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Projecting Soviet Military Forces and Weapons Procurement

A Technical Intelligence Report

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A Technical Intelligence Report

This paper was prepared by
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SOV 87-10066
November 1987

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Projecting Soviet Military Forces and Weapons Procurement

Summary

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

This paper describes an improved technique for developing projections of future Soviet military forces and the costs of procuring them. The methodology begins by estimating future production levels for individual weapon programs. It then explicitly takes into account judgments regarding the uncertainties surrounding each of these individual projections. For more than 300 major military programs, probability statements are established for the existence of each program, the date of its initial production, and the rate and longevity of its production run. Each judgment is based on the all-source evidence available on the projected system; the stronger the evidence, the greater the certainty attached to the prediction. In many cases, different levels of confidence are attached to different portions of the projection for a particular program. For example, there may be high confidence that a particular weapon will have a production run of at least five years, but less confidence the run will continue for eight years.

With these judgments in hand, we use computer simulation techniques to generate a "best estimate" of spending for future procurement. First, we use the set of judgments to generate a large number of possible force projections. The elements in each projection are randomly selected according to the odds expressed by the individual judgments for each military program. Next, the procurement costs are calculated for each of the projections. The "best estimate" of future procurement is then determined by selecting the median, or middle value, of all the projections. The collective simulations also form the basis for a range of uncertainty that surrounds the "best estimate." This method produces aggregate projections of procurement that reflect the uncertainties associated with each individual program.

The new projections method does not consider all the sources of uncertainty in the forecasts. Most notably, it does not take into account possible changes in the overall environment in which military programs will be pursued. Major changes in Soviet defense policy have been infrequent but can lead to significant shifts in the pace of military modernization. The resource implications of the projections should therefore be interpreted in the context of today's political and economic environment. If this environment should change, the Soviets might well alter their present plan in ways our projections do not anticipate. For example, we believe that the projected defense programs will be competing for resources with General Secretary

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Gorbachev's campaign to modernize the economy. If the campaign falters, the Soviet leadership will face tough decisions regarding priorities, and some military programs may well be slowed or canceled to divert resources to nonmilitary production.

The new method is directed at forecasting aggregate force characteristics, such as naval procurement costs, rather than item-by-item, year-by-year predictions of individual weapon systems. We are not able to foresee which one of the many possible alternatives will in fact be realized. In some respects, our method is analogous to projecting the outcome of a series of coin tosses. There is a sound statistical basis for saying we have a "best estimate" of 50 heads in 100 tosses. We have no basis, however, for predicting the outcome of each individual toss, other than to say there is a 50-percent chance of heads.

Using the new method, we have developed projections of Soviet procurement outlays (measured in 1982 rubles) that show growth at an average annual rate of about 1 percent during the 12th Five-Year Plan (1986-90). Spending at these levels would allow major advances across the entire spectrum of weapon programs. Each military service could continue to modernize by introducing large quantities of new weaponry. In the projections:

- The Ground Forces would receive large increases to fund vigorous programs to upgrade armor and artillery.
- Naval procurement outlays would support a wide range of programs, with special emphasis on ballistic missile and attack submarines.
- The Strategic Rocket Forces would receive a significant increment in resources to fund the next generation of ICBMs.
- The Air Forces would maintain their current high level of funding with the introduction of the Blackjack and the continuing deployment of the Backfire and several new tactical aircraft.
- The Air Defense Forces could continue to upgrade their surface-to-air missile and interceptor forces and the Moscow antiballistic-missile system.

Overall, we have more confidence in our new projections than we had in our previous estimates. Our confidence is greater for major portions of the total, such as projections by military service, than for lower levels of aggregation. Nonetheless, until we gain more experience in the use of this

method, it will be difficult to assess its reliability. We carried out a pilot study early in 1985 using an existing data base, cruder measures, and fewer substantive experts. This was followed by full-scale applications during our annual updates of 1985 and 1986. The results of the first two exercises were quite similar to those presented here. As more data became available and the first years of the early projections became history, we found that the early aggregate projections were confirmed. Our previous methods had repeatedly produced projections that were proved erroneous by data acquired during the following year.

We now know our new method gives us a better picture of the future than did past practices. We have found no indication, so far, of significant limitations or biases in the work. While this is reassuring, the true reliability test will be a retrospective comparison of our projections for 1986-90 with estimates—to be made in later years—of actual procurement for that period.

In summary, the new method improves upon our old methodology by specifically considering the uncertainty associated with forecasting individual programs. Our judgments of those uncertainties create the basis for reaching our ultimate goal of improved overall force projections. Combining these individual uncertainty judgments by computer simulation allows us to generate a set of force projections that no longer assumes all the projected programs will materialize "on schedule."

Contents

Projecting Soviet Military Forces and Weapons Procurement

Introduction

This paper presents projections of Soviet weapons procurement based on detailed force projections that were estimated with a procedure unlike that employed by the Intelligence Community in the past. We present the methodology used and the results of applying this technique to the force projections prepared by the Office of Soviet Analysis in 1986. Because the approach is new, particular attention is paid to: (a) how significant variables are reflected in the projections, (b) how the projections might be best used, and (c) how the projections process might be further improved.

