-quality workers and managers, have been channeled to the military-industrial sector, where they have been rewarded with high salaries, bonuses, and other perquisites such as housing.

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[9]A.S. Becker, *Soviet Central Decisionmaking and Economic Growth: A Summing Up*, R-3349-AF, The RAND Corporation, January 1986, pp. 9, 19-21.

In order to guarantee the quality of its inputs, the military itself manages a network of military representatives at production plants producing final goods or inputs for the military customer. These representatives have the responsibility and authority to reject output that does not meet the contractual specifications, and to work out corrective procedures with local managers.

Even more than in civilian industry, the military industrial ministries and factories try to assure that as many of its supplies and inputs are produced under its control as possible. For example, the Ministry of Aviation Industry includes aluminum production capabilities and rubber plants for tire production.

In short, military producers escape many of the effects of a seller's market. They insist on the meeting of agreed quantities, qualities, and schedules. And they have the advantage of planning priority, delivery authority, and independent on-the-scene inspection to implement their demands.

Party and government organs contribute to the reduction of supply uncertainties to military industry. Local Party secretaries, as part of their general function of obtaining supplies for enterprises under their jurisdictions, pay special attention to military production. They can divert needed supplies from civilian plants to military plants, comb the local area for reserves, and call on their comrades in other areas to do the same in exchange for commodity trades or future favors. Local Party leaders can use political pressure on producers to speed up production to meet deadlines, find transport equipment to move available goods, and otherwise attempt to solve the thousands of bottleneck problems that afflict Soviet industry. Some analysts claim that these functions legitimize the roles of local Party leaders, impeding reforms that would eliminate these functions and therefore the local Party's status and main *raison d'etre*.

When solutions to supply problems cannot be dealt with on the local level, Party secretaries can start ascending the Party hierarchy, seeking resolution at higher geographical and functional levels. At the top, the Party Secretary for Defense Industry can presumably call on the

entire national economy to solve a critical military industrial supply problem, mobilizing the planning and supply agencies, industrial capabilities, and stocks and reserves. The Party, therefore, both establishes the priority of the military sector, and in its deployed capacity throughout the country, stands ready to help implement its own policy.

The Party is aided in this task by an agency that is nominally attached to the Council of Ministers, but that is closely supervised by the Party Secretary for Defense Industry: the Military-Industrial Commission (VPK). The VPK is primarily an implementing organization of military-industrial policy rather than one that originates policy. One of its primary jobs is to coordinate and police military priorities throughout the economy and to see that decisions are actually carried out. The VPK participates in planning of weapons R&D and procurement at the national level in Gosplan, the Academy of Sciences, and the State Committee for Science and Technology (GKNT). With a supra-ministerial role and commensurate authority, its instructors have the knowledge, skill, and power to enforce compliance with contracts and program plans; apparently, they are not reluctant to use these powers, even if fulfilling military demands has adverse consequences for lower-priority users.

Two modifications to this rather bald description of priority are necessary to bring it closer to reality. First, although the military has priority, and this is recognized and acted upon throughout the system, the actors at all levels are not unaware of the harm done to other sectors of the society by slavish attention to military demands, no matter how unreasonable. Sharp changes in military requirements will be fought by decisionmakers and Party leaders if the changes drastically disrupt established plans and relations. From the top budget and planning agencies down to the low-level supply organizations, there is evidence that "reasonable" and "customary" military demands will be more or less automatically satisfied, but that unreasonable requests will be opposed or compromises sought. Over the long run, however, military industry has been successful in obtaining what it needs, while being sensitive to what the economy can provide--at least in the short run.

