# White Paper – LEAN 96-03

# Preliminary Observations on Program Instability

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**Summary**

This white paper reports emerging findings at the end of Phase I of the Lean Aircraft Initiative in the Policy focus group area. Specifically, it provides details about research on program instability. Its objective is to discuss high-level findings detailing: 1) the relative contribution of different factors to a program's overall instability; 2) the cost impact of program instability on acquisition programs; and 3) some strategies recommended by program managers for overcoming and/or mitigating the negative effects of program instability on their programs. Because this report comes as this research is underway, this is not meant to be a definitive document on the subject. Rather, is it anticipated that this research may potentially produce a number of reports on program instability-related topics.

The government managers of military acquisition programs rated annual budget or production rate changes, changes in requirements, and technical difficulties as the three top contributors, respectively, to program instability. When asked to partition actual variance in their program's planned cost and schedule to each of these factors, it was found that the combined effects of unplanned budget and requirement changes accounted for 5.2% annual cost growth and 20% total program schedule slip. At a rate of approximately 5% annual cost growth from these factors, it is easy to see that even conservative estimates of the cost benefits to be gained from acquisition reforms and process improvements can quickly be eclipsed by the added cost associated with program instability.

Program management practices involving the integration of stakeholders from throughout the value chain into the decision making process were rated the most effective at avoiding program instability. The use of advanced information technologies was rated the most effective at mitigating the negative impact of program instability.

## Introduction

One consistent theme in the many acquisition reform initiatives in recent years has been the identification of program instability as a major problem in acquisition. Program stability generally refers to the extent to which "the program is initiated with accurate and reconciled assumptions concerning user performance and support requirements, the current and near term technological capabilities, the availability and timing of resources (budget, manpower, facilities), the legal and regulatory constraints, and the time required to accomplish all the tasks" and "once the plan and the program are approved, the assumptions hold -- that is, the program is executed according to the expectations of the plan" (Clay, 1990). Several major reviews of defense acquisition since the early 1970s have cited program instability as a problem. These include the Report of the Commission on Government Procurement (1972); the Defense Resource Management Study Final Report (1979); The "Carlucci Initiatives" (1981); the "Grace Commission" (1984); and the "Packard Commission" (1986). The Packard Commission report said:

> "...Short, unambiguous lines of communication among levels of management, small staffs of highly competent professional personnel, an emphasis on innovation and productivity, smart buying practices, *and, most importantly, a stable environment of planning and funding*¾ [is] characteristic of efficient and successful management....
>
> "These characteristics should be hallmarks of defense acquisition. They are, unfortunately, antithetical to the process the Congress and the Department of Defense have created to conduct much of defense acquisition over the years....
>
> "Over the long term, there has been chronic instability in top-line funding and, even worse, in programs. This eliminates key economies of scale, stretches out programs, and discourages contractors from making the long-term investments required to improve productivity."(Packard, 1986, p. xxii, italics added for emphasis)

Most recently, the March 15, 1996 revision of the DoDD (Department of Defense directive) 5000.1 governing the management of DoD acquisition programs re-iterates that program stability should be a high priority:

> "The following policies and principles govern the operation of the defense acquisition system and are divided into three major categories: (1) Translating Operational Needs into Stable, Affordable Programs, (2) Acquiring Quality Products, and (3) Organizing for Efficiency and Effectiveness. These principles shall guide all defense acquisition programs:
>
> "…
>
> "c. Program Stability. Once DoD initiates an acquisition program to meet an operational need, managers at all levels shall make program stability a top priority. To maximize stability, the Components shall develop realistic long-range investment plans and affordability assessments. The Department's leadership shall strive to ensure stable program funding throughout the program's life-cycle." (pp. 3-4)

In addition to those consequences noted in the Packard Commission report, other manifestations of program instability include stretched program schedules, abandoned technical capabilities, reduced procurement quantities and resulting force size, and frequently renegotiated contracts. The consequences of this instability are higher weapon system acquisition costs, lengthened acquisition schedules, contractor's long-term business strategies rendered ineffective, lost confidence by the public, and reduced military capability (Clay, 1990).