The procedure begins with the development of production estimates for individual programs, such as the T-80 tank, the MIG-25 Foxbat, and the SA-10 surface-to-air missile (SAM) system. These estimates are then aggregated in terms of their ruble costs to gain perspective on the magnitude and trends of major categories of procurement.

Projecting the procurement of Soviet military hardware not only includes identifying what weapons will be procured, but also the timing, magnitude, and rate of production for each system. In making these projections, we assess:

- The Soviets' plans and doctrine for their forces over the next 10 years or so.
- The implied requirement for new production based on the current order of battle and the age of the weapons and equipment.
- The probable success of existing or projected research and development (R&D) programs.
- The capacity of the defense industry to produce the current-generation weapon systems.
- The capability of industry to master the production technologies needed to produce new, more complex weapon systems

Sources of Uncertainty in Projecting the Future

The influences on procurement fall into three classes. First, predictions of future activities must take place within some overall context. We usually enter the process, however, without knowing whether leadership priorities will change—for example, because of changes in the balance of forces within the Politburo or because of a shift in the international climate. Faced with this problem, the general approach in forecasting is to assume that current conditions will continue except, perhaps, for a few specified changes. The assumptions for a few critical events are then stated—for example, that there will be no arms limitation agreements in effect after 1987, or that major changes in Soviet leadership policy in the next year or two will result in a midcourse adjustment in the five-year plan to divert significant resources into the economy and away from defense. If changes from current conditions are postulated, it is then assumed that there will be no unstated reactive changes in existing military, political, or economic conditions in the United States or Western or Eastern Europe sufficient to alter Soviet actions.

Second, given the assumptions made about the environment within which Soviet military-economic decisions will be made, we are faced with predicting the actions the USSR plans to undertake. A great deal of data is available on Soviet economic plans, but the plans reveal little regarding defense program decisions. Considerable information exists on individual weapon programs—whether they are in the R&D stage, in series production, in the active inventory, or in some combination of these stages. We seldom have much information, however, as to Soviet intentions for a specific program or collection of programs. Information is inadequate to predict with confidence the

choices that have been made between competing programs, the relative priority given to those selected for further development or deployment, their planned size, or the pace at which they are to be pursued.

The third general challenge to forecasting centers on the implementation of the plan. On a program-by-program basis, information is insufficient to enable us to foresee those events that force changes in the plan—from the overall strategy for weapons procurement to the progress of an individual weapon program. That is, even with a stable environment and a defined weapons procurement plan, the outcome is still uncertain. The Soviets experience unexpected delays and cancellations in programs as do arms manufacturers in the rest of the world:

- An R&D program that now appears to be making reasonable progress may encounter difficulty, resulting in significant delays or cancellation of the program.
- Construction of production facilities may be delayed, postponing the initiation of series production.
- Inadequacies in manufacturing technologies may lead to delays or reductions in scheduled production. The system might even be sent back to the R&D stage to make it more producible.
- Production delays for one or more programs could result from problems with the manufacture of an important subcomponent.
- Delays of systems in the near term (the next two to five years), whether the difficulty is in the R&D or production phase, may necessitate revisions in the schedule for follow-on programs in the longer term (six to 10 years).
- Policy considerations could cause changes. For instance, the Defense Council may choose to cancel programs, expand or reduce them, or delay or speed them up based on purely military choices or as a result of pressure to adjust military and civilian priorities.

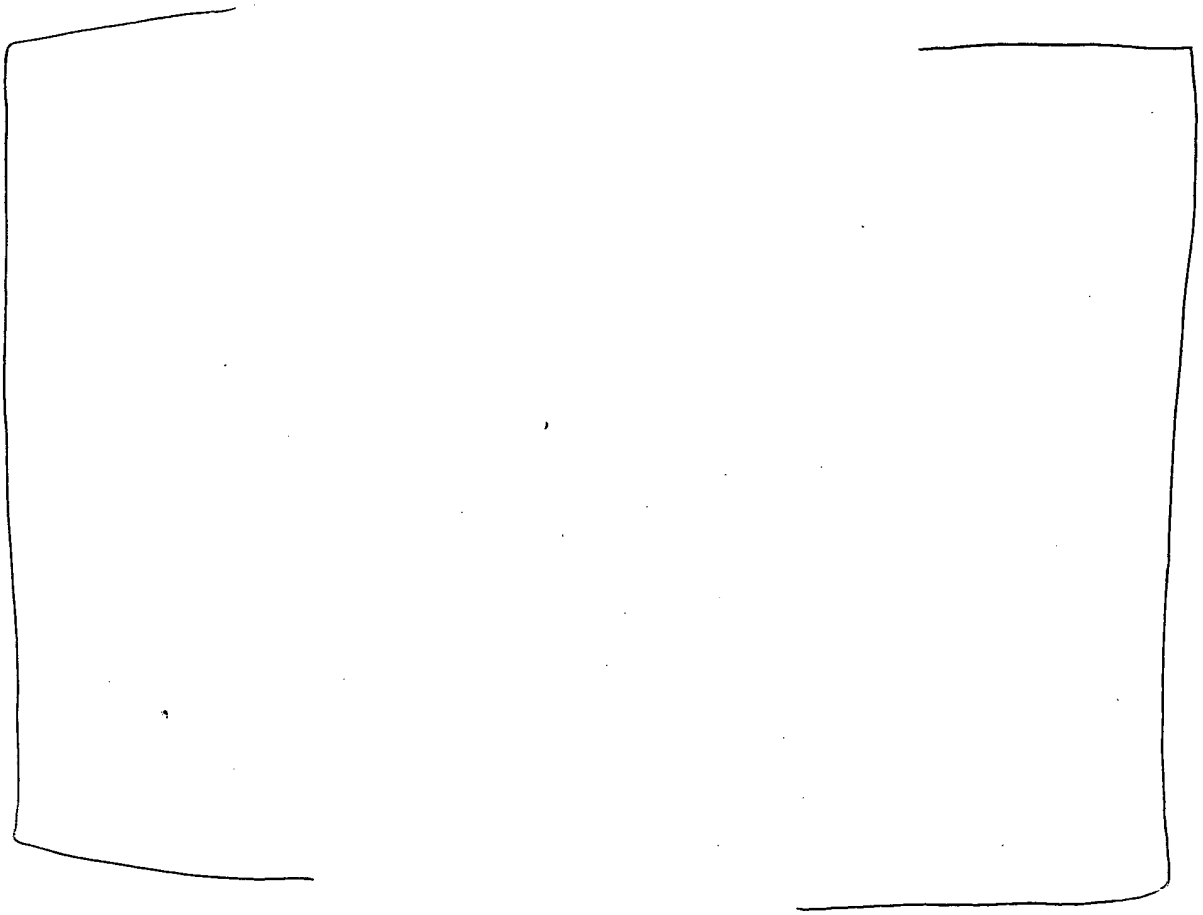
The inset lists actual instances of some of these kinds of problems experienced over the last few years