The second modification has to do with the proliferation or "blizzard" of priorities. As with many other units of exchange that are not backed by real resources, it is all too easy for the authorities to issue more than the available production capacity can support, thus leading to inflation. We have seen just such an inflation of priority in military production. Enterprises overbooked with priority orders end up by fulfilling those that are the easiest to produce. We thus see orders possessing Highest Party-Government Priority, Council of Ministers Priority, Ministry of Defense Priority, VPK Priority, industrial ministry priority, and so on down the list. As priorities proliferate, military industry becomes more like the civil sector, with all of the attendant problems of tautness and a seller's market.

Organizational Structure and the Chief Designer

Military industry deals with the problems of the functional separation of organizations in two principal ways, through the integrative role of the chief designer and through the VPK decision.

The chief designer stands between the research institute and the production plant, between the industrial sector and the military user, often in a separate organization within an industrial ministry. The designer is responsible for the development of new systems and the integration of technologies into a useful and acceptable product. He negotiates with the military customer the characteristics of the product. Sensitive to the ability of the economy to support his designs, he is usually extremely conservative in agreeing to highly advanced capabilities that would require sharp departures from previous practices. Although military industry can be buffered and isolated from the supply uncertainties and disincentives of the rest of the economy, it cannot be totally independent. The chief designer, knowing the deficiencies of the Soviet production sphere, and knowing also the penalties for not fulfilling agreed military demands, attempts to reduce the demands to manageable size--with a good deal of safety margin. Once agreed to, however, the designer has the incentive and the authority to develop a product with the cooperation of subsystem developers and

producers, and the support of the research establishment. Prototype construction and pilot plant production are available either in the design bureau or in designated factories. The design bureau formally and informally develops close relations with the production facilities to guarantee the producibility of the design and its successful transfer into production. Production specialists move from the plant to the design bureau in the later stages of design, and design personnel go with the design to the factory for the life of the product.

Over the past fifty years, the military design process has taken many steps to minimize the negative effects of functional specialization and of risks in the Soviet setting. Design handbooks closely control the choice of technologies, components, and manufacturing techniques, thus reducing inter-organizational requirements for coordination and minimizing the degree of risk in a new product--including the necessity of seeking new sources of supply. Standards organizations at all levels ensure that standardized parts and techniques are used to the greatest possible extent. Each project proceeds according to a formal set of precisely laid out steps that specify the tasks to be carried out in each phase, and the review and acceptance procedures.

Despite the advantages given to the military sector, the forces of conservatism are pervasive and powerful. Designers, customers, and producers employ strategies that ensure steady progress, and avoid radical solutions that may ultimately pay off, but that would do no one much good if failure cut short a promising approach, and with it, the participants.

Organizational Structure and the VPK

The goal-oriented program-planning approach to the management of complex problems in the civil economy mirrors the role of the VPK in military industry. The VPK decision, which is equivalent to a project plan in the civil sector, sets forth the overall project goals, establishes a lead organization, names the other participants and their tasks, allocates budgets, and sets out the timetables for the participants.

The VPK decision is legally binding on all concerned parties, and its implementation is subsequently reviewed by the VPK and Party organs. Failure to abide by the terms of the decision can lead to severe reprimands for noncomplying organizations, which can affect the careers of the responsible managers and the fortunes of the offending organizations.

The VPK decision thus integrates complex, multi-branch projects largely by ignoring the boundaries between organizations and functions. It can do this because the VPK assigns an overall manager, usually a chief designer, with an authority that cuts across ministries, academies, research institutes, and production plants. For the life of the project, the designer possesses the kind of authority found in similar projects in a U.S. corporation. Since it is the chief designer who has generally produced the draft VPK decision in the first place, the project plan is congenial to his desires. It must be recognized, though, that it is neither the decision nor the work plan embodied in it that allows the organizational and functional boundaries to be ignored in this way, but rather the supra-ministerial authority inhering in the VPK that is delegated to the lead organization.[10] It is instructive to note that the several commissions established in the civilian economy in the past ten years with nominally similar roles have not been able to duplicate the VPK's performance, largely, I suspect, because these commissions have not been backed by the political authority granted to the VPK. It must be questioned whether even a politically supported civilian commission could achieve similar results without the other perquisites accorded military industry: priority and the ability to say "no" to deficient suppliers.

