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Cost and Time Overruns for Major Defense Acquisition Programs: An Annotated Brief

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Preface & Acknowledgements

During his internship with the Graduate School of Business & Public Policy in June 2010, U.S. Air Force Academy Cadet Chase Lane surveyed the activities of the Naval Postgraduate School's Acquisition Research Program in its first seven years. The sheer volume of research products—almost 600 published papers (e.g., technical reports, journal articles, theses)—indicates the extent to which the depth and breadth of acquisition research has increased during these years. Over 300 authors contributed to these works, which means that the pool of those who have had significant intellectual engagement with acquisition issues has increased substantially. The broad range of research topics includes acquisition reform, defense industry, fielding, contracting, interoperability, organizational behavior, risk management, cost estimating, and many others. Approaches range from conceptual and exploratory studies to develop propositions about various aspects of acquisition, to applied and statistical analyses to test specific hypotheses. Methodologies include case studies, modeling, surveys, and experiments. On the whole, such findings make us both grateful for the ARP's progress to date, and hopeful that this progress in research will lead to substantive improvements in the DoD's acquisition outcomes.

As pragmatists, we of course recognize that such change can only occur to the extent that the potential knowledge wrapped up in these products is put to use and tested to determine its value. We take seriously the pernicious effects of the so-called "theory–practice" gap, which would separate the acquisition scholar from the acquisition practitioner, and relegate the scholar's work to mere academic "shelfware." Some design features of our program that we believe help avoid these effects include the following: connecting researchers with practitioners on specific projects; requiring researchers to brief sponsors on project findings as a condition of funding award; "pushing" potentially high-impact research reports (e.g., via overnight shipping) to selected practitioners and policy-makers; and most notably, sponsoring this symposium, which we craft intentionally as an opportunity for fruitful, lasting connections between scholars and practitioners.

A former Defense Acquisition Executive, responding to a comment that academic research was not generally useful in acquisition practice, opined, "That's not their [the academics'] problem—it's ours [the practitioners']. They can only perform research; it's up to us to use it." While we certainly agree with this sentiment, we also recognize that any research, however theoretical, must point to some termination in action; academics have a responsibility to make their work intelligible to practitioners. Thus we continue to seek projects that both comport with solid standards of scholarship, and address relevant acquisition issues. These years of experience have shown us the difficulty in attempting to balance these two objectives, but we are convinced that the attempt is absolutely essential if any real improvement is to be realized.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the Acquisition Research Program:

- Office of the Under Secretary of Defense (Acquisition, Technology & Logistics)
- Program Executive Officer SHIPS
- Commander, Naval Sea Systems Command
- Army Contracting Command, U.S. Army Materiel Command
- Program Manager, Airborne, Maritime and Fixed Station Joint Tactical Radio System

- Program Executive Officer Integrated Warfare Systems

- Office of the Assistant Secretary of the Air Force (Acquisition)

- Office of the Assistant Secretary of the Army (Acquisition, Logistics, & Technology)

- Deputy Assistant Secretary of the Navy (Acquisition & Logistics Management)

- Director, Strategic Systems Programs Office

- Deputy Director, Acquisition Career Management, US Army

- Defense Business Systems Acquisition Executive, Business Transformation Agency

- Office of Procurement and Assistance Management Headquarters, Department of Energy

We also thank the Naval Postgraduate School Foundation and acknowledge its generous contributions in support of this Symposium.

James B. Greene, Jr.   Keith F. Snider, PhD
Rear Admiral, U.S. Navy (Ret.)   Associate Professor

Panel 14 – Major Programs: The Good, the Bad, and the Ugly

Thursday, May 12, 2011	

9:30 a.m. – 11:00 a.m.	**Chair: Vice Admiral W. Mark Skinner,** USN, Principal Military Deputy, Assistant Secretary of the Navy (Research, Development, & Acquisition)
	
	An Assessment of the DoD's 2010 Portfolio of Major Defense Acquisition Programs
	
	    Michael Sullivan, GAO
	
	Cost and Time Overruns for Major Defense Acquisition Programs: An Annotated Brief
	
	    David Berteau, Guy Ben-Ari, Joachim Hofbauer, Gregory Sanders, Jesse Ellman, and David Morrow, Center for Strategic & International Studies
	
	Straight Talk: Major Program Manager Views of Defense Acquisition
	    Roy Wood and Al Moseley, DAU

Vice Admiral W. Mark Skinner—Principal Military Deputy, Assistant Secretary of the Navy, (Research, Development & Acquisition). Vice Admiral Skinner assumed his duties August 9, 2010.

Skinner was born in Houston, Texas and graduated from the United States Naval Academy in June 1977.

As a flag officer, he was the program executive officer for Tactical Aircraft Programs and commanded Naval Air Warfare Center, Weapons Division, and served as assistant commander, Test and Evaluation, Naval Air Systems Command. Skinner held both operational and shore commands, to include commanding officer Patrol Squadron 47, chief test pilot and commanding officer of Naval Force Aircraft Test Squadron, and program manager for a chief of naval operations special project.

He is a graduate of the Navy Test Pilot School and served in Force Warfare Aircraft Test Directorate, where he was recognized as Directorate Test Pilot of the Year in 1986. Additionally, he received a degree in Financial Management from the Naval Postgraduate School, where he graduated as a Conrad Scholar and was awarded the Department of Navy award for excellence in financial management and the Rear Admiral Thomas R. McClellan award for excellence in administrative sciences.

His awards include Legion of Merit (3 awards), Meritorious Service Medal (4 awards), Navy Commendation Medal (2 awards), Navy Achievement Medal, and other unit deployment citations and ribbons.