So just how big is the problem of program instability? Estimates of the *added cost* of weapon system acquisition due to program instability range between 5% and 40% of the annual acquisition budget (CSIS, 1987; Gansler, 1989; Glass, 1987; Thomas, 1987), although a figure of about 10-15% is frequently cited (Gansler, 1989). This means that at the height of the Reagan build-up in the mid-1980s, approximately $9-14 billion was spent annually that did not improve the readiness, increase the force size, or enhance the effectiveness of the US armed forces. In other words, the Department of Defense could have bought two additional wings (80 aircraft per wing) of F-16C and a wing of F-15C fighter aircraft, an additional Nimitz-class nuclear aircraft carrier, an Ohio-class ballistic missile submarine with 24 Trident II nuclear ballistic missiles, 200 AH-64 Apache Attack helicopters, and 500 M-1A1 main battle tanks *each* year for the same level of expenditure[1]. But it did not because of program instability.

## Research Methodology and Data Collection

Work on this research topic was initiated by the Lean Aircraft Initiative (LAI) Policy and External Environment focus group in June 1995. At the outset, it was acknowledged that the problem of program instability has been studied repeatedly over the years without dramatic changes in the level of the problem or the implementation of specific policies at the national level. Consequently, a research strategy oriented towards identifying specific issues and practices within the influence of an individual program manager or service to influence was chosen. The premise behind selecting that course of action was that the LAI would be much more likely to identify solutions having a reasonable chance of being implemented if those solutions did not depend upon high-level institutional change at the national level in order to be successful.

The detailed research strategy for this topic involved a number of steps. The first step was to review the existing knowledge and consensus on program instability. This involved a review of the literature documenting prior research activity in this area. The next step was to construct a model, based on that literature review, of the factors involved in program instability, as well as likely strategies to overcome its effects. This model also identified the type of data required for the research. The next step in the research involved collection of data to validate the relationships identified in the model. This report will discuss some of the findings to date based on the data collected during this research process.

## Review of the Literature

Over 100 reports and studies were reviewed as part of the survey of the literature on program instability. These sources were drawn from publicly-available unclassified reports and include, but are not limited to, US government documents, commission reports, private sector analyses, academic reports and theses, and case studies. While a brief summary of this review will be given here, a more detailed summary of this literature review will be deferred to a forthcoming LAI report. The literature reviewed falls into two general categories: 1) reports directly concerned with the phenomenon of program instability; and 2) case studies of individual weapon systems acquisitions that either have experienced significant levels of program instability, or that were seen to have used innovative management practices that might have applicability to overcoming the impact of program instability.

Much of the literature directly addressing the problem of program instability is based on analysis of high-level data such as aggregate budgets or summary-level program outcomes (e.g., data from the Selected Acquisition Reports or SARs). References in this category include official government documents (GAO, 1995; GAO, 1992; GAO, 1994; GAO, 1992; GAO, 1992; Glass, 1987; Thomas, 1987), independent analyses of official data (CSIS, 1985; CSIS, 1987; Dews et al., 1979; Gansler, 1989; Gansler, 1986; Rich, Dews and Batten, 1986), and an academic thesis (Iverson, 1990). These reports generally discuss causes of program instability at the Congressional, DoD, and Service levels (see Table 1). In general, because the data used in these

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[1] This estimate is based on the FY1986 acquisition budget authority level, and unit weapon system costs from FY1985. Where possible, attempts were made to adjust weapon system unit costs to compensate for price inflation due to funding instability and uneconomic rates of production.

reports is collected at such a high level, they generally do not address specific program management practices that might be useful in mitigating the impact of program instability.