[10]It is not certain when the VPK in its present form was established, but, since the 1930s, chief designers in aviation performed similar functions to those now established by VPK decisions, although the aviation designers did not have authority beyond their own ministry.

IV. EVALUATION OF RECENT POLICIES

It should be clear by now that I believe that a major source of military industry's success in the design, development, and production of advanced weaponry ultimately is embedded in political values and policies. Ofer delineates a Soviet leadership utility function that differs in a significant manner from the social welfare functions usually attributed to modern industrial countries whose goals are to maximize consumption and the welfare of the population in the long run.[11] Inferring the Soviet leadership's goals from their choices over the past 60 years, he develops, for analytical purposes, a so-called "extreme view" that "the maximand is internal and external power building, and that its translation into economic terms is the maximization of the growth rate of heavy industry and defense production capacity."[12] Ofer notes that the revealed preferences of the Soviet leadership, as it has evolved since Stalin's death, suggests a softening of this extreme view to include greater scope for population welfare; at a minimum, in the absence of the terror and naked compulsion of Stalin, higher consumption levels are a necessary social cost to encourage the labor force to produce the things the leadership really desires. However, political developments suggest that population welfare also enters the leadership utility function directly, if only weakly. The key question, therefore, is whether social welfare, either as an intermediate good or as a final value, has been assigned a higher value by the leadership, and whether such a reassignment would have effects on weapons acquisition in general, and on the technological capabilities of Soviet military industry in particular.

In order to detect possible shifts in leadership values, we can examine the new policies put forth in recent years for signs of departure from past practices and underlying values. In particular, we should look at the array of new policies for a relative shift in priorities toward civil uses and away from the military sector.[13]

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[11]Ofer, p. 1799.

[12]Ofer, p. 1800.

[13]In a sense, I am using here the economists' notion of "revealed preference"; it is not necessary to read the mind of a decisionmaker

Since Gorbachev's assumption of the General Secretary's position, he has overseen many new developments in the economic-production and scientific-technical spheres aimed at accelerating intensive growth, speeding innovation and modernization, and creating incentives for scientific progress in support of economic goals. These include: (1) a package of economic reforms announced in 1987; (2) a separate resolution on the scientific sector published in October 1987, and other science policies; (3) the creation of a new kind of science-R&D organization--the Inter-Ministerial Technical Complex (MNTK); (4) creation of a new Department of Informatics, Computer Technology, and Automation in the USSR Academy of Sciences to accelerate computerization of the nation; explicit copying and use of defense-industry management techniques, managers, and organizations have also figured prominently in several new policies: (5) establishment of a Machine Building Bureau under the Council of Ministers to oversee the whole machine-building complex of ministries; (6) transfer of a score of industry executives from defense industry to civilian industry management; and (7) the transfer of production plants from civilian production ministries to the authority of defense production ministries falling under the aegis of the VPK.

Economic Reforms

The package of economic decrees was intended to address many of the well-known features of the Soviet economic system that hinder movement toward intensive growth and technical dynamism; incentive and supply problems were high on the list of problems demanding attention. The decrees aimed at reducing the authority of central agencies such as Gosplan, Gossnab, and the ministries; increasing enterprise autonomy; moving to output indicators more consistent with notions of profit than the traditional gross output targets; increasing the volume of goods moving in wholesale trade rather than under central control; "radically"

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when it is possible to infer the underlying structure of preferences from observed behavior. In such cases, it is permissible to state that the decisionmaker (or leadership elite, or "the system") acts as though it held the inferred preferences because its pattern of behavior is consistent with actions predicted by the "revealed preferences."

reforming prices and wages; and progressive movement toward increased, decentralized foreign trade with a stage-by-stage progress toward convertibility of the ruble. Although these reforms call for vast changes in bureaucratic processes, they do not alter the basic organizational principles of the economic system, nor do they even establish a consistent view of desired behavior. For example, the decrees (especially the state enterprise decree) make enterprise autonomy a primary objective, asserting that the ministries are not to interfere in enterprise decisionmaking, but simultaneously declare that ministries are held responsible for production results and for ensuring that enterprises act "properly."

