



Chapter Title: Selected Acquisition Report Data and Analytics

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Chapter One. Selected Acquisition Report Data and Analytics

In the past four decades, the military services and the Office of the Secretary of Defense (OSD) have managed hundreds of very large weapon system acquisition programs. These programs, known as Major Defense Acquisition Programs (MDAPs), account for more than 40 percent of all weapon system acquisition funding appropriated by Congress. Cost growth and schedule slips in MDAPs cause difficulty in managing acquisition budget accounts and delays in delivering required capabilities to the warfighter. This analysis is one in a series designed to improve MDAP outcomes and develop better cost-estimating tools for use by the acquisition community.

We analyze cost growth in Air Force–managed MDAPs and in MDAPs managed by the U.S. Department of Defense (DoD), the Navy, or the Army that have substantial Air Force funding. Differing definitions of cost growth provide differing insights into program outcomes. In this analysis, we define cost growth as that for the entire acquisition effort, as measured from the point of commitment to system development. This commitment typically occurs at the time of program’s Milestone (MS) B (MS B) and the associated major development contract award. The analysis focuses on those MDAPs that contain the highest levels of development activity and that, at a minimum, have proceeded through the acquisition process to a point at which a portion of the production units envisioned at the program’s MS B were produced.

Selected Acquisition Report Data

To help the Air Force understand cost growth in MDAPs, RAND Project AIR FORCE (PAF) maintains an internal database of costs and schedules for these programs as reported in Selected Acquisition Reports (SARs) dating back to the 1960s. The database tracks costs and major milestones for each program’s acquisition in more than 300 MDAPs that, in aggregate, have published more than 5,000 individual SARs. This database includes MDAPs related to all the services and DoD, all weapon system types, and all acquisition-related costs. The database is unclassified, thus allowing the broadest possible use of the data to support analyses both within PAF and in the Air Force–wide acquisition community.

The purpose of the SAR database is to provide the current cost and schedule status of MDAPs in all stages of the acquisition process and to track the growth of costs and slips in schedule over time for each program. The database specifies consistent baseline definitions for major milestones in order to facilitate comparisons between programs, services, weapon system types, and the evolving acquisition process over the decades. The database allows for analyses over time that

- track cost and schedule estimate changes
- analyze trends in the accuracy of cost and schedule estimates
- identify correlations between cost and schedule changes
- provide understanding of budgetary impact.

To isolate different types of cost growth, the database tracks program estimates in both then-year (budget) and base-year (constant) dollars.¹ This allows us to isolate cost growth caused by inflation in each program. Cost estimates are also tracked as budgeted and with adjustments for quantity changes. The latter allows us to track unit cost growth in both procurement and for the program in total.

In the remainder of this chapter, we provide sample cost growth charts to illustrate the types of analyses that are possible with the database, and we illustrate the ways in which MDAPs can be categorized across the acquisition timeline.

Sample Cost Growth Charts

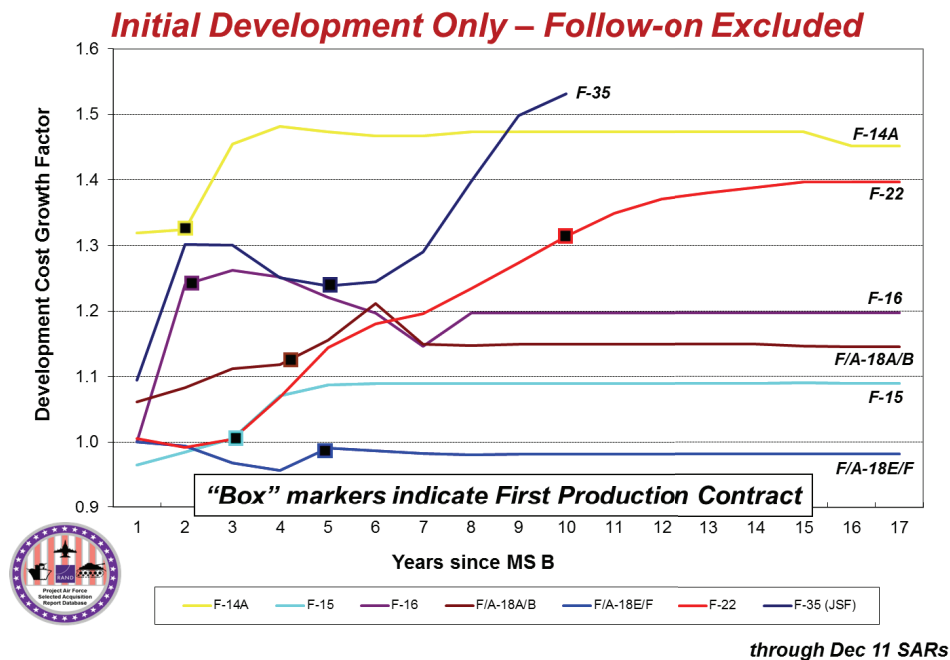
Figure 1.1 provides an example of the type of analyses made possible by the database. The figure displays cost growth for the initial development program in total at each year past the MS B for seven fighter aircraft programs.² The MS B typically coincides with the commitment to a weapon system development program, so it is the official or tacit beginning for all MDAPs that require substantial development prior to production.