Cost and Time Overruns for Major Defense Acquisition Programs: An Annotated Brief

David Berteau—Senior Adviser and Director, CSIS Defense-Industrial Initiatives Group, covering defense management, programs, contracting, and acquisition. Mr. Berteau's group also assesses national security economics and the industrial base supporting defense. Mr. Berteau is an adjunct professor at Georgetown University, a member of the Defense Acquisition University Board of Visitors, a director of the Procurement Round Table, and a fellow of the National Academy of Public Administration. He also serves on the Secretary of the Army's Commission on Army Acquisition and Program Management in Expeditionary Operations. [DBerteau@csis.org]

Guy Ben-Ari—Deputy Director, Defense-Industrial Initiatives Group at the Center for Strategic International Studies. Mr. Ben-Ari works on projects related to the U.S. technology and industrial bases supporting defense. His current research efforts involve defense R&D policies, defense economics, and managing complex defense acquisition programs. Mr. Ben-Ari holds a bachelor's degree in political science from Tel Aviv University, a master's degree in international science and technology policy from the George Washington University, and is currently a PhD candidate (ABD) at the George Washington University.

Joachim Hofbauer—Fellow, Defense-Industrial Initiatives Group at the Center for Strategic and International Studies (CSIS). Mr. Hofbauer specializes in U.S. and European defense acquisition and industrial base issues and their impact on the transatlantic defense market. Before joining CSIS, he worked as a freelance defense analyst in Germany and the United Kingdom. His analysis has been published in several U.S. and German defense publications. Mr. Hofbauer holds a BA in European studies from the University of Passau and an MA with honors in security studies, with a concentration in defense analysis, from Georgetown University.

Gregory Sanders—Fellow, Defense-Industrial Initiatives Group at CSIS. Mr. Sanders gathers and analyzes data on U.S. defense acquisition and contract spending as international defense budgetary and trade trends. He has also studied data visualization and ways to use complex data collections to create succinct and innovative tables, charts, and maps. Mr. Sanders holds an MA in international relations from the University of Denver and a BA in government and politics, as well as a BS in computer science, from the University of Maryland.

Jesse Ellman—Research Associate, Defense-Industrial Initiatives Group at the Center for Strategic and International Studies (CSIS). Mr. Ellman specializes in U.S. defense acquisition issues, with a particular focus on recent U.S. Army modernization efforts. He holds a BA in Political Science from Stony Brook University, and an MA with honors in Security Studies, with a concentration in Military Operations, from Georgetown University.

David Morrow—Research Associate, Defense-Industrial Initiatives Group (DIIG) at CSIS. Mr. Morrow focuses on federal professional services contracting, U.S. naval shipbuilding, and private security contracting. Previously, he interned at the U.S. Department of State's Office of European Security and Political Affairs and at the U.S.–Russia Business Council. He holds a BA in International Affairs from James Madison University and an MA in European and Eurasian Studies from the George Washington University.

Abstract

Cost and time overruns in Major Defense Acquisition Programs (MDAPs) have become a high-profile problem attracting the interest of Congress, government, and watchdog groups. According to the GAO, the 98 MDAPs from FY2010 collectively ran $402 billion over budget and were an average of 22 months behind schedule since their first full estimate. President Obama's memorandum on government contracting of 4 March 2009 also highlighted this issue.

This paper presents findings of research on the root causes of cost and schedule delays for 92 MDAPs active in 2010 and 12 cancelled programs. The results do not establish causality but they do indicate multiple notable correlations. Inaccurate cost estimates are responsible for the strongest correlation with net cost growth changes and are associated with 40% of the accumulated cost overruns. In addition, the start year has little impact on the compound annual growth rate of cost overruns. This suggests that relatively better performance of newer programs may prove illusionary as programs age. Finally, fixed price contracts appear to have relatively smaller overruns, although this may tell us more about which programs are likely to receive fixed price contracts rather than what effect fixed price contracts may have on program performance.

Introduction

Cost and time overruns in Major Defense Acquisition Programs (MDAPs) have become a high-profile problem attracting the interest of Congress, government, and watchdog groups. According to the GAO, the 98 MDAPs from FY2010 collectively ran $402 billion over budget and were an average of 22 months behind schedule since their first full estimate. President Obama's memo on government contracting of 4 March 2009 also highlighted this issue.

This paper[1] presents findings of research on the root causes of cost and schedule delays for MDAPs, incorporating 2010 SAR data.
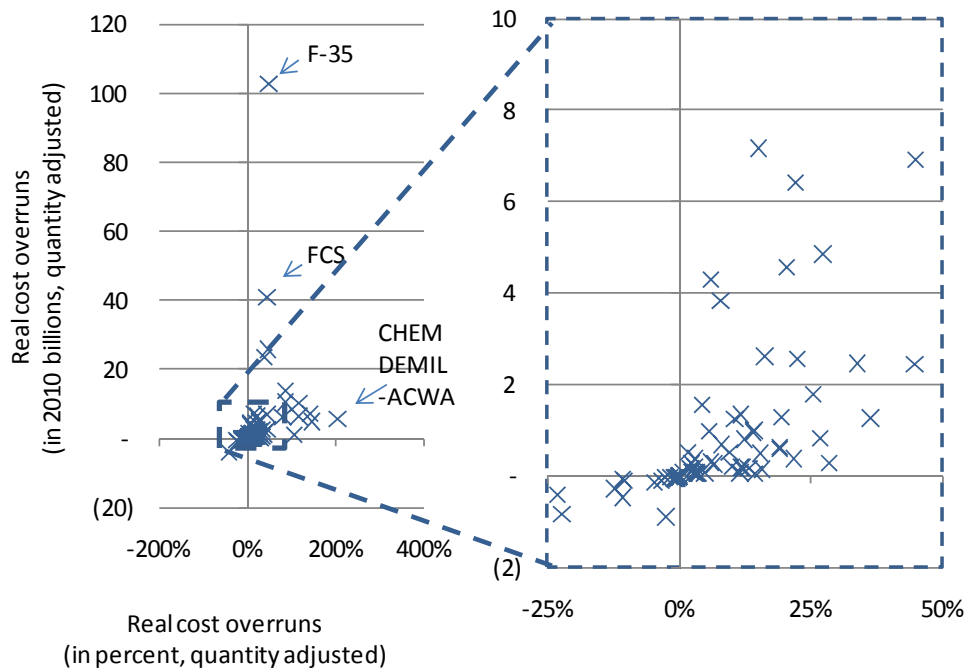

Figure 1.   Relative Cost Overruns vs. Absolute Cost Overruns for FY2009 MDAPs
Note. The sample includes 92 FY2010 MDAPs with a baseline estimate beyond Milestone B in the June 2010 SAR as well as twelve additional cancelled programs, notably including the Future Combat System (FCS). The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

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[1] Nicholas Lombardo was a contributing researcher on this report.