When we examine the range of economic reforms that are now in the implementation phase, there is little to suggest the kind of radical reform that would speed up innovation or the rate of technical change, or that would change the balance between civilian and military industry. As stated by Gertrude Schroeder, "They display the traditional conviction that economic development--the composition of output and the direction of investment--as well as the broad content and direction for scientific and technological progress must be managed by the center."[14] She goes on to note, "Since all of this does not create a competitive market environment, enterprise strategy likely will continue to emphasize risk avoidance and center orientation."[15]

Science Policy

A resolution on science attempted to attain for scientific and technical organizations many of the results that the economic decrees intended for production enterprises. Improving incentives and organizational relationships were key goals. The resolution focused "primary attention on strengthening ties between science and production and involving scientific collectives directly in operations throughout the research and development-production-sales-service cycle."[16] It

[14]Gertrude E. Schroeder, "Anatomy of Gorbachev's Economic Reform," in JEC, *Gorbachev's Economic Plans*, p. 234.

[15]Schroeder, p. 235.

[16]*Izvestia*, October 28, 1987, pp. 1,3.

emphasized earlier policies of developing priority areas and targeted programs, which would be specified by the central agencies. But the new element of the policy was a concept of scientific-technical output as a "commodity," whose sale through contracts is intended to become the main source of finance of the scientific organization; budget appropriations are to be used only in "essential" cases. A scientific organization that can find no client for its output or that does not produce results "is to cease its activity." Central agencies (including ministries), however, are still responsible for financing, through contracts, the "most important" projects. Notwithstanding the greater autonomy intended to be granted to the branch research institutes, ministries are charged with increased responsibility for overseeing their expenditures; the ministries themselves are to be double-checked by national-level organizations such as the State Committee for Science and Technology.

Research institutes of the Academy of Sciences are directed to focus on "fundamental research in the most important areas," which will be financed through central sources. However, these institutes are also to move to a self-financing scheme through the use of contracts with "ministries, departments, associations, enterprises, and organizations financed from clients' resources." Most important, the resolution establishes the right of individuals and groups to engage in scientific consulting, both within the structure of present organizations and outside such structures.

Other science policies have aimed at renewing the leadership of research organizations through the retirement of older directors and academicians to make room for the entry of younger, more active scientists into the higher ranks. In June 1988, the president of the USSR Academy of Sciences was able to announce that 114 out of 270 research institutes run by the Academy had replaced their directors within the past five months.

It is too early to evaluate these moves, but a certain amount of ambiguity and tension is obvious in their goals: more autonomy with more supervision; incomes depending on sales but with central funding; unsuccessful organizations encouraged to cease activities but with budget appropriations for "essential" cases; an Academy focus on

fundamental research, but an emphasis placed on economic, profit-oriented contracts with industry. As with the economic reforms, we find a recognition of the incentive and structural problems, but a reluctance to sharply change the institutions of the past.

MNTKs

The Inter-Branch Science and Technology Complexes (MNTKs) continued the policy line represented by the organization of NPOs in the 1970s: the consolidation under a unified management structure of the different functions required to develop and produce new key technologies or products possessing a large scientific or technical content. Whereas the organizational entities brought together in an NPO fell under a single ministry (or other administrative organ), the MNTKs cross sectoral boundaries and may include Academy of Sciences research institutes as well as institutes and enterprises from several industrial ministries. Moreover, the decrees establishing the MNTKs recognized the often unplannable nature of developing new products and granted the MNTKs authority to obtain resources outside the formal planning cycle.[17]

Evaluations of the MNTKs suggest that they have been considerably less successful than the NPOs, largely because of the same problems that the NPOs had to confront: inability to truly consolidate management and authority across organizational boundaries, and the failure to obtain supplies outside the formal planning and allocation process. Because of the more complex organizational structure of MNTKs and the absence of any political authority over priorities, they have made little headway in solving these problems.