**Table 1. Some Frequently Cited Causes of Program Instability.**

| Causes of Program Instability | |
|---|---|
| Annual budget cycle | Unrealistic program cost estimates/proposals |
| Shifting congressional/administration priorities | Lack of clearly-defined operational requirements |
| Micromanagement by external stakeholders | Use of immature technologies |
| Too many active acquisition programs | Overly aggressive acquisition management plans |
| Unrealistic outyear budget estimates | |

The second general category of documents reviewed as part of this research included case studies of military acquisition programs (Anderl, 1985; Anderson, 1992; Barbera, 1995; Beatovich, 1990; Birkler and Large, 1990; Bodilly, 1993; Bodilly, 1993; Camm, 1993; Camm, 1993; Chang, 1994; Conrow, Smith and Barbour, 1982; Delahoussaye, 1994; GAO, 1991; Holubik, 1988; Larson, 1990; Mayer, 1993; McIver, 1993; Wank, 1993). A number of these are summarized in Table 2. In addition to these case studies, numerous reports summarizing specific programs or groups of similar programs were reviewed. The primary objective in reviewing these case studies and reports was to identify specific program-level management practices that may have had an impact of the program's ability to avoid or to overcome program instability, as well as contingency variables or conditions that might explain a program's experience with instability. The case studies were an important contributor to developing a contextual understanding of the overall phenomenon, as well as the program-level causes and manifestations of program instability.

**Table 2. Military Acquisition Case Studies Reviewed.**

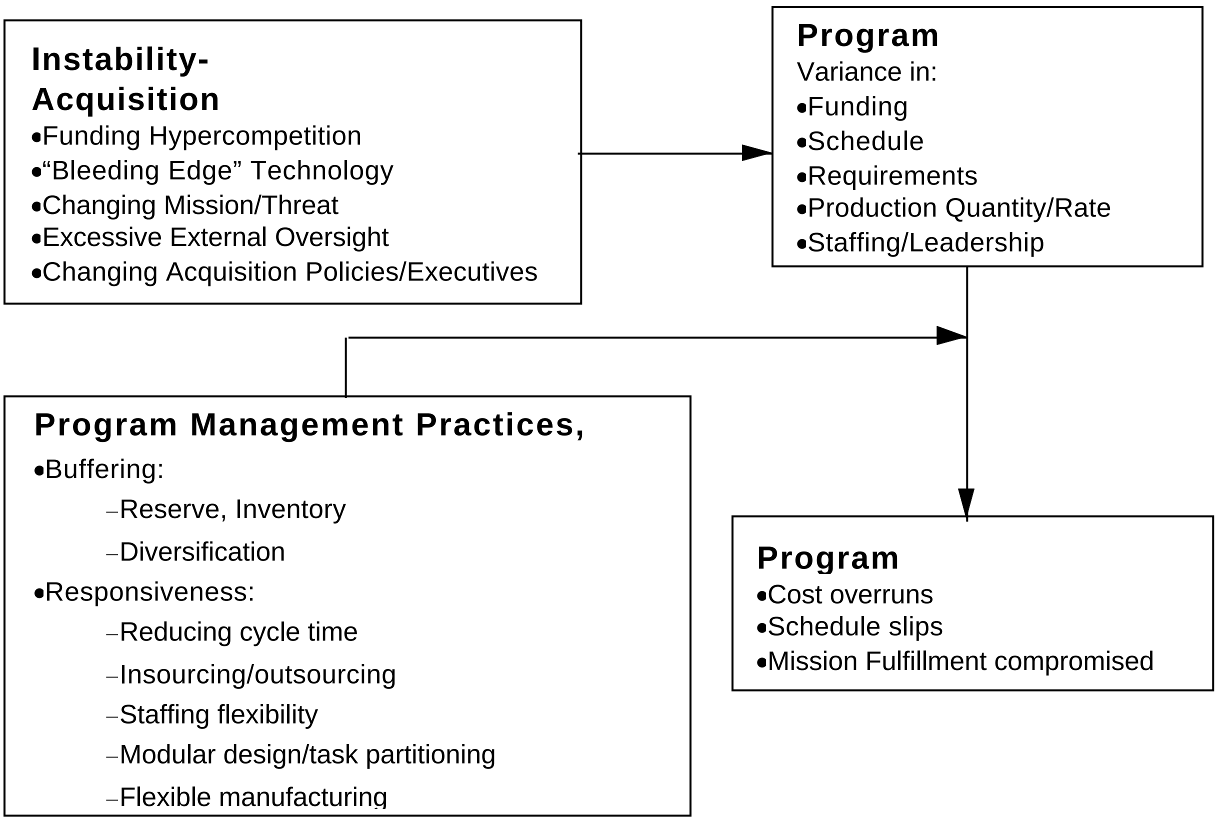
| Case Studies | |
|---|---|
| F-16 MSIP | ALCM |
| B-1B | Patriot Missile |
| F-14 | Small ICBM |
| F-14 upgrade | LANTIRN |
| KC-10A | FS-X Radar |
| XB-70 | F100-PW-220 |
| AMRAAM | F110-GE-100 |
| Tomahawk | Armored Gun System |

