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IS

**WEAPON
SYSTEM
COST
GROWTH
INCREASING?**

**A Quantitative Assessment of
Completed and Ongoing Programs**

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Summary

Cost growth in DoD acquisition programs has been a long-standing concern of senior policymakers and members of Congress. In recent decades, there have been numerous attempts to rein in this growth. Some changes involve reforms to the acquisition process, while others entail legislation. The RAND Corporation has a long history of studying cost growth in defense acquisition, with research reaching back to the 1950s.

Research Focus and Approach

The U.S. Air Force asked RAND to examine weapon system cost growth. To do so, we attempted to answer two questions:

- What is the cost growth of DoD weapon systems?
- What has been the trend of cost growth over the past three decades?

To answer the first question, we drew on a recent RAND report on the analysis of cost growth of completed programs (Arena, Leonard, et al., 2006) (see pp. 15–18). To answer the second question, we performed a new analysis of both completed and ongoing programs (see pp. 19–40). The data analyzed came from a SAR database maintained by RAND since the early 1990s (see pp. 9–14).

Cost growth is defined as the ratio between the most recent SAR estimate (or the estimate reported in the program's final SAR) and the cost estimate baseline reported in a prior SAR issued at the time of a given milestone. The values reported in SARs reflect the official position of the management authority of the program—either the Office of the Secretary of Defense (OSD) or one of the military services.

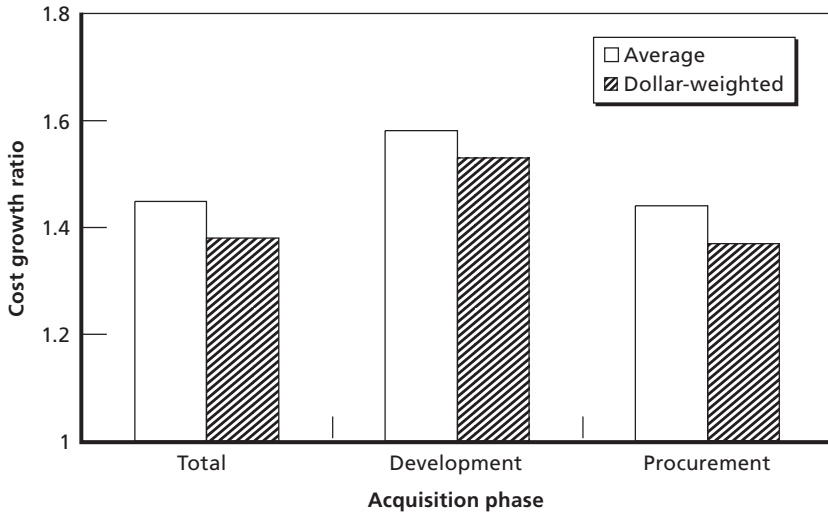
To address the magnitude of cost growth, the first part of this analysis relies on previous RAND work on cost growth analysis of completed programs (specifically, Arena, Leonard, et al., 2006) (see pp. 19–24). But to evaluate the trend over time, we also analyzed some ongoing programs (see pp. 25–29). To measure growth on an equivalent basis with completed programs, we measured cost growth five years after milestone (MS) B for all programs—completed and ongoing (see pp. 31–33).¹ Changes in the mix of system types over time were also considered because earlier studies have suggested that cost growth varies by program type (see pp. 33–35). DoD procures more space and electronics systems and fewer aircraft and helicopters today than it did a decade or two ago.

What Is the Cost Growth of DoD Weapon Systems?

Figure S.1 shows the results of the analysis with respect to the first question. It presents the results of the analysis of 46 completed programs for total development and procurement cost growth, both as a simple and a dollar-weighted average. As the figure shows, the average total cost growth ratio across all programs is 1.46. In other words, on the average, programs cost 46 percent more than estimated at MS B.

¹ In this monograph, we use the current acquisition process' milestone designations, i.e., MS A, MS B, and MS C as defined in DoD 5000.1 (U.S. Department of Defense, 2000). (See Chapter One for a full discussion.) However, some of the older programs use the older system of MS I, MS II, and MS III. For simplicity of presentation, we assume that the milestones are directly comparable, e.g., that MS II and MS B are essentially equivalent points in a program.