Computerization Drive

In 1983, the Academy of Sciences mounted a major reorganization in the computer field and created a new Department of Informatics, Computer Technology, and Automation to oversee a native scientific and technological base "capable of eliminating the national computer

[17]For an extensive discussion of the formation and early assessment of MNTKs, see Simon Kassel, *Soviet High-Technology Restructuring Drive: The MNTK Network*, N-2612-DARPA, The RAND Corporation, August 1987.

deficiency in the shortest possible time."[18] Although it was initiated before Gorbachev's rise to power, he has warmly embraced this effort as the leading edge of his modernization drive. This scheme embodies the creation of four new research institutes, the transfer of other Academy institutes, computer centers, and pilot plant capacity to the new department, and the implementation of a large, integrated network of R&D projects involving the new department, other Academy departments, and the computer industry.

To lead this entire effort, the Soviet leadership chose the physicist Ye P. Velikhov. Velikhov was a leading science administrator, promoter, and performer; a vice-president of the Academy of Sciences since 1977; and noted for his work on pulsed power and other high-energy concepts for space defense.

The technical reorganization of computer R&D was supplemented in 1986 by the creation of a State Committee for Computer Technology and Informatics with the apparent task of coordinating the industrial ministries involved in computer production, perhaps in similar fashion to the VPK's coordination of military industry. A second task of the State Committee is probably to facilitate the transfer of research results to production.

This reorganization of computer R&D under the leadership of a scientist with a strong military-technical background bears a close resemblance to other attempted solutions to Soviet R&D problems. The acquisition by the Academy, under a single managerial framework, of research organizations, pilot plants, a technology base, and a leadership role over national computer R&D is an attempt to consolidate a substantial portion of the research-development process under a single organizational and managerial umbrella. Thus, we find once again the Soviet solution to functional fragmentation is the development of larger and larger organizational superstructures to embody more and more functions. Nevertheless, most production and a still substantial

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[18] This statement was described as the department's main mission by the head of the new department Ye. P. Velikhov. For a detailed description of this effort, see Simon Kassel, *A New Force in the Soviet Computer Industry: The Reorganization of the USSR Academy of Sciences in the Computer Field*, N-2486-ARPA, The RAND Corporation, August 1986.

development responsibility remain in the several industrial ministries that continue to be responsible for computer production. The still serious problem of bridging the gap between R&D and production remains, although the Academy's control of pilot plant production could help smooth the technology transfer process. However, the incentive problems retarding innovation have not been touched by these organizational measures, and the basic conflicts of interest between R&D performers and industrial ministries have not been resolved.

The government newspaper *Izvestia* commented in mid-1988 on the lack of success in addressing the underlying problems in computers. It noted that commissions formed by the Supreme Soviet found that the lag in production and use of computers had reached a critical level, that the new organizations had failed to solve the problems of producing quality goods such as computers, and that the "State Committee for Computer Technology and Informatics had been hampered in its work because ministries had too much say in computer production."[19]

The Defense-Industry Policy Model

Several policies designed to stimulate technology and innovation were directly modeled after defense-industry practices; other policies even more directly used defense-industry resources. An early Gorbachev move was the creation of the Machine Building Bureau in late 1985. Apparently modeled after the VPK, the Machine Building Bureau oversees all of the machine-building industrial ministries in an attempt to energize this high priority area. It is headed by Ivan Silaev, the former minister of the aviation production ministry and a key defense industrialist. Silaev's title of deputy premier in his new job denotes the importance given to this new agency by the leadership.