While we know that problems will arise with projected systems, we are unable to predict which programs will experience difficulty or the corrective actions or program modifications the Soviets will institute in response. Also, we often have insufficient evidence to determine the nature of a problem when it does occur.

The old method of projecting military forces and their costs takes the results of forecasts for hundreds of individual weapon programs—each based upon the best evidence available—and sums them. We have learned, however, that merely summing the individual weapon projections produces total projections that are too high. The reasons for this overstatement can be seen by considering the nature of available evidence. We are able to compile a rather complete list of the programs that could be under way in the projection period. All of the programs that have a major impact on procurement and will be in series production during the next five to 10 years are technically complex and have long gestation periods. They are usually visible well in advance of the initiation of production. It has been rare for a new system to be "discovered" upon its entry into operational service. On the other hand, we have no evidence on future cancellations, postponements, stretchouts, and other delays in individual programs. Thus, the old method overstates procurement cost by the amount of these canceled and delayed programs.

The New Method

The new method improves upon the old method by taking the analysis one step further. It explicitly takes into account the uncertainties in the projections of each system and uses statistical techniques to develop projections of total forces likely to be produced, based on those uncertainties. This process provides projections of overall weapons production and total procurement outlays in which we have considerable confidence. While this method gives us good projections in the aggregate, it does not forecast the outcome of individual weapon programs in detail. There are too many uncertainties in the projections of these programs to do this



The method resembles the practice long used in the insurance industry to predict an aggregate outcome rather than individual programs. Life insurance companies predict the future for large classes of people rather than for individuals. Though they may require each client to pass a medical examination, they do not assume everyone insured will reach a ripe old age. Rather, they employ actuarial tables to project overall survival rates and establish their premiums accordingly, without regard to who the survivors will be.

Our process begins with individual projections and uncertainty assessments for each of the potential weapon programs.[1] The assessments, based on available evidence, cover the existence of a program, the precision with which the date of initial production can be predicted, and the level and longevity of subsequent production. A computer program then uses these assessments to develop many sets of alternative

[1] In 1986 these uncertainty judgments were developed for the more than 300 programs that together constitute major military procurement—all land armaments, naval ships and submarines, aircraft, missiles, and military and civilian space systems. These programs account for more than 75 percent of total procurement of military hardware.

force projections. The composition of each projection is determined by randomly selecting the individual weapon systems on the basis of their uncertainty assessments. Some 10,000 sets of projections are simulated in this manner to ensure a stable distribution of alternative projections has been obtained. The "best estimate" of future procurement is found by taking the median of the procurement values of each set of force projections. Confidence intervals about the "best estimate" are formed by picking suitable percentiles of these values. For example, the 5th and 95th percentiles of these values provide a 90-percent confidence interval around the "best estimate."

Uncertainty Assessments

Four categories of uncertainty are used in providing the uncertainty assessments. The categories are labeled for convenience with the letters A, B, C, and D. Category A is for estimates having almost no uncertainty. We are persuaded by the evidence that programs in this category will, in fact, occur as estimated. Category B is for estimates having more uncertainty than A, but for which there is strong evidence. Estimates in this category will prove to be accurate about three-fourths of the time. Category C is for those estimates having about equal evidence for and against. These estimates are about as apt to be correct as not, but about half will be wrong. The last category, D, is for those estimates based on only limited evidence or informed speculation. Only about a quarter of these estimates will prove correct (see inset).

In the simplest case, an entire weapon program might be placed in a single uncertainty category, for example, B. That would mean there are about three chances in four that the pace and size of the program will be as predicted. A more generalized case would assign different confidence levels to various portions of a given program, indicating that the evidentiary base is stronger for one part of the program than for another.