In addition to information found in the literature, government program managers from six different program offices were interviewed at the Aeronautical Systems Center at Wright-Patterson AFB in November 1995. Also in November 1995, contractor program managers from three different acquisition programs were interviewed at a contractor's facility. These interviews were used to fill in the gaps in information found in the literature, as well as calibrate practices identified in the literature with the experience of "real world" practitioners. The interviews were especially important for refining insights already gained into program-level management practices relating to program instability.

**Program Instability Framework Development**

The information gained from the literature review and program manager interviews was distilled into a framework describing the causes of and potential remediations for program instability. The purpose of this framework is to guide and focus research in this topic area. The framework is not considered to be a model, in that it is not intended to be predictive or definitive. Rather, it is a summary of the understanding and insight gained through the search of the existing literature and through interviews. It is an intellectual model of the phenomenon being studied. It defines variables and hypothesizes relationships between them. In so doing, it identifies the data to be collected as part of the research. The framework is shown in Figure 1.

**Fig. 1. Program Instability Research Framework**




The framework can be broken down into two main elements. The first of these elements describes the causes and effects of program instability, with its impact on overall program performance. This element draws on the observations of the numerous studies reviewed in the literature summarized above. The framework characterizes a number of high-level practices in the acquisition environment, such as funding over-committment, the use of immature technology, etc., as drivers of program instability. This instability is manifest by way of variance in funding, schedule, requirements, production quantity, or staffing at the program level. The outcome of this instability is program cost and schedule overrun and ultimately, the weapon systems' operational effectiveness being compromised.

The second element of the framework describes potential intervention strategies for reducing the negative impact of program instability on program performance. These interventions primarily involve strategies to buffer the program against the variability associated with program instability. A traditional buffering solution is to either build reserve into the program or diversify the overall system so that instability in one area can be offset by stability in another. Another strategy, essentially "virtual buffering", involves creating a rapidly reconfigurable or responsive system so that changes in key resources or plans can be accommodated without suffering the full costs potentially resulting from frequent changes in resources or plans.

Once the framework and program instability research objectives were developed, several sources of existing DoD data were identified and investigated to see if they offered a low-cost alternative to all-original data collection. Three DoD program reporting databases were investigated in October 1995, including the CAS database (including Defense Acquisition Executive Summary, DAES, section 7 data); the CAR database (complete DEAS, SAR, and Annotated Program Baselines); and a Five Years' Defense Plan (FYDP) database. All three were found to have limited usefulness for this specific research because they only addressed a few of the areas highlighted by the research framework. Specifically, none of the databases contained data on program management practices, and particularly, those practices identified as "lean" in the context of other industries. Furthermore, only the largest of programs are required to provide data for those databases, so their data are potentially not fully representative of the types of issues faced by programs of all sizes and at all points in the acquisition process. Finally, there were also government security-related complications associated with at least some of the datasets which would have strictly restricted some of the more useful types of analysis that could be performed on the data. Based on these concerns, the use of existing sources of data was abandoned in favor of collecting additional data through an original LAI survey tailored to the specific needs of this research.