Silaev's appointment is representative of another policy, the transfer of defense industry managers to the civil sector. For example, two of Silaev's deputies in the aviation production ministry were appointed to civilian jobs--one as Silaev's deputy in the Machine Building Bureau, and the other as deputy chairman of Gosplan. Other

[19] *Izvestia*, August 15, 1988.

such moves included the former minister of communications industry who was appointed chairman of Gosplan and first deputy premier, appointments to chairman of Gossnab, chairman of the State Committee on Computer Technology, chairman of the State Committee on Science and Technology, minister of The Machine Tool and Tool Building Ministry, and minister of the Ministry of Heavy and Transport Machine Building.[20]

A movement in the reverse direction is the transfer of enterprises from civilian production ministries to defense industry. A radical example of such restructuring was the decision to abolish the Ministry of Machine Building for Light and Food Industries and Home Appliances with the transfer of many of the enterprises to the Ministry of Defense Industry.[21] The several defense production ministries have also been directed to become more engaged in the development and production of products for the civil market. Thus, it was reported that the elimination of intermediate-range nuclear missiles would allow the switch to the production of drilling equipment, metal cutting tools, and food-processing equipment.[22] In all of the defense industry ministries that have been listed as absorbing civilian enterprises there has also been announced the appointment of a new deputy minister, presumably (although this has not been directly confirmed) to oversee these new responsibilities. Similarly, the VPK appears to have a new deputy responsible for the light industry enterprises now in defense industry.

Defense industry has undoubtedly benefited from the managerial competence, technological capabilities, production skills, and coordination that the leadership has guaranteed to it in the past. The key issue is whether these factors are transferable through the movement of individuals, enterprises, production responsibilities, and organizational forms. The evidence is accumulating that without the

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[20]A list of such transfers is given in Paul Cocks, "Soviet Science and Technology Strategy: Borrowing from the Defense Sector," in U.S. Congress, 100th Congress, 1st Session, Joint Economic Committee, *Gorbachev's Economic Plans*, Vol. 2, November 23, 1987 (S. Prt. 100-57, Vol. 2).

[21]*Izvestia*, March 2, 1988.

[22]*Sotsialisticheskaia Industria*, August 17, 1988.

additional transfer of politically backed priority, the transplant will not thrive in its new location. This evidence includes incidents such as Gorbachev's strong criticism of former defense industry managers Sergey Afanasyev and Boris Balmot for failing in the new jobs. This was followed by Central Committee reprimands of four defense industry ministers for allowing the production of poor quality radios, tape recorders, and television sets, which were so dangerous that many of them had blown up and started fires in apartment buildings.[23] What this evidence indicates is that the same managers who performed well in defense industry failed to produce in the civil sector, that the defense industry itself has the same kinds of problems producing civilian goods as civil industry, and that it may be possible to mimic the form of the VPK but not its effectiveness. In short, these attempts to duplicate the success of defense industry have left out a vital ingredient. This omission leaves the weapons acquisition, defense technology situation in pretty much the same position it has occupied for fifty years.

V. THE FUTURE FOR WEAPONS ACQUISITION

The brief review of economic policies and changes in science and technology suggest that not much has happened to alter the balance between the civil and military industrial sectors in their incentives and disincentives for innovation. For the civil sector, profit-like measures of performance conflict with the needs of central planners to assure inputs to meet planned outputs, supplies remain uncertain in a continued taut planning environment and seller's market, competition for markets has not arisen to compel producers to innovate, priorities to obtain materials in short supply have not been granted. In summary, the old centrally planned system remains largely in place and we can observe little reallocation of political priority to the civilian sector.

Likewise, the defense industry sector largely continues as before. It has been assigned some new tasks in the management and production of civilian products and it has lost a few of its executives, but the structure and fabric appear not to have changed.

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[23] Many of these criticisms were highlighted by Cocks, pp. 154-155.