Problem Definition

Past studies on this topic either have not offered rigorous data analysis or were focused on a critical but still narrow aspect of the problem, such as technical maturity. Meanwhile, Congressional leadership often focuses on different issues such as contract type and competition. As a result, acquisition reform efforts like the Weapon Systems Acquisition Reform Act of 2009 are hampered by an insufficient analytical basis.

For instance, in its annual assessment of selected weapon systems, the Government Accountability Office (GAO) predominantly focuses on knowledge-based factors such as technology, maturity, and associated program decisions as causes for these problems. Former Under Secretary of Defense for Acquisition, Technology, and Logistics, John Young, claimed in a memorandum on 31 March 2009 that many of the allegations of the GAO are based on inadequate analytical methods and that consequently many of the results are misleading.

This disagreement is exemplary of the diverging set of opinions that exists regarding the root causes of MDAP cost overruns and schedule delays. The result amplifies disagreement regarding potential fixes. On the government side, Senator McCain identified the usage of cost plus contracts as a major source for cost increases and Secretary Gates pointed towards the contract structures as a key source of cost and schedule overruns in some MDAPs. Defense contractors, on the other hand, regularly cite the altering of requirements in advanced program stages as an important factor for cost increases.

The currently ongoing process of reforming and fixing the defense acquisition system still lacks the foundation of a detailed evaluation of the causality chain of cost overruns and program delays of MDAPs. This lack of understanding of underlying mechanisms makes the design of adequate solutions inherently difficult and renders them potentially ineffective. This study directly aims at developing the urgently needed knowledge base that will better guide efforts to correct the growing trends of cost increases and schedule overruns.

Methodology

This report analyzes a series of variables—namely realism of baseline program cost estimates, government management and oversight, the role of contractors and lead military Services, levels of competition, and contract structures—to determine what factors might contribute to or be correlated with the observed cost overruns in the execution of MDAPs.

This research draws on three primary data sources:

1. Selected Acquisition Reports (SARs): The SARs track Major Defense Acquisition Programs, reporting on their schedule, unit counts, total spending, and progress through milestones. The unit of analysis is the programs themselves, making it the ideal source for top level analysis.

2. Federal Procurement Data System (FPDS): The FPDS is a database of every government contract, with millions of entries each year. Each entry has extensive data on the contractors, contract type, competition, place of performance, and a variety of other topics as mandated by Congress. Cross-referencing individual contracts with MDAPs is possible using the system equipment codes (which match up with those of the MDAPs). This source provides the most in-depth data on the government contracting process.

3. Department of Defense budget documents: In addition to budget data, these documents provide topical information on each MDAP and its

subcomponents. They will primarily be used to categorize projects as well as to support and double check spending figures from the other two sources.

The report focuses on MDAPs from the FY2010 MDAP list. Within this sample group the analysis is limited to 104 MDAPs with cost estimates set at Milestone B or beyond, including MDAPs that were cancelled between 1999 and today. That gate is meant to be a hurdle that requires programs to reach a certain level of technological maturity. As a result Milestone B "is normally the initiation of an acquisition program" ("Acquisition History Project," n.d.). This common starting point ensures that only programs in a relatively mature acquisition phase are compared. Cancelled programs are included to avoid the selection bias that results from excluding several of the worst performing proposals from analysis. Figure 1 provides an overview of the cost overruns of these 104 programs.

Unfortunately, full data are not available on all 104 MDAPs when examining contract type and competition, because not all of the programs have at least 50% of the SARs contract value accounted for in 2004–2009 FPDS data. As a result, the "unclear" category is used to signify this missing data in competition and contract type findings. In addition, FPDS totals for program spending are sometimes higher than the funding status according to the SARs. In those cases, the SAR totals are treated as the more reliable figure.

These snapshots provide an adequate starting point for detecting correlations between a series of potentially relevant factors and cost growth. The charts reflect the basic information arranged across a variety of data elements, but they do not constitute a sufficient basis for establishing causality or policy changes, for which further analysis would be needed.

Analysis

This analysis focuses on examining the impact of baseline cost estimates, quantity, and schedule changes, as well as engineering problems, the extent of competition, contract structure, the lead branch of military service, and the identity of the prime contractor on the cost performance on MDAPs.
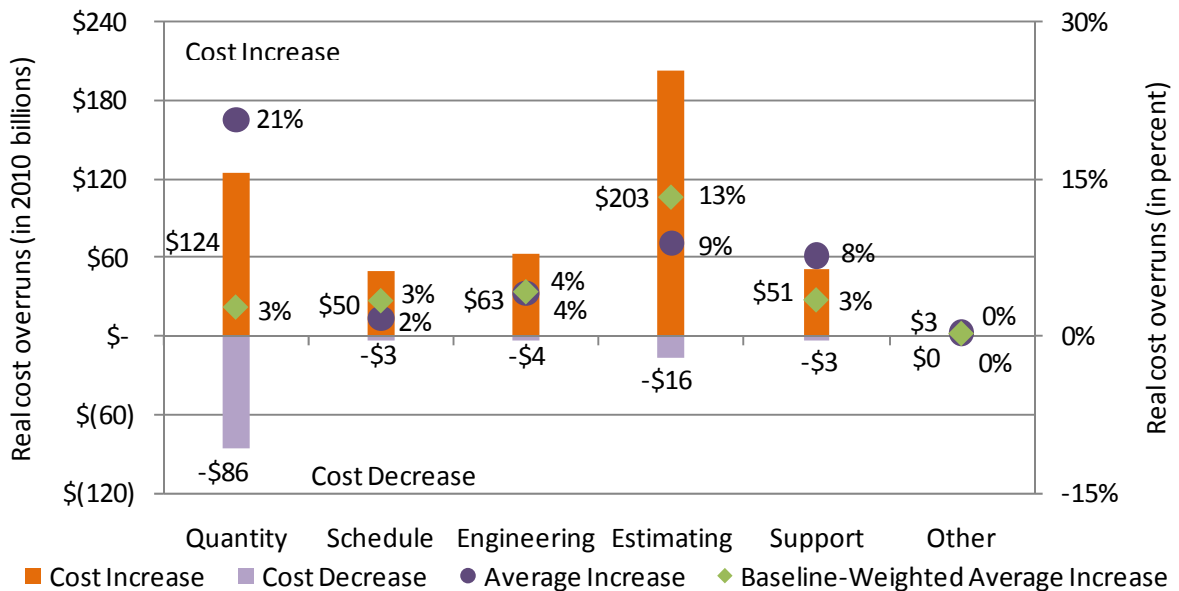

