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Sources of Weapon System Cost Growth

Analysis of 35 Major Defense
Acquisition Programs

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Summary

Background and Purpose

Previous RAND Project AIR FORCE work has concluded that the Department of Defense (DoD) and the military departments historically have underestimated the cost of new weapon systems. Analysis of the data in Selected Acquisition Reports (SARs)¹ for a sample of 68 completed programs showed that the average total cost growth² (after adjusting for procurement-quantity changes) was 46 percent over the baseline estimate made at Milestone B (MS B) and 16 percent over the baseline estimate made at MS C. The cost growth typically continued for about 75 percent of the time between the initiation of major development and the expending of 90 percent of program funding. Most of the cost growth occurred early in the acquisition phase, and the magnitude of development cost growth at completion for programs initiated in the 1970s, 1980s, and 1990s remained relatively steady (Arena et al., 2006).

Although quantifying cost growth is important, the larger issue is why cost growth occurs. To answer that question, this analysis examines 35 mature, but not necessarily complete, major defense acquisition programs (MDAPs) from the database of SARs that document

¹ SARs are documents prepared by DoD for the U.S. Congress. They cover all major defense acquisition programs. They are submitted at least annually and are required by Public Law 10 USC 2432. For a more detailed discussion of SARs, see Arena et al., 2006, and Drezner et al., 1993.

² The average cost growth includes both cost overrun and cost underrun.

the development and procurement of a variety of systems, including aircraft, missiles, electronics systems, launch vehicles, munitions, vehicles, and satellites. The programs were similar in type and complexity to those conducted by the Air Force. We analyzed a relatively small number of programs because of the labor-intensive nature of the work. We first examined the programs as a complete set and then analyzed Air Force and non-Air Force programs separately to determine whether the causes of cost growth in the two groups differed.

Categorizing Cost Growth

The SARs establish a baseline cost estimate at the time of a program's MS B. Changes to that estimate (or "variances") are made and documented as time passes to explain increases or decreases in current and future budgets. In SARs, variances are assigned to the following categories: quantity, schedule, engineering, estimating, economic, other, and support. We defined different variance categories oriented toward the causes of cost growth and then reclassified the variance data from the SARs into our causally oriented structure. Because we wanted to allocate all variance data provided in each SAR, we did not normalize our results for changes in quantity. This approach had the added benefit of illuminating the relative effect of all cost-estimate changes in creating "realized" cost growth, which is the growth that must ultimately be managed within the budgeting process.

Several sets of causally oriented variance categories were explored during the study, each of which presented unique problems (e.g., overlap between categories, ambiguity in assigning growth, infrequently used categories). The final set meets our criteria (e.g., the categories were useful in explaining the causes of growth while being easily differentiated) better than the previous sets, but it may be improved through further revision in the future. This final set allocates cost variance into four major categories: (1) errors in estimation and planning, (2) decisions by the government, (3) financial matters, and (4) miscellaneous sources. As shown in Table S.1, the categories contain several subcategories.

Table S.1
RAND Cost-Variance Categories

Errors in estimation and planning	
Cost estimates	Program rebudgeting caused by an inappropriate initial estimate of costs
Schedule estimates	Program rebudgeting and rescheduling caused by an inappropriate schedule plan
Technical issues	Program replanning and rebudgeting resulting from significant technology development or implementation problems
Decisions by the government	
Requirements	Increase or decrease in program requirements, either with or without additional funding
Affordability	Decision by OSD, Congress, or the service to change the program because of cost issues (reprogramming decisions)
Quantity	Increase or decrease in the quantity of systems built
Schedule	Decision by OSD, Congress, or the service to change the program schedule (extend, contract, or restructure)
Inter- or intraprogram transfers	Color-of-money transfers within a program (between development and procurement or operations and maintenance (O&M)) or between programs
Financial matters	
Exchange rate	Program cost changes associated with differences between predicted and actual exchange rates
Inflation	Program cost changes associated with differences between predicted and actual inflation
Miscellaneous sources	
Error corrections	Variances from errors in the SARs
Unidentified	Unexplained variances
External events	External events affecting program cost, schedule, or technology

Errors made by the government, program contractor, or subcontractors include inaccurate estimation of costs or the inability to conform to initial or revised program schedules. This category also includes problems stemming from unanticipated technical difficulties encountered during acquisition.

Decisions made by DoD include requirements changes (usually associated with added performance and functionality), externally imposed funding changes (not driven by work-scope changes) that are typically precipitated by the need to free up funding for other priori-

ties, changes in the quantity of systems to be acquired, program schedule changes that are not associated with program execution difficulties, and decisions involving intraprogram (between appropriation categories) or interprogram transfers of funds and work scope.

Financial issues include unanticipated inflation levels and changes in exchange rates, which are relevant in programs in which a portion of the system is built by a foreign contractor or in a foreign country.

Miscellaneous sources are items not directly associated with errors in the program or decisions by the government. They include reporting errors, unidentified variances whose origins are simply not described well enough to allocate to any other category, and external events that affect the program but are not a result of errors or decisions directly associated with it.

Results of the Analysis

Overall Cost Growth

Table S.2 shows average development, procurement, and total (development plus procurement) cost growth for the 35 mature programs we examined. The values shown include the effects of changes in quantity. In most cost-growth studies, these effects are removed from the results by normalizing the figures to reflect their expected value if no quantity changes had occurred. Because we have included quantity variances, the results of this study are not directly comparable to those of most prior studies.