In the figure, the calendar or fiscal year (FY) in which each program's MS B occurred is irrelevant. Arranging the cost growth data this way allows us to compare development cost growth across several programs at equivalent times after the decision to move forward with major development. *Major development* is defined as the award of the primary full-scale development (FSD), engineering and manufacturing development (EMD), or system design and development (SDD) contract.

¹ SARs report program costs in both then-year and base-year dollars. Service and appropriation specific inflation indexes are utilized to convert base-year cost data in programs to a common base year for all programs, thus facilitating their comparison.

² F-35 program cost growth shown represents the U.S. program in its entirety. This includes F-35A, B, and C aircraft variants.

Figure 1.1. Development Cost Growth over Time in Fighter Aircraft Programs

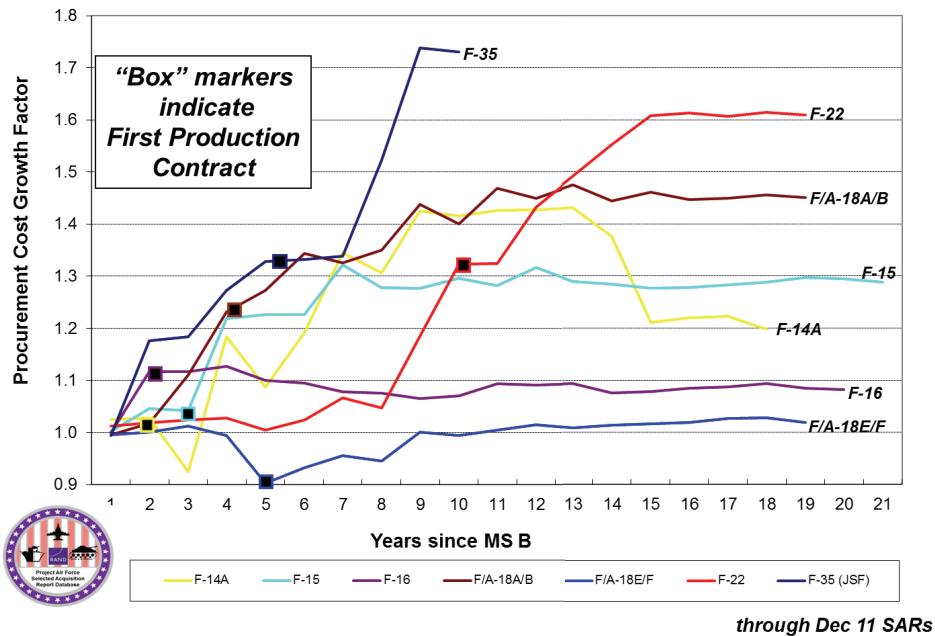


The x-axis shows the number of years from the program’s MS B. The y-axis shows development cost growth as a factor, with 1.0 equaling no growth, 1.1 equaling 10 percent growth, 1.2 equaling 20 percent growth, and so on. The box on each program’s development cost growth line represents the point after the MS B at which the program’s first significant production contract was awarded, typically that for the program’s initial production lot. The cost growth calculations exclude development funding in the years after the program’s initial development effort that is typically added late in the development effort for capabilities not envisioned at the time of the MS B. Removing this funding for follow-on development activities, such as block upgrades and modernization efforts, ensures that the cost growth calculations over time represent (as closely as is possible) the capabilities included in the estimate at the time of the MS B.

