TECHNICAL REPORT

Historical Cost Growth of Completed Weapon System Programs

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PROJECT AIR FORCE

Summary

Review of Cost Growth Literature

Overall, most of the studies we reviewed reported that actual costs were greater than estimates of baseline costs. The most common metric used to measure cost growth is the cost growth factor (CGF), which is defined as the ratio of the actual cost to the estimated costs. A CGF of less than 1.0 indicates that the estimate was higher than the actual cost—an underrun. When the CGF exceeds 1.0, the actual costs were higher than the estimate—an overrun.

Studies of the weapon system cost growth have mainly relied on data from Selected Acquisition Reports (SARs). These reports are prepared annually by all major defense acquisition program (MDAP) offices within the military services to provide the U.S. Congress with cost, schedule, and performance status. The comparison baseline (estimate) typically corresponds to a major acquisition decision milestone (e.g., Milestone II).

Prior studies have reported Milestone (MS) II CGFs for development costs ranging from 1.16 to 2.26; estimates of procurement CGFs ranging from 1.16 to 1.65; and total program CGFs ranging from 1.20 to 1.54. Regarding the differences among cost growth due to service, weapon, and time period, prior studies tended to find the following:

- Army weapon systems had higher cost growth than did weapon systems for the Air Force or Navy.
- Cost growth differs by equipment type. Several reasons are given for the differences including technical difficulty, degree of management attention, and protection from schedule stretch.
- Cost growth has declined from the 1960s and 1970s, after it was recognized as an important problem. However, improvement with recent acquisition initiatives has been mixed.

The literature describes several factors that affect cost growth. The most common ones included acquisition strategies, schedule, and others, such as increased capabilities, unrealistic estimates, and funding availability.

Analysis of Historical Acquisition Cost Growth in the Department of Defense

Our analysis also shows that, by and large, the Department of Defense (DoD) and the military departments have underestimated the cost of buying new weapon systems. (See pp. 21–24.) For our analysis, we used a very specific sample of SAR data, namely only pro-

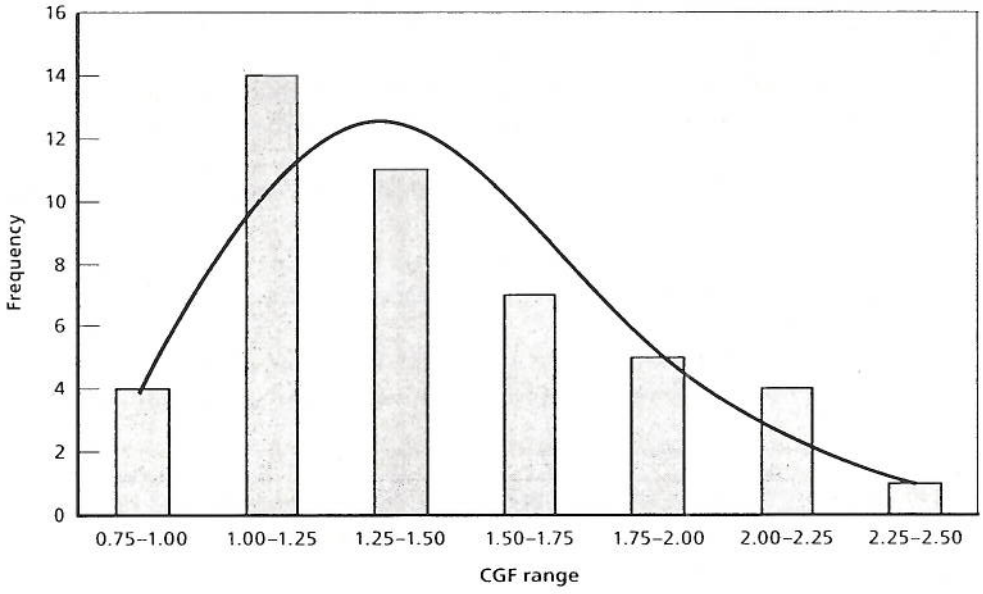
grams that are complete or are nearly so.[1] We deliberately chose to analyze completed programs so that we could have an accurate view of the total cost growth. It typically takes many years before the complete cost growth emerges for a program. Development costs continue to grow well past the beginning of production. Previous studies have mixed both complete and ongoing programs—potentially biasing their cost growth downward. While this sample selection reduces our sample size, we think that we have a better measure of final cost growth.