Figure S.1
Weapon System Cost Growth by Acquisition Phase for Completed Programs



NOTE: All cost growth ratio calculations include adjustments to remove the effects of inflation. Procurement and total cost growth ratio calculations include additional adjustment to remove the effects of changes in the number of systems built in the program's procurement phase.

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The highest cost growth occurs in the development phase, with the ratio reaching almost 1.6. When calculated on a dollar-weighted basis, the growth is slightly less but still substantial.

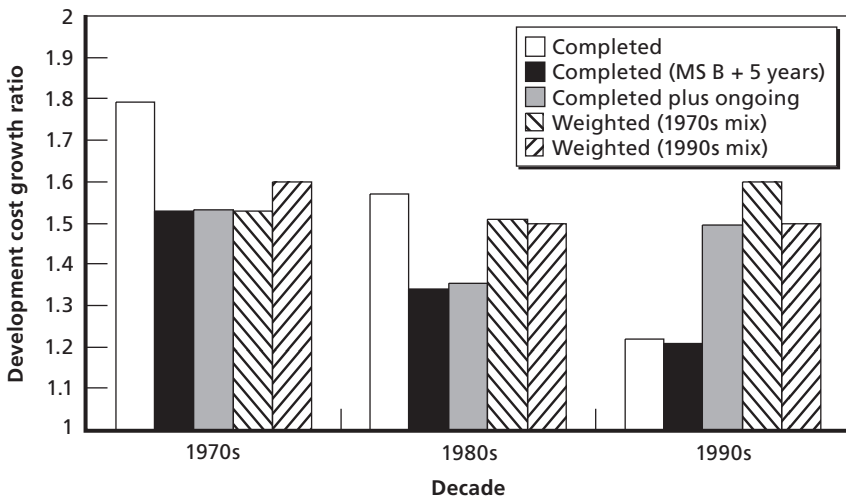
What Has Been the Trend of Cost Growth?

As Figure S.1 shows, DoD has averaged 46 percent total cost growth in procuring its major weapon systems. It has long been aware of this problem and has initiated a variety of acquisition reforms to reduce cost growth (see Lorell and Graser, 2001, and Hanks et al., 2005). The question is, then, have these reforms reduced cost growth over time? The answer lies in the trend of cost growth over time (see pp. 33–35).

Figure S.2 shows the results of PAF analysis of the time trends in cost growth. It presents five views of mean values of development cost growth in three decades—the 1970s, 1980s, and 1990s. The first bar is development cost growth measured at the program completion point, and the other bars indicate measurements at five years after MS B. We focus on development cost growth because it is a good early indicator of total program cost growth and because its growth trend is similar to procurement and total program cost growth (see pp. 36–38).

The first bar for each decade shows the development cost growth factor (DCGF) of completed programs. Categorization into a particular decade is based on the decade in which each program had its MS B (or equivalent) decision. These first bars indicate declining DCGF, from almost 1.8 in the 1970s to just over 1.2 in the 1990s. However, this trend should be regarded with a measure of skepticism, in part because the averaged data for each decade include programs of different lengths (more recent programs are necessarily shorter) and in part because the mix of types of programs that are completed from each decade is quite different. For example, any project completed in the

Figure S.2
Trend of Weapon System Development Cost Growth



1990s would have to be of shorter duration and would tend to be of the type that experiences the lowest cost growth (Arena, Leonard, et al., 2006). The previous research shows that electronics programs tend to have less cost growth and that the vast majority of the completed programs in the 1990s fall into that category. The research also shows that shorter projects tend to have less cost growth than do longer ones. Thus, the apparent decline in cost growth may be influenced by the inclusion of shorter projects and commodity classes that typically experience less cost growth (see pp. 38–40).

The second bar in each decade grouping traces the DCGF trend by examining the same set of completed programs, but measured at five years past MS B. As might be expected, measuring the DCGF from the five-year point does result in a lower DCGF. The relative ranking of the decades remains unchanged, but the growth in the 1970s and 1980s is less because all growth after the five-year point is excluded (see pp. 38–40).