Figure 2.   Functional Reasons for Cost Overruns

Note. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

Breaking down cost growth by functional areas as provided in the SARs identifies variances in the estimating process as the primary driver for cost growth, being responsible for $202.8 billion in cost growth for the 104 MDAPs analyzed.

Another noteworthy observation from Figure 2 is the fact that the cost savings achieved through quantity changes equals approximately two thirds of the cost growth originating from changes in unit numbers. This is not encouraging, as for programs with upfront research and development costs, reducing the number of units lowers the overall program cost but it increases the per-unit cost, effectively curtailing the government's buying power. In turn, cost increases deriving from increases in the number of units require a higher overall program budget but lower the price per unit.

Nunn-McCurdy breaches, for instance, are based on the growth in the per-unit acquisition cost rather than overall program cost in order to account for this fact. This presentation therefore focuses on quantity-adjusted cost changes. The Selected Acquisition Reports do not list the exact methodology for quantity adjustments; unfortunately, the adjustment is not equivalent to the sum of cost adjustments that are not attributed to quantity changes. This complicates analysis of the functional reasons for cost growth.
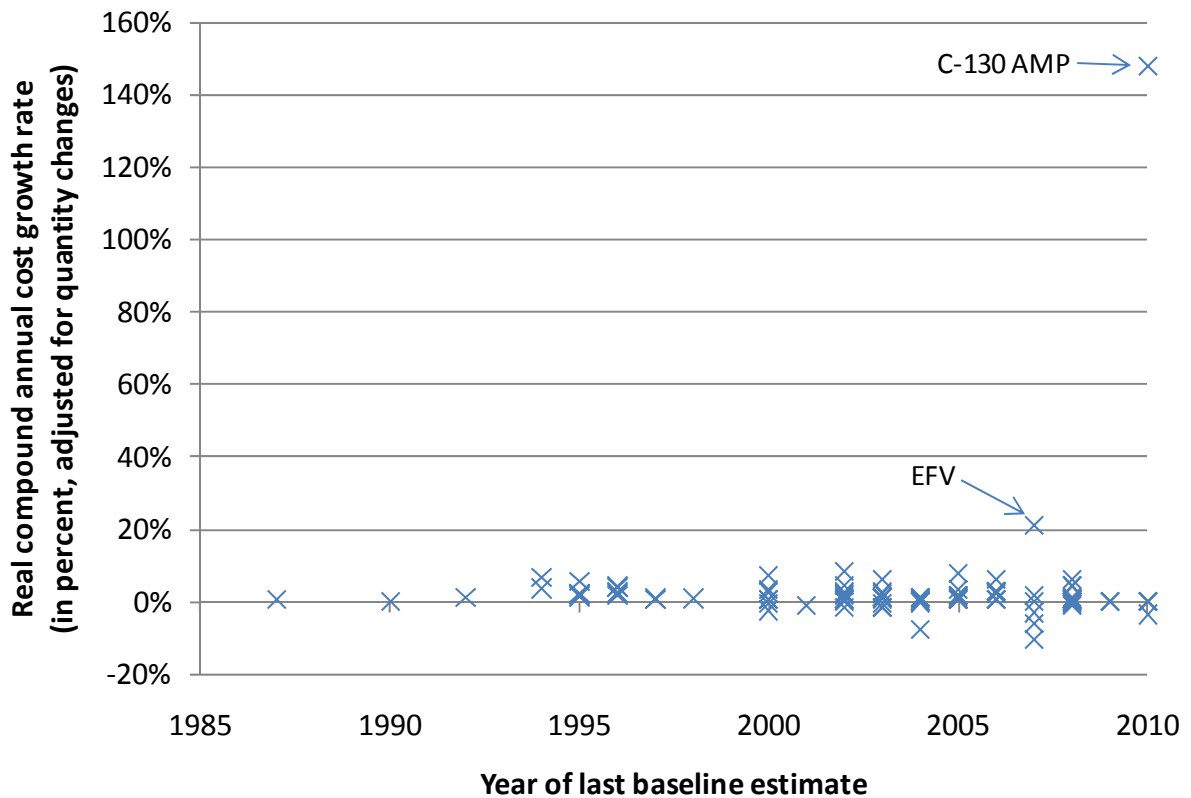

Figure 3.   Time-Cost Correlation
Note. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

The next explanatory variable examined for its impact on program performance is the time-cost growth correlation. If cost increases accrue over time, then programs with an older

baseline estimate would tend to accumulate relatively higher cost increases. The data for the analyzed programs show that older programs indeed experience larger overruns.