Applying the concept of revealed preferences therefore indicates that political values and priorities have not changed. How can this conclusion of no change be consistent with the sheer volume of new policies and the impassioned rhetoric of General Secretary Gorbachev? This is not the place to go into an analysis of the entire economic reform process, but we can note that the reforms simply will not do what Gorbachev has intended. For the most part, they leave the economic system basically intact; and those policies that include a kernel of true reform (e.g. the legalization of non-state economic activities) are being desperately fought by the threatened economic and Party bureaucracies. Given that the system will not respond on its own to the desired changes, that traditional Soviet solution must be called into play--the application of political direction to priorities.

The reduction of military priority--were it to occur--could have significant effects on both military and civilian innovation. The major effect would be to reduce supply risks to the civil enterprise manager and increase them on the military side. Such a policy would require a rooting out of decades of practice and habit, beginning at the top-most planning levels, reaching down through Party cadres and economic managers at the lowest levels. It would mean that if, for example, aluminum sheet were in short supply, it would more probably end up at a toaster factory than at a MiG aircraft plant. It would require that countless thousands of daily decisions, made according to powerful institutional incentives, reinforced by fifty years of habit and experience, be reshaped according to new priorities. All of the Soviet experience suggests that, in order to be effective, such a change in values and policies would require a massive mobilization campaign, wholesale removal of old cadres and appointment of replacements, and visible punishments and rewards to emphasize that the desired performance, on which incentives are based, had indeed changed.

If priority were shifted to the civilian sector, much of the clout of the VPK would also vanish. The delegated authority of a chief designer would no longer be effective as he sought the cooperation of an electronics laboratory that was now designing components for color

television sets or compact disc players. The VPK would still provide a great deal of useful coordination, but the implementation of decisions would become less effective.

Consideration of truly effective economic reforms is more complex, partly because it depends on just what shape such reforms could take. We can envision a reform with greater enterprise autonomy, more freedom for enterprise entry and exit into a product line or industry, enterprise incentives based on a profit-like measure, and greater reliance on inter-enterprise contracts and wholesale trade than on central plans and supply allocations. Such changes could occur in the civilian sector, but would be less likely in the military, where traditional Soviet planning and management practices would continue to prevail. To the extent that military industry is isolated from and independent of the rest of the economy, such reforms would have little effect on military productivity. But, Soviet military industry does depend on its ability to divert resources from the civilian economy through its priority over supplies in order to relieve the tautness of its own plans and to assure its enterprises the inputs they require. This interdependence is almost certainly increasing as military products use a broader array of materials, components, and other inputs from the advanced industrial producers throughout the economy. In such a reform as assumed above, the military enterprises would have to join the queue with other customers and compete for its inputs. Even with the preservation of nominal priorities, it would become harder to enforce them in the face of profit-making incentives influencing enterprise managers: priorities are more enforceable when the alternatives are less compelling. If the profitability of non-military production greatly outweighed the directed production for military uses, managers throughout the economy would find methods to evade the imposed demands; greater autonomy and freer access to resources would weaken the levers used to enforce priority. We are witnessing a similar process in China today.

If military industry were also part of a reform, the possibilities are more wide open. Innovation in civilian industry could flourish. This higher technological level would benefit the military if it had the

flexibility and resources to take advantage of it. The net effect could leave the relative position of military industry unchanged. But in absolute terms, it would gain the benefits of a more innovative and flexible civilian sector; it would lose some of its customary advantages, but benefit from its own reform; it would have to adapt to a different style of management. In the long run, it would almost certainly be in a stronger position due to the growth of national economic and innovative capacities.

Any real change in the ability of military industrial managers and designers to carry on as they have since the 1930s will be clear enough to outside observers. Such changes will be accompanied by new priorities, wholesale movements of cadres, complaints by military industrial people about supply problems, and an overall transformation of relative capabilities. I see no changes of this magnitude on the horizon at this time, but these are the things to look for.