Total (development plus procurement) cost growth is dominated by decisions, which account for more than two-thirds of the growth. Most decision-related cost growth involves quantity changes (22 percent), requirements growth (13 percent), and schedule changes (9 percent). Cost estimation (10 percent) is the only large contributor in the errors category. Growth due to financial and miscellaneous causes is less than 4 percent of the overall growth.

Table S.2
Cost Growth, by RAND Category (mean for 35 mature programs)

Category	Development Cost Growth (%)	Procurement Cost Growth (%)	Total Cost Growth (%)
Errors	19.6	14.7	14.6
Cost estimate	18.0	8.4	10.1
Schedule estimate	1.0	0.9	0.9
Technical issues	0.6	5.4	3.5
Decisions	30.7	57.4	41.6
Requirements	17.5	9.5	12.9
Affordability	-1.9	-0.5	-1.3
Quantity	4.3	40.8	21.9
Schedule	6.0	10.0	8.9
Inter- or intraprogram transfers	4.8	-2.4	-0.7
Financial	1.0	1.8	1.4
Exchange rate	0.1	0.1	0.1
Inflation	0.9	1.7	1.3
Miscellaneous	5.2	1.4	2.4
Error correction	-0.5	-0.3	-0.4
Unidentified	-0.3	-0.3	-0.4
External events	6.0	2.1	3.1
Total	56.5	75.4	60.0

The dominant influence of decisions is somewhat unexpected, because previous studies have reported nearly the reverse. A clear contributor is our inclusion of quantity changes, which are responsible for more than one-third of total cost growth and more than half of the total for the decisions category. Also somewhat unexpected is the small contribution of technical issues to average cost growth. Such issues contributed to cost growth in only a few programs.

Errors due to cost estimating account for nearly one-third of the overall development cost growth, and changes in requirements account for almost as much. However, growth due to decisions still dominates development cost growth. More than half of the average procurement cost growth is due to quantity changes. The other two major factors are schedule and requirements changes.

Cost Growth in Air Force Programs

In addition to estimating total cost growth, we examined cost-growth sources separately for the 16 programs that were managed by the Air Force. While the averages of total cost growth for the Air Force programs were somewhat higher than those for the other programs, the differences were not statistically meaningful (see pp. 35–38). The lack of statistical significance results in part from the relatively high values of standard deviation found in both portions of the sample. It does not appear that the Air Force programs perform better or worse than the overall, multiservice average. This result is consistent with results of prior RAND studies, which found no statistically meaningful differences among the military services.

Cost Growth by Program Type

We examined three program-type subsets from the full sample of programs: aircraft and helicopters, missiles, and electronics. Total cost growth for aircraft and helicopters averaged 74 percent; that for missiles averaged 44 percent; and that for electronics averaged 28 percent (see pp. 38–43). Decisions accounted for the majority of cost growth in aircraft and helicopters and missiles, and for virtually all of the cost growth in electronics. Cost estimating was the single largest cost-growth contributor in aircraft and helicopters and missile programs at 27 percent and 15 percent, respectively. Quantity, at 18 percent, was the single largest contributor to cost growth in electronics programs.

By and large, we did not see any statistically significant differences for development cost growth, with the exception that affordability changes tend to be positive for electronics programs (possibly indicating unfunded requirements) and negative in the other programs. Other observed differences in development cost growth were minor, with the exception of greater cost-estimating errors in aircraft and helicopters.

There were some important and statistically meaningful differences in procurement cost growth. Aircraft programs had larger procurement cost growth due to errors in cost estimating and technology issues. The growth due to errors was statistically significant; that due to technology issues was not. Electronics programs had statistically significant lower procurement cost growth due to errors.

Opportunities to Reduce Cost Growth in Weapon-System Programs

Our results show that decisions involving changes in requirements, quantities, and production schedules dominate cost growth. Therefore, program managers, service leadership, and Congress should look for ways to reduce changes in these areas. However, we understand that a careful balance must be struck between containing growth and providing the right capabilities to the warfighter.

Improving the quality of cost estimates, particularly in system development and in aircraft and helicopter procurement costs, would yield the greatest reduction in cost growth. While correction of cost-estimating errors will not directly reduce overall system costs, it will better align expectations with reality and may indirectly provide modest overall cost reductions through reduction in the “churn” of program plans and activities resulting from the common mismatch between them.

Ways to Improve SAR Data

Our attribution of cost variances in the SARs to underlying causes was challenged by inconsistent quality and nonspecific attribution in SAR cost-variance descriptions. More-stringent specifications and consistent application of variance descriptions could greatly enhance the usefulness of the SARs to their customers. In particular, each variance value should be restricted to a single source. Current practice on many programs is to string together two to five apparently unrelated causes and associate a single cost-variance value to the aggregate. This practice makes the variance results essentially meaningless. In addition, we recommend that variances with values over a specified threshold (e.g., \$10 million in fiscal year (FY) 2005 dollars) should require a more detailed narrative that describes the events and activities that led to the ultimate recognition of the cause of the variance. Finally, we recommend that OSD consider changing the variance categories in SARs to provide information that is more causally oriented.