However, Figure 3 shows that when measured in compound annual growth rate[2] rather than aggregate relative cost growth, the time-cost growth correlation is almost constant. The C-130 AMP project is distorting this trend because its estimate was not changed when it was given a new baseline in 2010. Notwithstanding C-130 AMP, this growth correlation not only provides further evidence for the assertion that cost growth occurs steadily throughout the program lifespan, but it also suggests that younger programs are not performing better than older programs.
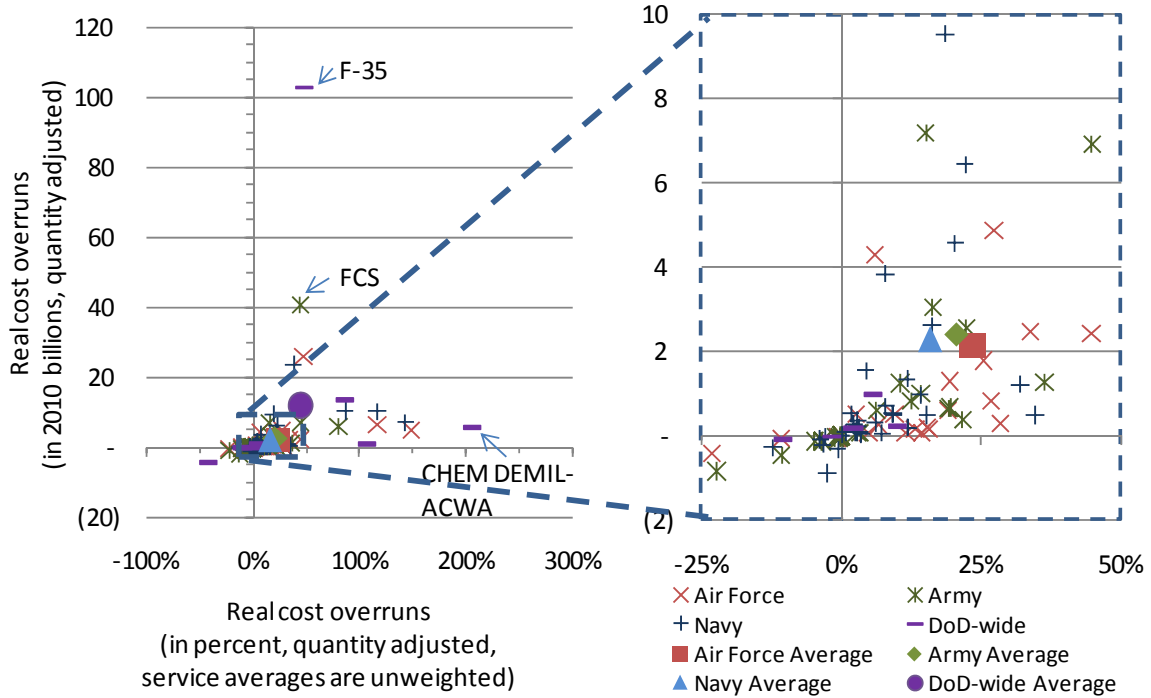

Figure 4.   Cost Overruns by Lead Service (I)

Note. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

The analysis of the correlation between the lead branch of military service responsible for MDAPs and cost growth patterns reveals that programs led by the Army appear to have fewer, smaller overruns, followed by the Navy and then the Air Force, whereas DoD-wide programs tend to accrue significantly larger cost overruns. The picture alters slightly when utilizing baseline-weighted averages with the Navy showing the least overruns followed by the Army, the Air Force, and DoD-wide programs. The considerable difference for the Army's results—11% on average versus 20% for baseline-weighted averages—is driven by the cancelled Future Combat System. It is important to note that DoD-wide includes both programs managed by DoD agencies and joint programs such as the Joint Strike Fighter.

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[2] The compound annual growth rate describes the average year-to-year cost growth of program spending since its baseline. Thus if comparing two programs with the same percentage of cost growth since their baseline estimate, the program with an earlier baseline year would have a smaller compound annual growth rate.

The outcome of this data analysis might be skewed based on the relatively small sample group utilized in this analysis. For instance, it appears that the DoD-wide category might be heavily influenced by the negative cost developments in the Joint Strike Fighter program. As for the other components, further analyses with larger sample groups are required to validate observed trends.

Any conclusions from Figure 4 identifying superior program management of existing programs by Service are premature, even if additional data and analysis were to confirm this variation in cost performance based on lead Service. A number of other factors may explain the differences, such as a tendency toward less risk-prone MDAPs. Further research will be needed to analyze the underlying causality and detect the true root causes for these trends.
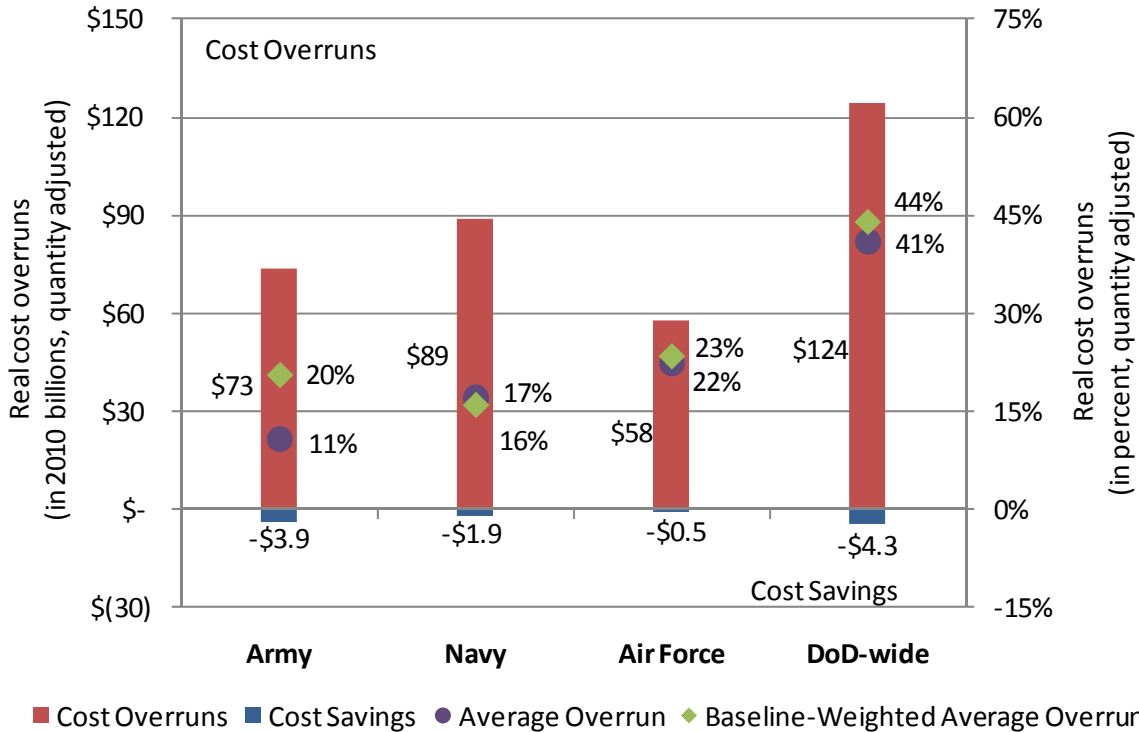