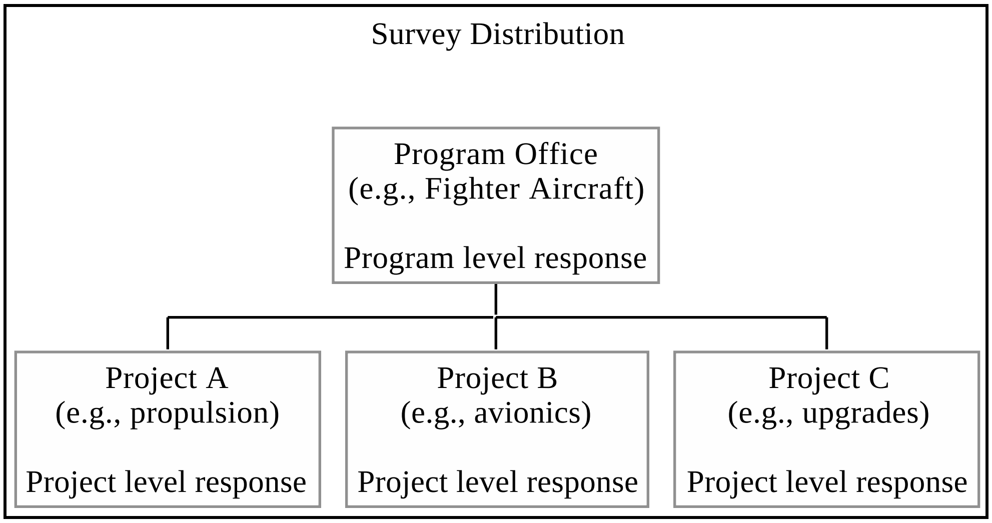
## Survey Development and Distribution

Two surveys have been developed to collect data for this research. The first was designed with the government program managers of military acquisition programs as its intended target sample. The second survey was designed as a companion to the first, but with the private-sector contractor program managers of military acquisition programs as its intended target sample. This report will discuss the development, data collection, and analysis of data from the former of the two surveys exclusively, since data is only beginning to become available from the contractor survey at the time of this writing. Reporting of results from the contractor survey will be forthcoming as that specific line of research progresses.

The government survey was developed based on the program instability research framework and insights gained during its development. The specific questions contained in the survey were drawn from discussions with program managers as well as from important issues highlighted in the literature. Additional questions were included in the survey (beyond those investigating program instability) to support research on DoD cycle time reduction conducted within the LAI. Once written, the survey was pre-tested with a number of active acquisition program managers from the target population. Feedback obtained from this pre-testing was incorporated into the survey. Once the concerns raised during the pre-testing were addressed, the survey was distributed.

The survey was designed to collect information at the program and project level. Managers at the project level were chosen specifically to receive the survey because projects account for a substantial amount of the work performed during the acquisition process. In many cases, project-level work on a major weapon system may contain work scope and resource requirements equivalent to or greater than those found in other complete acquisition programs. The managers of these individual projects are given responsibility for budget, schedule, and program execution within the realm of their responsibility, so they clearly represent an important source of knowledge about the costs and avoidance strategies relating to program instability. This survey distribution approach represents a unique source of data since project-level data seldom leaves the program office and is unavailable in official sources of information. The survey distribution strategy is shown in Figure 2.

**Figure 2. Survey Distribution Pattern Within Government Acquisition Program Offices.**




The survey was targeted for distribution for the aerospace systems development centers associated with the Air Force, Army, and Navy. These centers included the Aeronautical Systems Center (ASC) at Wright-Patterson Air Force Base, the Army Aviation and Troop and Command (ATCOM), the Naval Air Systems Command (NAVAIR), the Electronic Systems Center (ESC) at Hanscom Air Force base, and Army Tactical Missile and Missile Defense programs at Redstone Arsenal. Programs and projects at each site were identified through LAI consortium members. Surveys were then distributed through points of contact at each site, or directly to the program managers if no formal point of contact existed. A DoD report control symbol (RCS) number was obtained, and the surveys were distributed under a cover letter from the Deputy Undersecretary of the Air Force (management policy and program integration), with additional cover letters from specific center commanders or program executive officers (PEOs) in many cases. The surveys were returned directly to the researchers at MIT by the respondents.

**Survey Demographics**

Some 430 surveys were distributed initially, with an additional 40 surveys made available to respondents who reported misplacing their surveys during follow-up prompting. A total of 133 surveys were returned by 1 Sept. 1996, yielding a response rate of 30%. The distribution of returned surveys is shown in Table 3.