Figure 1.2 shows similar data for procurement cost estimates in the same seven fighter aircraft programs. In these data, the effects of quantity changes have been removed, allowing us to understand how unit cost estimates grew over time. After the MS B, the portion of the entire production run that is currently estimated and was estimated at the MS B are compared to calculate cost growth. If the current program has more units than the MS B baseline estimate, then the cost growth for the baseline quantity is used for this calculation. For example, in the F-16 tactical fighter aircraft program, 650 U.S. production aircraft were envisioned at the MS B; eight years later, the program planned to build 2,165 U.S. production aircraft. The cost growth shown is for the initial 650 aircraft. If the current program has fewer units than the MS B baseline estimate, then the cost growth calculated is based on the current quantity. The F-35

program envisioned 2,852 U.S. production aircraft at the MS B;³ eight years past that milestone, the program planned to build 2,443 U.S. production aircraft. The cost growth estimate shown is for the 2,443 aircraft.

Figure 1.2. Procurement Cost Growth over Time in Fighter Aircraft Programs, Adjusted for Quantity Changes



Figures 1.1 and 1.2 illustrate just how high cost growth is in the F-35 program compared with that of other fighter aircraft programs. Not only does the F-35 program have the highest cost growth of all fighters represented, but this level of cost growth occurs at a relatively early point in the typical 20-plus-year acquisition duration of a fighter program, and the total value of the F-35 program far exceeds that of any previous fighter aircraft program, regardless of whether quantity changes are factored in. Future additional cost growth in the F-35 program remains likely, given that its initial operational test and evaluation is not yet complete. In contrast, data for all other fighter programs extend to the point at which cost growth has stabilized.

Figures 1.1 and 1.2 provide just a small sample of the type of analyses that are possible given the breadth and depth of the database. Similar figures are available for these same seven programs showing procurement cost growth when not adjusting for quantity changes, and program total cost growth (including development, procurement, military construction [MILCON], and acquisition-related operations and maintenance [O&M]), both adjusted and

³ F-35 models A, B, and C.

unadjusted for quantity changes. Also available are a similar series of figures for nonfighter aircraft and a separate series of figures covering space systems.

Figures of this type can be created for programs measuring cost growth from MS A, B or C, and for all weapon system types DoD-wide,⁴ including

- aircraft (includes fixed-wing unmanned aerial vehicles [UAVs] and remotely piloted vehicles [RPVs])
- helicopters (includes rotary-wing UAVs and RPVs)
- missiles (tactical, cruise, strategic, and torpedoes)
- vehicles (includes tanks)
- ships and submarines
- electronics (radios, telecommunication terminals, avionics upgrades, weapon guidance kits)
- space (satellites and launch vehicles).

Major Defense Acquisition Program Estimation and Categorization in the Acquisition Timeline

In the past, any MDAP with substantial development effort (and therefore funding) submitted its first life cycle cost estimate at the time of its MS B.⁵ This estimate included all costs from the initiation of development efforts through the decades-long operational period for the system. Separate estimates were generally developed by both the program office and an independent body, such as the Air Force Cost Analysis Agency (AFCAA). The two estimates were then reconciled to create a service cost position, which was presented to the defense acquisition executive at the time of the MS B review. If the program passed the review, then the cost estimate became the baseline for the MDAP. Thereafter, the estimate was updated annually and reported to Congress via the program's SAR. Note that the analysis herein addresses only the acquisition portion of the overall life cycle estimate, so the program's operations and support costs are not part of this analysis.