Figure 5.   Cost Overruns by Lead Service (II)

Note. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

Figure 5 supports the conclusion of the previous chart, with the poorest cost performance in DoD-wide managed MDAPs, while Army and Navy MDAPs, depending on what kind of average is utilized, display the smallest cost overruns. In absolute terms, the Air Force shows the lowest total in real cost overruns. Notably, while the Navy performs relatively well on a percentage basis, it also has the largest share of overruns in absolute terms for any of the three Service branches. This can be attributed to the size and duration of many Navy programs.

This comparison provides further support for the assertion that MDAPs managed by the Army and the Navy suffer smaller overruns, while DoD-wide managed MDAPs tend to accrue larger overruns. However, the level of analysis conducted so far does not allow for any firm conclusions on the actual role of any Service's program management skills in these trends.
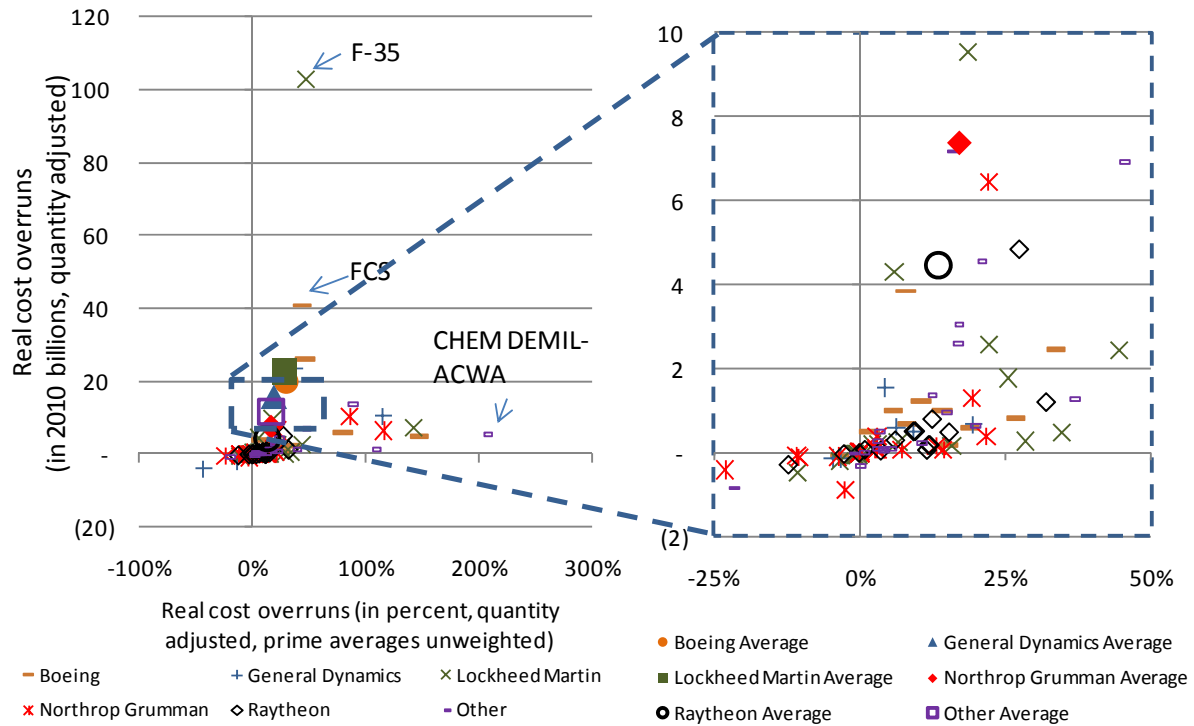
Figure 6.   Cost Overruns by Prime Contractor (I)

Note. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

Another predictor for program performance could be the identity of the prime contractor for a given program. One striking trend in Figure 6 that is visible for the "big five" U.S. defense companies is the fact that Raytheon on average appears to be associated with significantly better cost performance outcomes than other defense companies. Due to a lack of data granularity, the other companies category includes joint ventures and projects that are split between multiple contractors.