**Table 3. Survey Responses by Site.**

| Service | Surveys Returned |
|---|---|
| Air Force | 106 |
| Army | 23 |
| Navy | 4 |
| Total | 133 |

Of those programs or projects reporting, the average total program cost (comprising all program phases for which budget information was provided) was $3.7 billion, with a median program cost of $237 million. Figure 3 shows the distribution of program budget size among the responding programs. Note that the mean value of $3.7 billion was found at the 83rd percentile of responding programs. This suggests that this survey's sample comprises a few very large programs and numerous smaller programs. This is not unintentional given the survey sampling strategy outlined above. The DoD Acquisition Category (ACAT) designation of responding programs is shown in Table 4. Note that the largest responding category of programs are the ACAT I programs. Over half of the ACAT I-level program survey respondents fell below the mean budget level for the entire sample, however, possibly due to the fact that individual projects are not assigned ACAT designations, so a single large program might have numerous smaller programs that identify themselves as ACAT I. The fact that this sample population contains a small number of very large programs, several medium-sized programs, and numerous smaller programs suggests that it is an adequate representation of a typical mix of programs of different size and complexity found in the DoD and the Services' acquisition portfolios.

**Figure 3. Size of Responding Programs.**

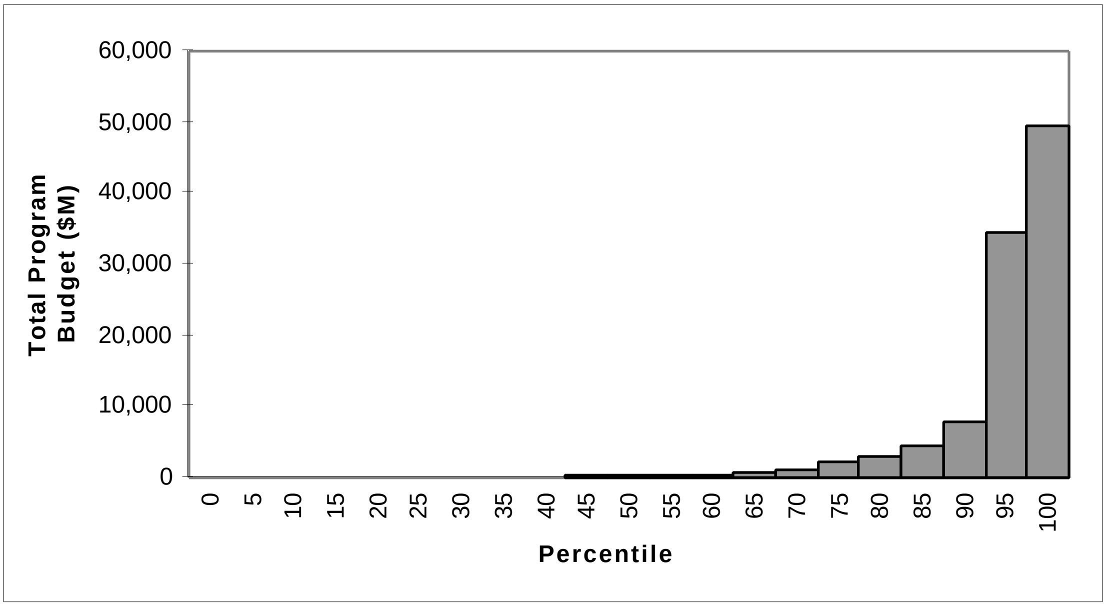



**Table 4. ACAT Designation of Responding Programs.**

| Acquisition Category | % of Sample |
|---|---|
| ACAT I C/D | 41% |
| ACAT II | 10% |
| ACAT III | 35% |
| ACAT IV | 14% |

**Table 5. Developmental Phase of Responding Programs.**

| Program Phase | % of Sample |
|---|---|
| Concept Exploration | 5% |
| Dem/Val | 7% |
| EMD | 36% |
| Production | 29% |
| Sustainment | 12% |
| Other (Closeout, pre-MS I, etc.) | 11% |
| Total | 100% |

The mean program length from program start to initial operational capability (IOC) was 7.75 years, with a median of 6.4 years. Table 5 shows that a majority of the responding programs were in the Engineering /Manufacturing Development (EMD) or Production program phases, followed by programs in the post-production phase.