[1] A separate assessment regarding the date a system enters series production is also made and is discussed below

The Uncertainty Categories

A: Near Certainty
The estimate is deemed to be a precise description of the future. There is almost complete certainty for this program or part of a program. This could be a system for which series production has been under way for some time and for which we have special information on the ultimate force level.

B: High Likelihood
There are about three chances out of four that this program or part of a program will occur as predicted. This rating requires a strong evidentiary base but acknowledges that some uncertainty exists.

C: Close Call
This rating indicates that a significant body of evidence exists to support the forecast but that there is only an even chance that this program or part of a program will materialize.

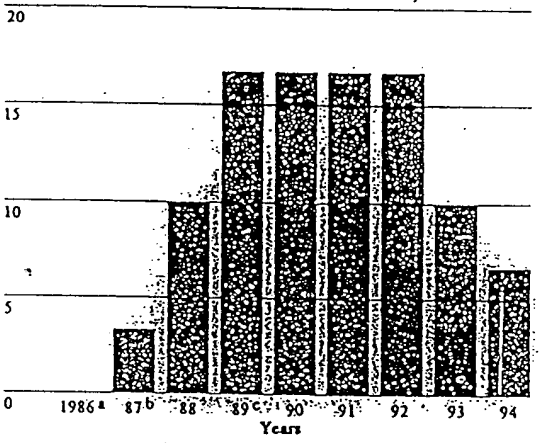
D: Low Likelihood
This rating allows for the inclusion in the estimate of a program or part of a program for which the evidence is quite limited. We do believe, however, that the evidence is sufficient to indicate that there is about one chance in four that the program might occur.

An example estimate of a program is presented in figure 1, which portrays projected outlays and production quantities for a hypothetical new mortar. The program has been divided into two segments. One segment, which is associated with category A probability (near certainty), reflects hard evidence that the program has completed development, the plant to produce it is ready, and 1,600 of them will be produced to replace an existing system in all high-strength motorized rifle divisions. Additional information (more tenuous) indicates that the system could also be used to replace another system in other elements of the Ground Forces. This would require an

Figure 1
Projected Outlays and Production for a Hypothetical New Soviet Mortar, 1986-94

Measure	Cumulative production
Category A: near certainty	1,600
Category C: close call	1,300

Numbers in bars represent production quantities



Note: Uncertainty about start of production.
[a] Earliest possible date—1986.
[b] Best estimate of date—1987.
[c] Latest likely date—1989.

The figure presents an example of how the uncertainty categories may be used in projecting a weapon program. The red bars indicate a firm estimate that at least those numbers of weapons will be produced, for a total of 1,600. The blue bars indicate there is an even chance an additional 1,300 will be produced. The timing of the production is shown for a start date of 1987 (best estimate). Because of uncertainty over when production might start, the entire set of bars might shift one year to the left (corresponding to the earliest possible start date of 1986) or as many as two years to the right (corresponding to the latest likely start date of 1989).

additional 1,300 to be produced and—because we believe there is about an even chance this will occur—that segment of the program is given a category C probability.

The figure also shows an assessment of the uncertainty surrounding our estimates of when series production would begin. Similar assessments were made for every program with production starting in 1986 or later to allow the analyst, where the evidence indicated it was appropriate, to range startup dates. This step was included because our pilot study indicated that in earlier, single-value estimates, the forecasts clearly were biased toward giving a too early date for the introduction of new programs. We believe that making explicit the range of possibilities for the initiation of a system helps to eliminate that bias.

The range of possibilities for production of this mortar includes, at one extreme, the maximum possible production, with production beginning at the earliest date (1986). This would result in cumulative outlays of 57 million rubles (1,900 mortars produced) through 1990—the whole program is moved forward with the earlier startup date. At the other extreme is a shift to the latest date of series production (1989) and the inclusion in the estimate of only that portion of the production we gave the highest level of confidence. This would result in outlays of only 12 million rubles (400 mortars produced) by the end of 1990.

Statistical Analysis of the Projections Data

All the uncertainty judgments associated with the initial program estimates are then processed using computer simulation. The major steps of the simulation process are:

- Calculating the annual costs of each program production estimate. The costs are then allocated to one or more of the A, B, C, and D categories on the basis of the uncertainty judgments made for each program or its parts.

- Simulating a trial projection by randomly selecting from the cost lines according to the probabilities assigned to each category. Each selected line is then

assigned a starting year according to the probabilities developed for the date of initial series production.

- Generating a large number of such trial projections. For each projection, some statistic of interest is calculated (for example, growth rate or cumulative outlays). Using this statistic, the data are then ranked from highest to lowest. The median (midpoint) of the ranked data is the "best estimate," and the 5th and 95th percentiles form a 90-percent confidence band. Experimentation has shown that about 10,000 trial projections are required to obtain stable estimates of this confidence band.

The first major step is accomplished using the standard costing techniques that are applied in estimating past procurement. The other two steps are summarized below.