The preliminary character of the analysis does not fully validate any findings of superior management or outcomes. In addition, even if confirmed, it would be premature to start praising any company for better program execution because other factors such as specialization in technologically more mature program areas might be the true drivers behind this trend. As was the case for the breakdown by lead Service, further research will be needed to analyze the underlying causality.
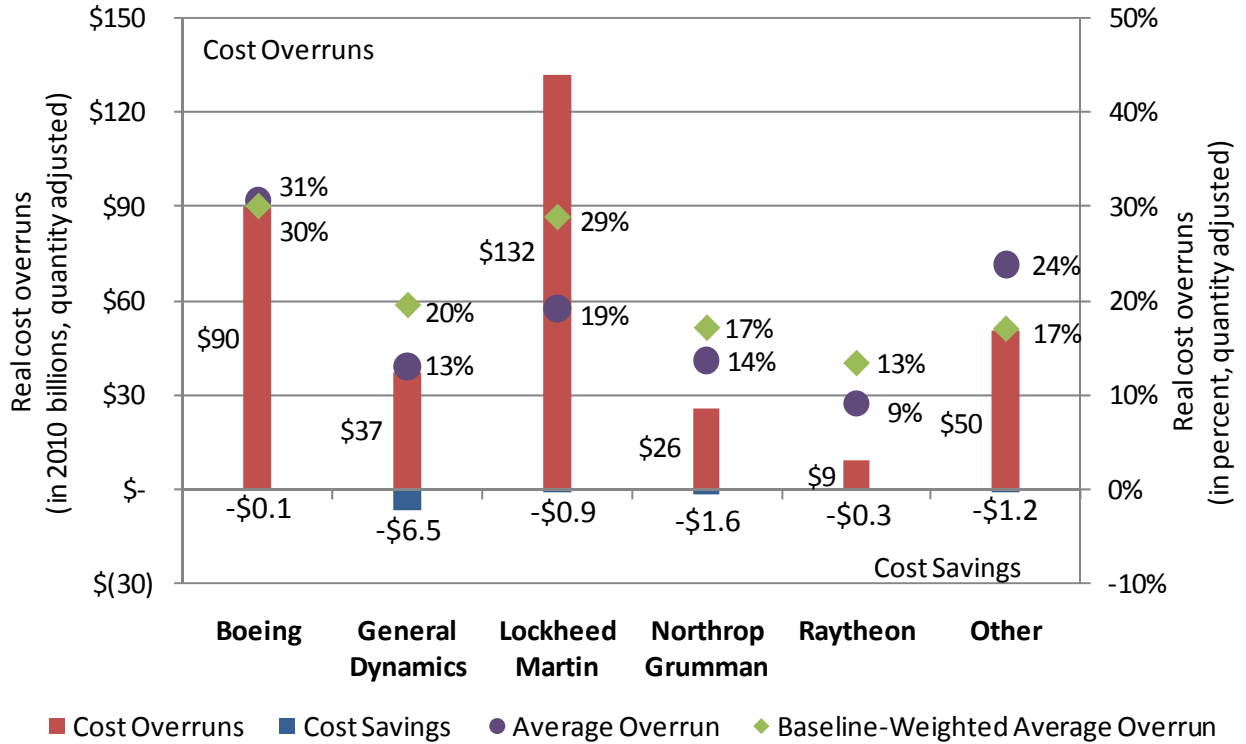
Figure 7.   Cost Overruns by Prime Contractor (II)
Note. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS
Defense-Industrial Initiatives Group.

The comparison between the share of cost growth and the share of contract value for
MDAPs, aggregated by prime contractor, correlates with the finding that MDAPs for which
Raytheon is the prime contractor appear to exhibit the best cost performance amongst the
big five defense companies. When it comes to the remainder of the big five, Figure 7 shows
that their average performance varies based on the means used to measure it with different
results when the programs are weighted by the baseline estimate than if all of the MDAPs
are treated as having an equal weight. Again, this variance gives reason to be cautious in
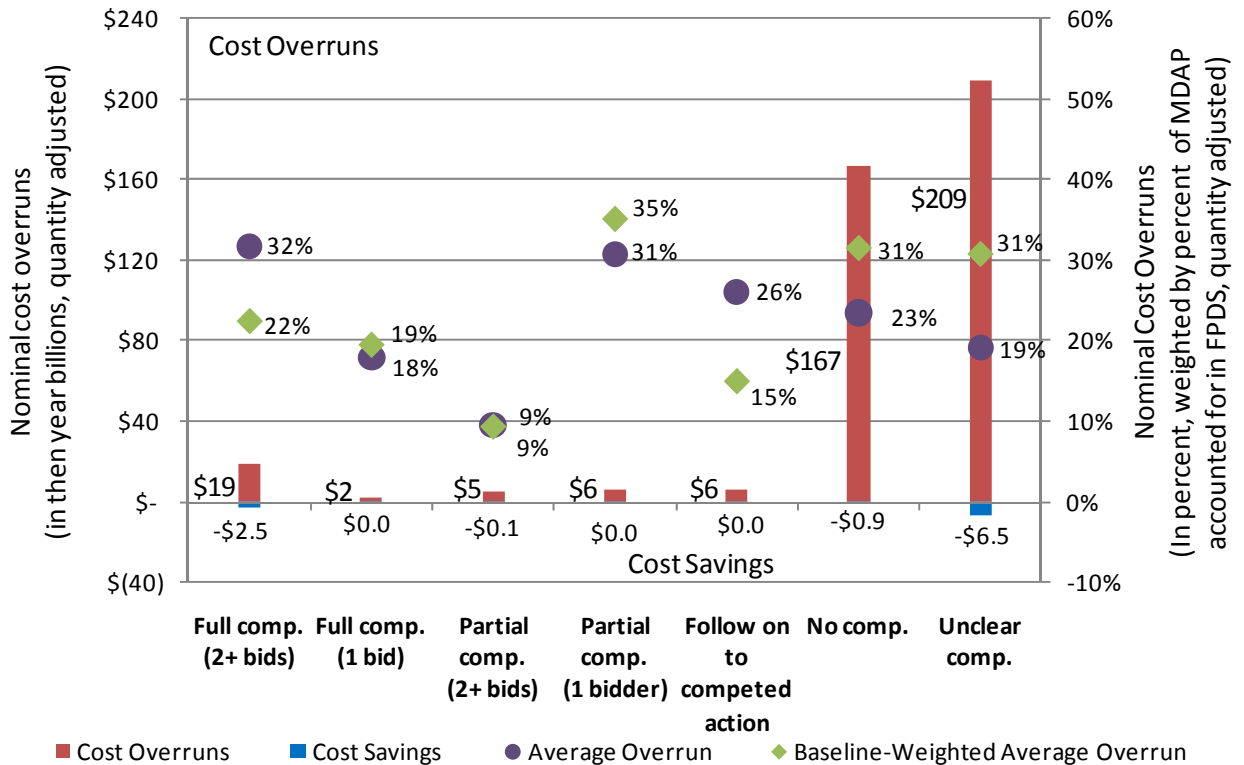extrapolating from these results.

Figure 8.   Cost Overruns by Type of Competition
Note. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

The type of contract award process could potentially also be correlated with the cost performance of MDAPs. The findings in Figure 8 are decidedly mixed. In absolute dollar terms, competitive contracts produce less cost growth than contracts awarded with no competition or under unclear circumstances. This is driven by the comparative scarcity of competed contract dollars in the sample. As a result, when comparing relative cost overrun rates the results are different. Only partial competition[3] with multiple bidders displays a notably better outcome.