Figure S.1 shows the cost growth of programs that dealt with systems that were similar to those procured by the Air Force (e.g., aircraft, missiles, electronics upgrades).[2] The metric (total CGF) displayed in the figure is the ratio of the final cost to that estimated at MS II (or its equivalent). The figure shows that the majority of programs had cost overruns.

The analysis indicates a systematic bias toward underestimating the costs and substantial uncertainty in estimating the final cost of a weapon system. Our analysis of the data indicates that the average adjusted total cost growth for a completed program was 46 percent from MS II and 16 percent from MS III. The bias toward cost growth does not disappear until about three-quarters of the way through system design, development, and production.

In contrast to the previous literature, we observed very few correlations with cost growth. (See pp. 27–38.) We observed that programs with longer duration had greater cost growth. Electronics programs tended to have lower cost growth. Although there were some

Figure S.1
Distribution of Total Cost Growth from MS II Adjusted for Procurement Quantity Changes



RAND TR343-S.1

[1] We defined the program as complete if that program had delivered 90 percent or more of its procurement quantity or if the final SAR has been submitted.

[2] The data have been modified to mitigate the effects of inflation and changes in the number of units procured.

differences in the mean total CGF among the military departments, the differences were not statistically significant. While newer programs appear to have lower cost growth, this trend appears to be due to factors other than acquisition policies.

Table 2.1
Cost Growth Measures

Citation	Data Sources	Time Period	Sample	Reported Measure	CGFs		
					Development	Procurement (Production)	Total Program
Tyson, Nelson, Om, and Palmer (1989); Wolf (1990)	SARs (last SAR for program or December 1987) and concept papers	1960–1987	89 weapon systems	Mean ratio	1.27 (n = 80)	1.65 (n = 63)	1.51 (n = 63)
Tyson, Harmon, and Utech (1994)	SARs (last SAR for program or December 1992) and historical memoranda	1962–1992	20 tactical missiles	Median ratio	1.26 (n = 20)	1.59 (n = 20)	1.54 (n = 20)
			7 tactical aircraft	Mean ratio	1.20 (n = 7)	1.17 (n = 7)	1.20 (n = 7)
McNicol (2004)	PA&E database	1970–1997	138 that passed MS II and had completed at least 3 years EMD and had not entered acquisition process at MS IIIa or MS IIIb	Average percentage change from DE baseline	1.45 (n = 138)	1.28 (n = 138)	Not reported
Drezner et al. (1993)	SARs (last SAR for program or December 1990 SAR)	1960–1990	128 programs with DE	Average adjusted CGF n	1.25 (n = 115)	1.18 (n = 120)	1.20 (n = 120)
Unpublished 1959 draft RAND report	Weapon system reports	1946–1959	24 weapon systems (9 fighters, 3 bombers, 4 cargos/tanks, 8 missiles)	Adjusted total factor increase	Not reported	Not reported	3.23 (n = 24) (st. dev. 2.273)
				Unadjusted total factor increase	Not reported	Not reported	6.06 (n = 24) (st. dev. 5.4)
Shaw (1982)	Last SAR for program or latest available	1973–1982	6 intercept missile programs	Percentage change in development cost growth and unit total cost procurement growth (FSD to procurement) for each weapon system	2.26 (n = 6)	1.43 (n = 6)	Not reported
Asher and Maggelet (1984)	Last SAR for program or December 1983	As of December 1983	52 systems that had achieved IOC	DE to IOC; mean cumulative total development CGF; cumulative total procurement unit cost growth factor at IOC	1.52 (n = 52)	1.30 (n = 52)	Not reported