The third bar in each decade grouping incorporates 34 ongoing programs with the completed ones, all measured at five years past MS B. The combined sets of programs are compared at this common point. This bar shows that, although DCGF declined between the 1970s and the 1980s, in the 1990s, DCGF rose again to about the same level as in the 1970s. In addition, the large increase in DCGF from the second to third bar in the 1990s grouping indicates that ongoing programs begun in the 1990s have substantially higher DCGFs than do those begun in that decade that are now complete (see pp. 38–40).

Previous research (Arena, Leonard, et al., 2006; McNicol, 2004; Drezner et al., 1993) indicated significant differences among types of weapon systems (e.g., aircraft, missile, electronic). To assess the effect of weapon program type, we controlled for type by normalizing the contribution of each program type to the DCGF based on the proportions of each weapon system type in the 1970s or the 1990s. Chapter Six explains this normalization method. These normalized cost growth figures are shown in the fourth and fifth bars in each decade's grouping in Figure S.2. The fourth bar shows completed and ongoing programs measured at five years past MS B and weighted by the 1970s program mix, and, similarly, the fifth bar shows DCGF of completed and ongo-

ing programs, all measured at five years past MS B and weighted by the 1990s program mix. Controlling for the 1970s mix of programs shows some increase between the 1970s and the 1990s, but not a significant one. Controlling for a 1990s program mix shows a slight decline between the 1970s and the 1990s, but it is not statistically significant. They show that cost growth has not improved over the decades.

We also conducted a statistical analysis to examine whether there were any differences in the trend of development cost growth among various weapon system types and the military services, and we conclude that the three services do not differ significantly in their DCGF levels for their respective programs. We repeated the statistical analysis for development cost growth weighted by development budgets in constant dollars to highlight whether programs with higher development costs have different time trends from those with lower costs. By and large, various weapon system types do not have significantly different trends, with the exception of helicopters (for nonweighted DCGF) and space systems (for weighted DCGF), which did show higher levels of development cost growth than the average of all weapon system types (see pp. 39–40). While the results are statistically significant at the 0.05 level, the small number of observations (eight helicopter programs, three satellite programs, and three launch vehicle programs) included in the analyses means that caution should be used in making any generalizations about these particular results.

Conclusion

Perhaps the most important finding of the analysis is that development cost growth in the past three decades has remained high, with no significant improvement. However, the analysis also suggests that there was greater variability in development cost growth in the 1990s; that is, some observations were substantially higher than the mean. Thus, despite the many acquisition reform and other DoD management initiatives over the years, the development cost growth of military systems has not been reduced. This is not an indictment of the government personnel or contractors involved in the acquisition of systems for the

military. There is no doubt that the systems developed in each successive decade are more complex than those of the prior decade. The ever-increasing complexity of technology, software density, system integration complexity, and the like make the estimating a total system's development cost, at the inception of major development activities, an increasingly challenging endeavor (Arena, Blickstein, et al., 2006).

As our very rough comparison with the analysis by Flyvbjerg, Holm, and Buhl (2002) of public works projects shows, weapon system total cost growth is higher than that of rail, fixed-link, and road projects. This difference is understandable given that the technologies involved in those projects are extremely well understood and include the conservative, evolutionary adaptation of new technology over time. Most DoD defense development programs involve much higher levels of new technology adaptation and therefore result in inherently higher levels of cost and schedule uncertainty.

This is also not to say that DoD cannot do better in controlling cost growth. Undoubtedly it can, and it should bend its efforts to doing so. Over the years, several studies, by RAND and others,² have attempted to identify the causes of cost growth and what steps can be taken to address them. These causes fall into the following broad areas: overoptimism, estimating errors, unrecognized technical issues, requirements creep, lack of incentives to control cost, and schedule extensions. Therefore, addressing the issue of cost growth requires vigorous involvement of all stakeholders in DoD. However, there may be one aspect of the acquisition process that merits special attention, and that is the cost estimates that form the basis of program budgets. Cost growth may also reflect poor initial budget estimates. Better cost estimates would not necessarily save any money; however, they would provide decisionmakers a better basis for deciding whether to pursue a given program.

² Recent RAND studies that address ways in which DoD can address the growing cost of weapon system development include the following: Arena, Younossi, et al. (2006); Arena, Blickstein, et al. (2006); Younossi, Stem, et al. (2005); Lorell and Graser (2001); and Cook and Graser (2001).