Generating a Trial Projection. The following process is applied to each weapon program, and the combined results represent a single trial. Each program will include one or more lines of cost data depending on the number of uncertainty categories used in describing it. These lines are ranked in order of certainty (for example, category A would be first). A category A line is always selected. If there are additional cost lines for a program, they are selected according to the value of a random number drawn from a uniform (0, 1) probability distribution. The probability criteria for the lines assign 75 percent to category B, 50 percent to category C, and 25 percent to category D. The C and D probabilities are marginal probabilities of selection. A C or D line cannot be selected, however, if a line of higher probability is available but is not selected. Therefore, if a line of higher probability is selected, the conditional probability that a C or D line is selected is greater than its marginal probability (see table 1)

At this stage, the lines selected for a program provide an expenditure pattern over time with respect to the best estimate of production start time. The actual start time for each trial is chosen by drawing a random number from a triangular probability distribution. The best estimate of start time is the mode, or highest probability point, of the distribution, and the earliest and latest possible start times are the minimum and maximum possible values of the distribution.

Table 1
Conditional Probabilities of Selecting a Category Line When All Lines of Higher Probability Have Been Selected *

Category	Next Higher Category			
	None	A	B	C
C	.50	.50	.67	
D	.25	.25	.33	.50

* If G is an event whose occurrence is uncertain, then we can represent the probability of the event occurring with the expression P[G]. Similarly, the probability of another event, H, occurring is P[H]. If G and H are related events, we represent the conditional probability that the event H occurs given that G in fact has occurred by the expression P[H|G]. The joint probability that both G and H occur together is expressed as P[G,H]. From probability theory, we know $P[H|G] = \frac{P[G,H]}{P[G]}$. This formula is used to calculate the values in the table.

For example, suppose we have a projected program with a D category line whose next higher probability line is in category B. Because the D line can only occur if the B line occurs, and the occurrence or not of the D line has no effect on the likelihood of the B line occurring, the probability that both lines will occur, P[B,D], is equal to the probability of the D line occurring, P[D]. Putting all of this together, we have:

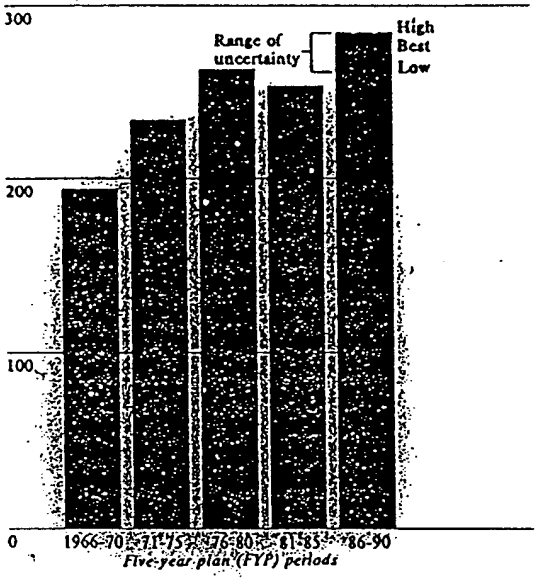
$$P[D|B] = \frac{P[D]}{P[B]} = \frac{.25}{.75} = .33$$

Selecting a Projected Value. As outlined above, the best estimate (and confidence range) of any particular statistical measure is determined by ranking the 10,000 trials on that statistic and selecting the appropriate points. No further explanation is needed for single-value statistics such as the average annual growth rate during 1986-90. The multiple value series—such as that shown in figure 2—are chosen as described in the inset

Applying the Methodology

The new methodology was developed during a pilot study early in 1985 and relied upon in producing our

Figure 2
Soviet Military Procurement, 1966-90



Note: The bars compare total spending for procurement by FYP periods. The projected spending shows higher outlays for the 12th FYP (1986-90) than for any previous FYP period.

projections since then. This section presents the results obtained when we applied the methodology in late 1986. The projections are presented for various aggregates of interest (see inset on historical perspective)

Total Procurement

The Soviet forces projected for 1986-90, the period of the current five-year plan (FYP), imply that the very high outlays of the recent past for military hardware will rise by about 1 percent annually.[3] We have

[3] The data for 1986 are considered projections since they were prepared during the year and do not benefit from the historical review accorded data for all previous years

Technical Procedure for Selecting Multiple-Value Series

The first step is to independently select the 5th, 50th (median), and 95th percentiles for each projection year; for example, for a given year the 10,000 trial totals are ranked, and the indicated three values are recorded. The resulting values represent the best estimate and the 90-percent band for a given year, but they may not correspond to any feasible collection of production programs across time. The feasible series are then found by selecting from the 10,000 trials the three trials that minimize, respectively, the squared errors when compared with the three values chosen for the individual years. For example, the best estimate is that trial which minimizes the sum of squared errors when its values are compared with the median values for each of the years. For the projections in this paper, the resulting feasible estimates were all within 1 percent of the independent estimate for any given year

calculated both a "best estimate" (based on a median case) and a range within which we are 90 percent confident the actual value will lie. That is, we believe there are only five chances in 100 that the actual value will lie above the range and the same probability that it will lie below the range. In this context we believe cumulative outlays for military hardware will be between 260 billion and 285 billion rubles during the current FYP.[4] The best estimate implies a level of outlays of roughly 270 billion rubles, slightly higher than that of the late 1970s. Such an amount would be the highest cumulative level of outlays for any FYP period since World War II (see figure 2)

Our projections indicate that the massive force modernization programs pursued by the Soviets since the early 1960s can continue. The introduction of new

[4] These values are expressed in 1982 prices and include outlays for procurement of military equipment that is added to the existing inventory; they also include all outlays for capital repair

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Historical Perspective

From the mid-1960s through the mid-1970s, ruble outlays for Soviet military hardware procurement grew (in constant prices) an average of about 5 percent per year. The growth rate slowed only briefly in the early 1970s, when outlays dipped slightly between the completion of one generation of missile programs and the initiation of the next. During this entire period the Soviets expanded and modernized their defense forces across the board. Since the mid-1970s this growth has essentially ceased, but procurement has remained very high.