Table 2.1—continued

Citation	Data Sources	Time Period	Sample	Reported Measure	CGFs		
					Development	Procurement (Production)	Total Program
Wandland and Wickman (1993)	Program management system contracts for 5 Air Force organizations compiled in Acquisition Management Information Systems	1980–1990	261 competed and 251 sole-source contracts	Average total CGF competed			1.14 (n = 261)
				Average total CGF sole-source contracts			1.24 (n = 251)
Tyson, Nelson, and Utech (1992)	Marshall Space Flight Center's NASA cost model, GAO reports, related IDA projects, and NASA briefings	Not given	23 space programs with cost growth and program size information	Average cost growth			2.01 (n = 23)
		Not given	23 space programs with cost growth and program size information	Weighted (program size) average cost growth			2.10 (n = 23)
This study (2006)	Last SAR for program	1968–2003	68 completed programs, similar complexity to those acquired by U.S. Air Force	Average cost growth (mean)	1.58 (n = 46)	1.44 (n = 44)	1.46 (n = 46)

This page summarizes findings from a subsequent 2007 RAND Project Air Force Report

Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs

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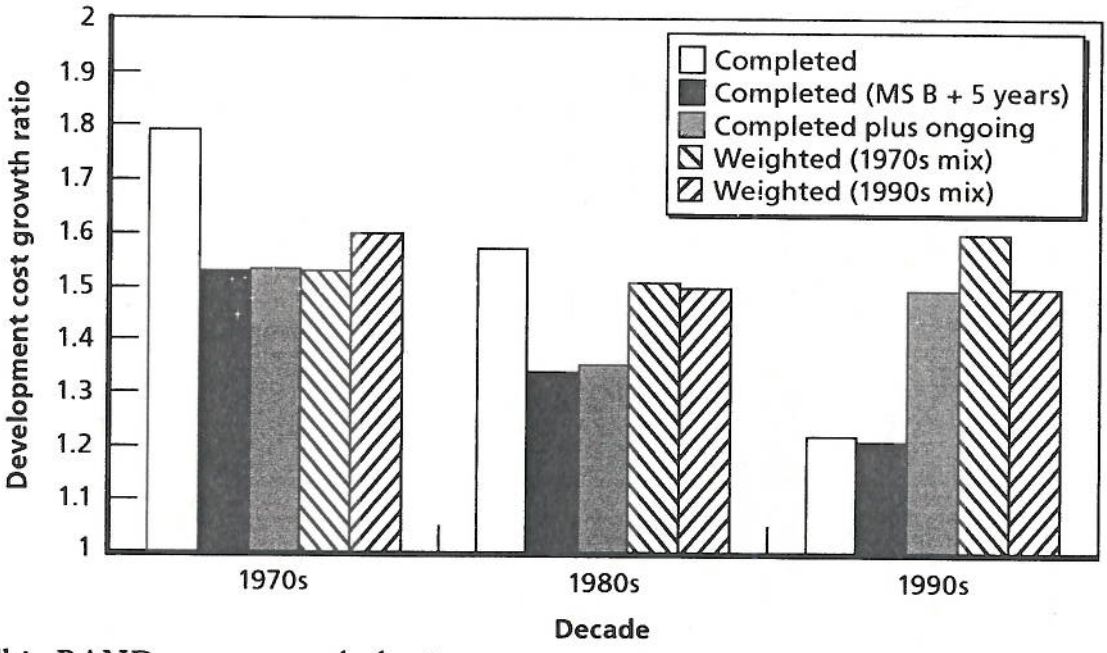
Figure S.2
Trend of Weapon System Development Cost Growth



This RAND report concludes in part:

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 system has not been reduced.