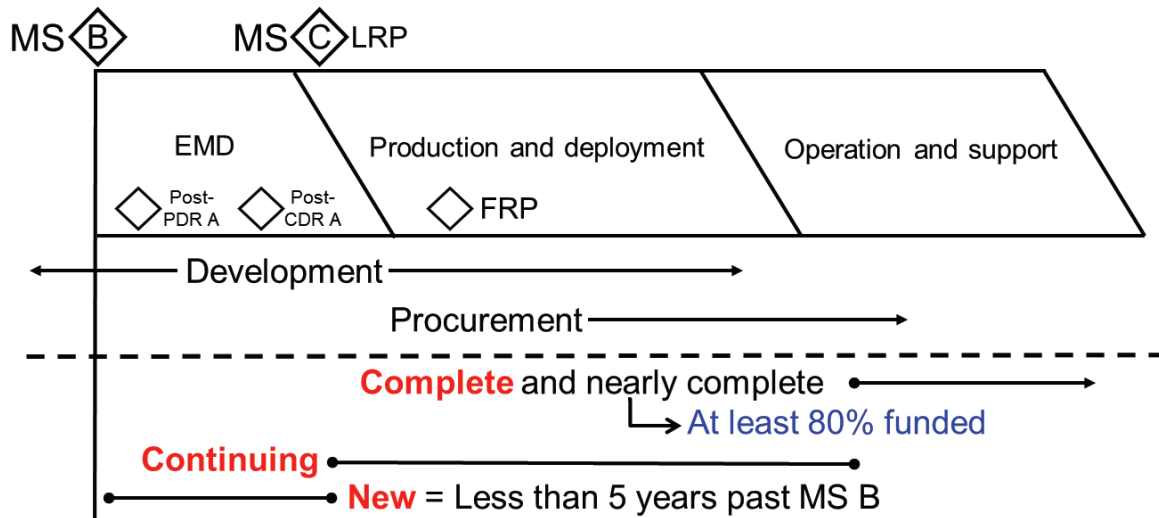
To analyze acquisition cost growth, we first categorize programs based on their position in the timeline of the acquisition process. Major development, and thus the commitment to an acquisition program, typically begins at MS B, which is the primary milestone from which we measure cost growth. In older MDAPs that employed similar versions of this same basic process, the initiation of major development activities through the award of a contract at or near the time of the program's Milestone II was used as the point from which we measure acquisition cost growth. The acquisition timeline from MS B is shown in the top of Figure 1.3.

⁴ Major Automated Information System (MAIS) programs do not report to Congress via SARs unless the program is also categorized as an MDAP.

⁵ With the Weapon Systems Acquisition Reform Act of 2009 (Pub. L. 111-23), the policy changed to require a complete life cycle cost estimate at MS A.

In general, the cost growth and associated analyses in this work include Complete and Continuing programs. The former are generally used as a reference point for the latter to assess outcomes for programs currently under active Air Force acquisition management. The New programs are not appropriate for such comparisons. We explain each category below.

Figure 1.3. MDAP Categorization in the Acquisition Process Timeline



NOTE: LRP = low-rate production. PDR = preliminary design review. CDR = critical design review. FRP = full-rate production.

New Programs

We define New programs as those that are less than five years past MS B. New programs are typically not far enough beyond their MS Bs for substantial cost growth to have occurred. Although some cost growth may have occurred, in most programs, it is far too early to estimate the level of additional future cost growth each program may experience. Difficulties in executing MDAPs to the plan established at MS B take time to work through the process of determining mitigation plans and assessing the cost and schedule impacts of the proposed resolutions. Because of this delay, the costs of problems uncovered in MDAPs can take years to manifest themselves. For these reasons, MDAPs that are less than five years past MS B are not good analytical candidates to compare with Complete programs and thus are generally excluded from such comparisons. Of all post-MS B programs, policy changes have the greatest opportunity to change the outcomes of these programs. For the Air Force, the New programs are

- KC-46 aerial refueling and strategic transport aircraft
- Small Diameter Bomb II (SDB II)
- Global Positioning System (GPS) IIIA (GPS IIIA).

Continuing Programs

Continuing programs are at least five years past MS B but are not yet 80 percent funded. These programs are in the heart of the acquisition process. They are far enough along in that process to potentially develop significant cost growth but are not so advanced in the process that future cost growth is unlikely. Measuring cost growth in Continuing programs gives insight on how well current programs are performing. These programs are far enough into acquisition to evaluate performance, yet have enough acquisition execution remaining that policy changes may affect their final outcomes. For the Air Force, the Continuing programs are

- Air Force variant of the Joint Strike Fighter (F-35A)
- C-5 strategic airlift aircraft Reliability Enhancement and Re-engining Program (RERP)
- Advanced Medium-Range Air-to-Air Missile (AMRAAM)
- Joint Air-to-Surface Standoff Missile (JASSM)
- Advanced Extremely High Frequency (AEHF) satellite system
- Evolved Expendable Launch Vehicle (EELV)
- Space-Based Infrared System, High Component (SBIRS High).