We can put these programs in perspective by comparing them with those of the United States, because we also value the Soviet defense program in dollars. In 1970 the estimated dollar value of Soviet procurement of weapons exceeded US outlays for weapons procurement for the first time, and by the mid-1970s they were double the US outlays. Even with the rapid growth in US programs that began in the late 1970s, the dollar costs of Soviet programs remained above those of the United States until 1983.

and improved strategic missile programs and a large-scale modernization program for conventional ground forces are the most important programs in resource terms for the projected time period, followed by procurement of naval ships and submarines.

All of the weapon programs projected are considered to be feasible in terms of defense industry capacity. Major investments over the last decade have permitted sizable expansion and upgrading of facilities. Indeed, virtually all the weapon programs projected over the next five or more years are likely to be manufactured in existing facilities. It is clear, however, that the resources required for these programs include some for which the competition will be particularly intense if Gorbachev's modernization program is pursued vigorously. In the event the modernization program encounters serious difficulty, the Soviets might decide to adjust some defense programs—either by delaying their introduction, cutting back the size of the program, or reducing annual production rates. Because such a decision was not included in our general context for making the projections, we expect it would cause spending to drop below that projected.

Procurement by Service

An examination of the outlays for weapons procurement by the different services provides additional insight regarding the projection period. Although the data are presented as single values (for ease of illustration), they should be considered representative values lying within a range of uncertainty.

We are reasonably confident about our ability to identify the military service subordination of each of the historical and projected programs. We have much less confidence, of course, in the projections of individual programs. Nonetheless, in the discussion that follows, we identify the individual programs or classes of programs that heavily influence our projections of weapons procurement. While these programs may change in scope or timing, the evidence strongly supports our judgment that they will be the major programs in resource terms through the end of the decade.

The estimated and projected outlays by services and their shares of the total are presented in tables 2 and 3. The annual levels and shares fluctuate somewhat, but when outlays for the entire period 1966-90 are accumulated, the Ground and Air Forces and the Navy each account for about one-fifth of total procurement. The others—Strategic Rocket Forces (SRF), Air Defense Forces, support services, and the space program—each account for roughly one-tenth.[3]

Ground Forces. The sustained growth in outlays for ground forces hardware over the last 20 years reflects the long-term priority associated with the massive

[3] In subsequent estimates, we intend to allocate the resources for the space program among the services according to the mission of the individual program.

Table 2
USSR: Military Procurement by Service, 1966-90 [a]

Billion 1982 rubles

	1966-70	1971-75	1976-80	1981-85	1986-90 [b]
Total [c]	194	234	263	254	272
Ground Forces	35	46	50	52	57
Air Forces [d]	22	43	49	50	50
Navy	42	50	53	48	54
Strategic Rocket Forces	24	20	33	19	23
Air Defense Forces	34	31	26	23	29
Space programs	14	18	21	26	22
Support forces [e]	23	27	32	35	37

[a] The expenditure data in this table are for all procurement of military weapons and equipment, including their capital, or major, repairs. All service reorganizations have been reflected in the year they occurred. The structure in place in 1985 has been used for 1986-90.
[b] For ease of comparison, only the "best estimates" are shown. The 90-percent confidence bands present a more reliable projection of future procurement.
[c] Because of rounding, components may not add to total shown.
[d] Air Forces procurement includes military transport but not naval air programs (included in outlays for the Navy) nor fighter/interceptor programs (included in outlays for Air Defense Forces).
[e] Procurement for support forces includes Ministry of Defense support as well as rear services.

expansion and modernization program carried out by the USSR. The increment in resources projected for the Ground Forces during the current FYP continues this trend. We foresee very large programs to upgrade the conventional forces, with major emphasis on armor programs. High rates of production for the T-80 as well as a major program to modernize several thousand older tanks are forecast. In addition, we foresee extensive production of the BMP-2 infantry combat vehicle, procurement of several new artillery and tactical air defense weapons, and the introduction of a new model tank. As a result of these programs, we project a slight increase in the Ground Forces' share of total procurement outlays.