Perhaps surprisingly, full and open competition with multiple bidders performs on average worse than no or unclear competition. Only when considering baseline-weighted averages does full and open competition with multiple bidders perform better than no or unclear competition. Based on the SAR's data, this can be attributed to full and open competition with multiple bidders having the highest percentage of estimating variance of any of the categories. This result is consistent with the hypothesis that bidders may propose lower costs in order to win price-based competitions. However, further study would be needed to determine whether full and open competitions also suffer from a selection bias or other unexplained cause.

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[3] Partial competition refers to forms of competition other than full and open because the number of bidders is legally limited.
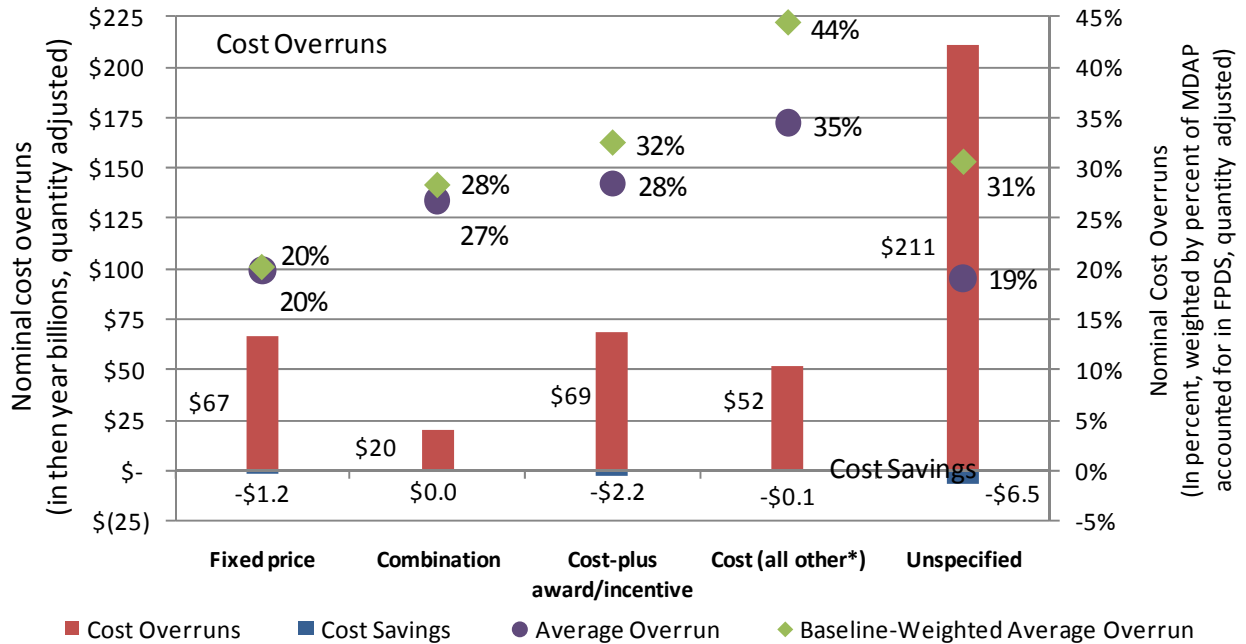
Figure 9.   Cost Overruns by Contract Type

Note. *Cost (all other) includes time and materials contracts as well as labor hours contracts. The source for this figure was Selected Acquisition Reports; the analysis was by CSIS Defense-Industrial Initiatives Group.

Contract structure provides another possible determining factor for the performance of MDAPs. One key observation from Figure 9 is that fixed price contracts appear to have on average less cost growth and the cost all other contract types appear to have more, when comparing the share of cost growth and the share of contract value for MDAPs. An interesting finding is the fact that unspecified contract types, while responsible for the majority of cost overruns in absolute terms, perform best when measured based on baseline-weighted averages.

Acquisition reformers often point toward cost-plus contracts as a factor driving cost overruns. This argument is supported by the high average cost overrun percentages of both categories of cost plus contracts. The type of fee structure used also appears relevant, because cost-plus award/incentive contracts have lower relative cost growth than all other forms of cost reimbursement contracting although this is driven in part by the outsized influence of the F-35 project which falls within the cost (all other) category. However, fixed price contracts are more commonly the vehicle of choice for mature technology in full rate production, which are generally considered low risk.

Findings

This report provides a foundation for future researchers and reformers grappling with the problem of cost overruns in major defense acquisition projects. The results discussed below have been validated by the two most recent Selected Acquisition Reports, and together with the underlying data and methodology provide a roadmap for future work.

The strongest correlation with net cost growth is shown in Figure 2: changes in cost estimates are responsible for around 40% of the accumulated cost overruns. Of similar importance, Figure 3 shows that the start year has little impact on the compound annual

growth rate of cost overruns. This suggests that the relatively better performance of newer programs may prove illusionary as programs age. Finally, Figure 9 shows that fixed price contracts appear to have relatively smaller overruns, although this may tell us more about which programs are likely to receive fixed price contracts rather than what effect fixed price contracts may have on program performance.

There are three logical avenues for future research to build on these results. First, additional factors could be added to the mix to help allocate responsibility to the underlying characteristics of an MDAP versus the methods chosen to implement it. Second, the dataset could be steadily expanded to include completed projects and to widen the historical scope and sample size of the project. Third, researchers could examine cost growth throughout the history of a select number of programs and also better control for the effects of updated baselines on older projects. Finally, the government could facilitate all three approaches and enable a range of assessments by allowing outside researchers to access the data that underlies the Selected Acquisition Reports.

Reformers and others studying this issue can take the next step by accessing the data, which will be posted at the Defense-Industrial Initiatives Group website (http://www.csis.org/diig) in time for the May 2011 Naval Postgraduate School conference. The authors intend to stay fully engaged with this issue as the root causes underlying the crisis in MDAP cost growth are being identified and addressed.

References

Acquisition history project working paper #3: The evolution of DoD Directive 5000.1 Acquisition Management Policy 1971-2003. (n.d.). Defense Acquisition History Project. Retrieved from http://www.history.army.mil/acquisition/research/working3.html