Complete Programs

Complete and nearly Complete programs have ceased SAR reporting or will do so shortly. They are at least 80 percent funded through the current fiscal year. These programs should experience little if any additional cost growth. Given their late stage in the acquisition process, Complete programs provide an excellent reference from which to assess the Continuing programs. These programs are too far into their acquisition for changes in policy to significantly affect their outcomes. For the Air Force, the Complete programs are

- F-15 air superiority fighter aircraft
- F-16 tactical fighter aircraft
- F-22 air superiority fighter aircraft
- A-10 ground attack aircraft
- B-1B strategic bomber aircraft
- C-17 strategic airlift aircraft
- E-3A Airborne Warning and Control System (AWACS) aircraft
- E-4 Advanced Airborne Command Post (AABNCP) aircraft
- RQ-4A Global Hawk remotely piloted surveillance aircraft
- T-6A/B Joint Primary Aircraft Training System (JPATS) aircraft
- E-8 Joint Surveillance Target Attack Radar System (JSTARS) aircraft
- Air-Launched Cruise Missile (ALCM)
- Ground-Launched Cruise Missile (GLCM)
- AGM-65A/B television-guided air-to-ground Maverick missile
- AGM-65D imaging infrared air-to-ground Maverick missile
- E-3 Sentry AWACS Radar System Improvement Program (RSIP)
- B-1B Conventional Munitions Upgrade Program (CMUP), computer segment

- B-1B CMUP, Joint Direct Attack Munition (JDAM) segment
- B-2 strategic bomber Extremely High Frequency Increment 1 (EHF I-1) satellite communication upgrade
- B-2 Radar Modernization Program (RMP)
- EF-111A Tactical Jamming System aircraft modification
- Global Broadcast System (GBS) terrestrial satellite transmit/receive system
- JDAM bomb guidance kit
- Joint Tactical Information Distribution System (JTIDS) class II terminals
- Minuteman (MM) intercontinental ballistic missile (ICBM) Guidance Replacement Program (GRP)
- Multi-Platform Radar Technology Insertion Program (MP-RTIP)
- GPS first-generation (Block I/II/IIA) satellite system
- GPS second-generation (Block IIR/IIR(M)/IIF) satellite system
- Defense Satellite Communications System, phase III (DSCS III) communication satellite system
- Titan IV heavy space-launch vehicle
- Wideband Global Satellite Communications (WGS) system.

Major Defense Acquisition Programs Suitable for Cost Growth Analysis

The SAR database contains 111 MDAPs managed by the Air Force that generated at least one SAR each in the past 40-plus years. Of these programs, just 36 both have cost estimates at their MS Bs and have progressed far enough into the acquisition process to be analytically useful. They represent the vast majority of cost growth contained within the database—in both dollar and percentage terms—and were therefore used in the analyses that follow.

The remaining 75 programs cannot be used to assess cost growth from MS B for one or more of the following reasons:

- The vast majority began SAR reporting at their MS Cs or at some point after their MS Bs. Therefore, they do not have MS B cost estimates from which to measure cost growth.
- Some of the 75 programs are New, and not enough time has elapsed from their MS Bs to make them suitable for comparative analyses.
- The rest are not in the analysis sample because of termination or because their values fell below the SAR reporting threshold well before program completion. These programs did not progress far enough into the acquisition process to be analytically useful.

Excluding these 75 programs from the analyses is necessary for meaningful analysis; however, excluding these programs does not mean that a significant fraction of the dollars associated with cost growth are excluded. This is the case because each excluded program can be characterized by at least one of the following:

- began at MS C because little or no development funding was required and therefore the program contained lower acquisition risk. Lower risk generally equates to lower cost growth in percentage terms.

- began as an acquisition category (ACAT) II or III and grew in costs to become ACAT I sometime after MS B. These programs are of low dollar value by ACAT I standards; thus, their cost growth is low in dollar terms.
- are less than five years past their MS Bs and therefore have not yet experienced substantial cost growth
- were terminated and thus delivered few if any operational units, rendering measurement of their cost growth meaningless.