Air Forces. Since the early 1970s the Air Forces have received nearly one-fifth of total weapons procurement. These resources have been used to expand and upgrade the intercontinental and peripheral attack, tactical aviation, and military transport missions. The procurement of bomber and fighter aircraft make up the bulk of these outlays

The systems projected for these forces during the current FYP would require the continuation of the very high outlays that have occurred since the 1970s. The introduction of the Blackjack intercontinental bomber and continued production of the Backfire would be very expensive. Meanwhile, projected tactical aircraft programs, particularly the MIG-29 Fulcrum, the SU-27 Flanker, and the SU-25 Frogfoot, would continue to claim a large share of air force procurement. In addition, Soviet airlift capability is projected to improve

Table 3
USSR: Distribution of Procurement by Service, 1966-90 [a]

Percent

	1966-70	1971-75	1976-80	1981-85	1986-90 [b]
Total	100	100	100	100	100
Ground Forces	18	19	19	20	21
Air Forces [c]	12	18	18	20	18
Navy	22	22	20	19	20
Strategic Rocket Forces	12	8	13	8	8
Air Defense Forces	17	13	10	9	11
Space programs	7	8	8	10	8
Support forces [d]	12	12	12	14	14

[a] The expenditure data in this table are for all procurement of military weapons and equipment, including their capital, or major, repairs. All service reorganizations have been reflected in the year they occurred. The structure in place in 1985 has been used for 1986-90.
[b] For ease of comparison, only the "best estimates" are shown. The 90-percent confidence bands present a more reliable projection of future procurement.
[c] Air Forces procurement includes military transport but not naval air programs (included in outlays for the Navy) nor fighter/interceptor programs (included in outlays for Air Defense Forces).
[d] Procurement for support forces includes Ministry of Defense support as well as rear services.

Navy. Naval procurement reached its highest levels during the 1970s, when additions to submarine-launched ballistic missile (SLBM) forces were in full swing. In the first half of the 1980s, naval procurement declined—in large part because of reduced outlays for SLBM programs.

Substantial growth is forecast for naval procurement during the current FYP. Submarines are again likely to lead the way. However, we believe that additions to the attack submarine fleet—with the Sierra-class attack submarine playing a major role—would require resources nearly equal to those for procurement of ballistic missile submarines—with the Typhoon likely to lead the way. The Soviets will continue to upgrade their surface combatant fleet as well. Two new carriers are projected to enter the fleet, along with other ships such as a modified version of the guided-missile destroyer Sovremennyy. We expect procurement for naval air programs to also rise.

Strategic Rocket Forces. Procurement for the SRF is driven by the acquisition of ICBM systems, causing sharp declines and spending fluctuations as each generation of ICBMs is introduced. The projected forces signal a period of high expenditures with the continuing deployment of the road-mobile ICBM, the SS-25, and the introduction of one or more new missiles. As a result, a large increase is projected in SRF procurement over that of the 1981-85 period.

Air Defense Forces. Procurement for Air Defense Forces in absolute terms and as a share of the total has declined since the second half of the 1970s, when these forces were assimilating a large number of new systems. Spending associated with the forces projected for the next five years would bring this decline to a halt, however. The principal programs projected are

the SA-10 program, the MIG-31 Foxhound and SU-27 Flanker, and the upgrade of the Moscow antiballistic-missile system.

Space Programs. Soviet investment in space programs, which are primarily military, has grown rapidly over the last 20 years. The peak expenditure levels of 1981-85 will slip somewhat with the systems projected for 1986-90. The principal ones are expected to be the military reconnaissance systems, with a major allocation to the heavy-lift launch vehicle and space shuttle, which support many programs.

Support Forces. Outlays for procurement of hardware for support services are a function of the size of the forces and increased when the Soviet defense establishment was growing rapidly. The growth in support forces slowed considerably during the first half of the 1980s, and they are expected to show little growth during the current FYP

Table 4
USSR: Production Quantities for Selected Weapon Classes

	Estimated 1981-85	Projected 1986-90
ICBMs	300	200
Conventional and ballistic missile submarines	47	50
Tanks	11,000	18,000
Fighter aircraft	2,400	2,000
Helicopters	2,300	2,300
Strategic bombers	220	210

Weapons Production

The new projection method produces much improved forecasts of future weapon programs in the aggregate. The method also produces a "median force," which generates the forecasts of expenditures. This force could be viewed as a single-value "best estimate" composed of a complete listing of the weapons and equipment that are expected to be procured during the current FYP. The individual elements, however, should not be viewed or used as individual "best" projections. The analysis in the previous sections, which presents the implications of a median case, makes the fullest practical use of the data. As indicated previously, while we have been able to forecast the total and the service allocations within reasonable bounds, we cannot predict accurately all of the individual programs within those totals

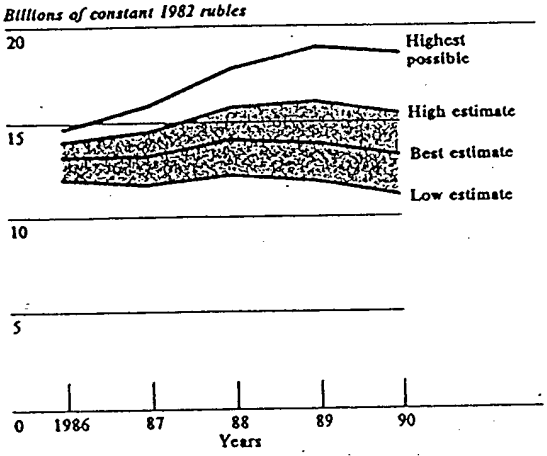
Each unique set of forces reflects the random selection process within the stated uncertainties. For practically any aggregate measure, alternative but equally likely sets of forces could also have been selected. We have presented in table 4 one of several arrays of selected weapons that could be produced with the spending levels described above. This illustrative example of possible weapon types and production quantities for the current FYP is compared with estimated production of the last FYP to put the numbers in context. The actual mix of systems and their levels could be different, but these programs are achievable within the resource levels forecast and would permit significant improvements in Soviet military forces.