Values for Cost Growth Metrics

Table 1.1 shows simple average⁶ values for cost growth, one standard deviation above the average, and the sum of these two—to which we refer as the *extreme cost growth threshold*⁷—for the five cost growth metrics measured from MS B. The percentages in Table 1.1 were developed using the combined Air Force data set of Continuing and Complete MDAPs.

The average length of time from MS B to final SAR in the Complete programs is 13.0 years. The average length for Continuing programs to each program's most recent SAR (dated December 31, 2011, in this analysis) is somewhat longer (14.6 years). Cost growth tends to be higher in longer programs, but the cost growth difference attributable to the average program length difference in the two data sets is small. Keeping this in mind, direct comparison of the two data sets is appropriate.

There are two types of cost growth metrics: budgetary and unit. Budgetary metrics are unadjusted for program quantity changes from the quantity planned at MS B. These measures show just how much more, in real terms (after removing effects of inflation), was spent or is planned to be spent in programs than was estimated at each program's MS B.⁸ The table shows Budgetary metrics, including mean, one standard deviation, and the extreme cost growth threshold values for Budgetary metrics, for development, procurement, and program total. Also shown are Unit metrics, which are those adjusted for program quantity changes from the quantity planned at MS B.⁹ These metrics, calculated for procurement (average procurement unit cost

⁶ Simple averages treat the cost growth in every program equally, thus ignoring size differences (in dollar terms) between programs in the data set.

⁷ A scatter plot of cost growth data points suggests a beta distribution skewed to the right. Approximately 10 percent of programs experience cost growth of more than one standard deviation above the mean. We designate these programs as having extreme cost growth.

⁸ Inflation is excluded from the budgetary metrics because its estimation and ultimate effect on program costs is out of the control of the acquisition system, so its effects confound any objective assessment of the performance of that system.

⁹ To make these adjustments, we compared estimated costs for the quantity common to estimates at both MS B and the current (or final) program plan. If the MS B quantity was larger than that in the current plan, then the portion of the MS B estimate representing the current quantity was calculated and compared with the current estimate for that quantity. If the MS B quantity was smaller than that in the current plan, then the portion of the current estimate representing the MS B quantity was calculated and compared with the MS B estimate.

[APUC]) and program total (program acquisition unit cost [PAUC]), indicate how accurately the program was estimated—again, in real terms—at its MS B.¹⁰

Table 1.1. Air Force MDAP Cost Growth Averages, Standard Deviations, and Extreme Thresholds from the 2013 President’s Budget Selected Acquisition Report Data (%)

Metric	Budgetary Cost Growth			Unit Cost Growth	
	Development	Procurement	Total	APUC	PAUC
Average	79	92	81	63	60
Standard deviation	109	137	99	87	69
Extreme cost growth threshold	188	229	180	150	129

The highest value of cost growth in each metric from the Air Force program sample of Continuing and Complete programs is

- development cost growth in Titan IV (447 percent)
- procurement unadjusted cost growth in SBIRS High (574 percent)
- total unadjusted cost growth for Titan IV (401 percent)
- APUC (quantity-adjusted) growth for SBIRS High (407 percent)
- PAUC (quantity-adjusted) growth for SBIRS High (279 percent) and for EELV (273 percent).¹¹

Figure 1.4 is a scatter plot of PAUC growth in percentage terms. The programs are shown over time by MS B date along the x-axis. The y-axis value for each program is its cost growth. Three of the 36 programs show extreme cost growth: the Continuing SBIRS High and EELV as mentioned above and the Complete Titan IV launch vehicle program. The dashed line at 129 percent represents the extreme cost growth threshold value (as shown in Table 1.1) for this cost growth metric.

¹⁰ APUC is the average cost per unit when considering the program’s procurement funding only. This measure does not include the costs of development, MILCON, and acquisition-related O&M that, in aggregate, make up the entire weapon system cost. PAUC is the comprehensive measure of average unit cost. It includes all of the aforementioned acquisition cost categories.

¹¹ EELV SARs ceased reporting as of September 2007. This and other estimates in this report were derived from that SAR, the president’s budgets (PBs) that have ensued, and a July 2012 program estimate based on 150 Air Force launch vehicles produced and flown through 2030.

Figure 1.4. Program Acquisition Unit Cost Growth in Complete and Continuing Programs