Figure 3 presents another view of the results obtained from the new method—in this case, a forecast of the procurement for all missiles. The top line represents the resources required to procure all the programs considered possible—by the end of the decade they would amount to roughly 19 billion rubles. The range in the figure illustrates how the accumulation of the uncertainty judgments made for each missile program modifies our perception of the future. This approach indicates that some growth in missile procurement is expected through the late 1980s and that, by 1990, outlays will probably be between 11 billion and 15 billion rubles. We believe that displays of ranges for the future, similar to those in this figure, in either resource or physical terms, could be usefully adapted to the National Intelligence Estimate force projections.

Evaluation of the Method

We believe the new method described in this paper provides a much improved assessment of future programs, but it does not resolve satisfactorily all of the concerns noted earlier. A definitive assessment of the

Figure 3
Projected Soviet Outlays for Missile Procurement, 1986-90



Note: This band shows the likely range (90 percent confidence) of spending for missile procurement over the 12th Five-Year Plan period. The "highest possible" line represents the spending that would occur if the high side of all of the projections for individual missile programs actually occurred—a most unlikely event.

success of this method will take some time. At this stage, however, it is possible to review the approach and how it addresses the sources of uncertainty that affect force projections

Usefulness of This Approach

The new methodology does not take into account possible changes in the overall environment in which future military programs will be pursued. The history of Soviet military programs over the last 25 years or so suggests that fundamental changes do not occur frequently in the resources allocated to procuring military hardware. In the early 1960s Soviet efforts to modernize military forces began a prolonged period of growth in weapons procurement. The only deviation from that rapid growth prior to the mid-1970s was the pause between missile programs in the early part of that decade. Even though basic changes in the environment have occurred infrequently, however, when one does take place, its impact can be pervasive and result in dramatic shifts in the pace of weapons procurement. A policy change may have taken effect in the mid-1970s, when the rapid growth in outlays for weapons procurement ceased. Further, these changes are not easy to identify; initially, we are likely to perceive such changes only as adjustments to individual weapon programs. Accordingly, we are not likely to be able to predict them with confidence.

Other "global" factors—such as political and economic considerations—also can affect the implementation of a procurement plan. The new forecasting method does not incorporate these influences into the individual program estimates in any significant way. We are committed to improving this element of our analysis, however, and have begun an effort to examine ways to bring our perceptions of the "global" environment to bear upon our force projections. This is a large and amorphous problem that is not likely to yield easily to analysis, nor does it lend itself readily to quantification. We believe, nonetheless, that we can make progress on this issue and develop techniques that will allow us to apply the Community's knowledge in this area directly to our force projection effort.

At this stage, it is not practical to reflect the projected growth of Soviet GNP or the evolution of Gorbachev's industrial modernization program in, for example, the estimate of future production of the Blackjack bomber. But it is feasible, in fact crucial, to review the overall resource implications of our force projections jointly with projections of overall economic performance. This allows us to determine if adjustments are required in either or both estimates

Alternatively, the review may indicate both the economic and force projections are possible, but only under restricted conditions. The forces projected here would add substantially to Soviet military capabilities by the end of the decade. We have concluded, however, that the projections, in conjunction with our

assessments of future economic performance, indicate that considerable stress is in store for the Soviet leadership. This stress can be relieved only if Gorbachev achieves his proposed growth in output and productivity. If his campaign is not successful and economic performance falls substantially short of the plan—a situation we believe likely—some very tough choices will have to be made, and revisions in military programs are possible.

A Better Fix on the "Plan" and Its Implementation

We believe the new method does permit an improvement over past methods in two problem areas noted earlier—predicting the Soviet plan and forecasting its implementation. The treatment of these two sources of uncertainty is the goal of the new projections methodology, and it is here that we believe a breakthrough has been achieved.

Our perception of the "plan" is based on individual program estimates, and we believe the quality of these individual estimates has improved, as a result of our more detailed analysis of the evidence. A much larger data base has been created and more complex analyses undertaken on the capability of the Soviet military R&D establishment and the proficiency and capacity of defense industries. These analyses have been integrated with the analyses of weapons in the field and future military requirements. All these results combine to allow us to develop projections for individual programs consistent with the intelligence available and to use that same evidence to develop uncertainty statements for each program. These explicit judgments about the probability that an individual program or a part of it will occur as predicted are the foundation for our overall assessment of future forces.

The uncertainty judgments are program-specific and vary widely, particularly among different classes of military hardware—land arms, ships and submarines, aircraft, missiles, and military and civilian space systems. There are variations within a class—ICBMs and SLBMs, for instance—and within a subclass—for example, different measures are applied to individual models of tactical aircraft. Further, for each system, judgments are developed with respect not only to the likelihood of a program occurring, but also to the time of its introduction, its level of development, and the pace at which it will progress toward that level.

All these judgments create the basis for reaching our ultimate goal, improved overall force projections. Combining individual uncertainty measures with the help of computer simulations allows us to generate a set of force projections that no longer assumes all the projected programs will materialize "on schedule."