Aircraft airframes, mechanical systems, avionics, and propulsion systems (the three sectors represented within the LAI) account for 42% of the surveys returned. Electronics or software account for an additional 31% of the sample. Missiles, munitions, and miscellaneous systems account for the remainder of the sample. The distribution of system types is shown in Table 6.

**Table 6. Product Type Being Developed by Responding Programs.**

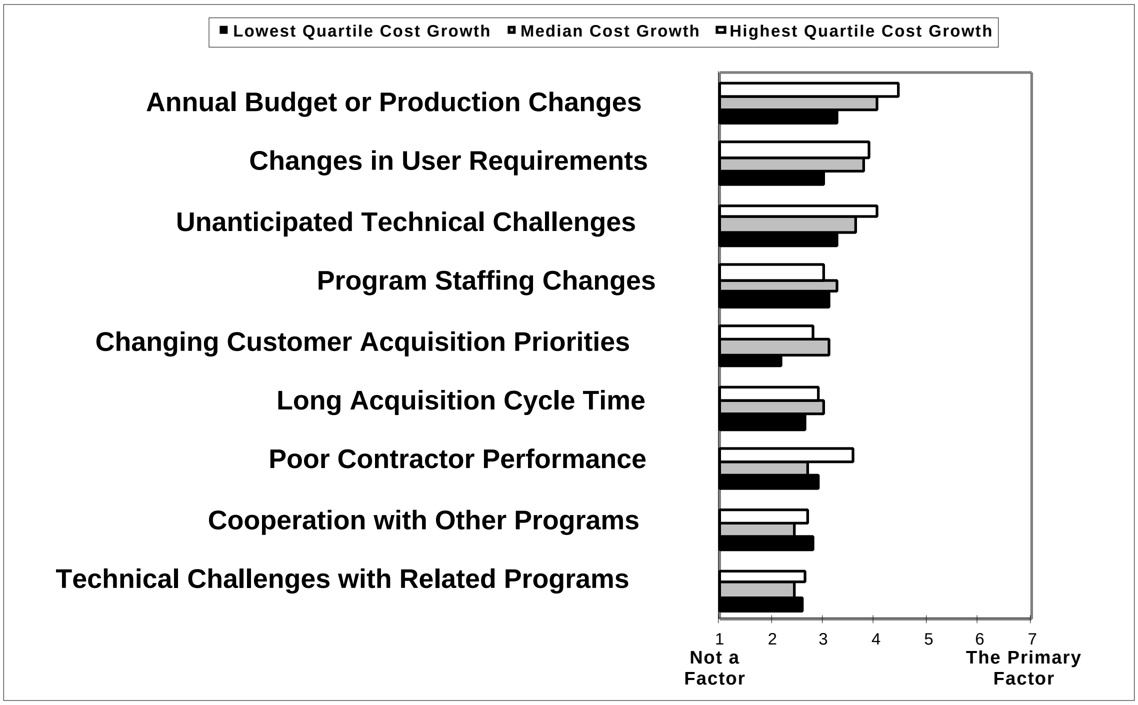
| System Type | % of Sample |
|---|---|
| Airframe and mechanical systems | 12% |
| Avionics | 25% |
| Engines | 6% |
| Electronics | 14% |
| Missiles/munitions | 14% |
| Software | 16% |
| Other (training systems, etc.) | 13% |
| Total | 100% |

## Program Instability Data Analysis Results

Of the 133 surveys returned, only those that were returned from projects or single-product level programs (totaling 104 surveys) were used in this analysis. This eliminates duplication of data at both the program and the project level for surveys returned from the same program. Survey responses from the program office level will be analyzed separately from this group.

The survey respondents were asked to rate the impact any of a number of potential sources of program instability had had on their specific program. The mean response of those ratings from across the sample are shown in Figure 4. Within Fig. 4, for each source of program instability three different rating scores were created, based on the program's cost growth performance. Those programs experiencing cost growth in the lowest quartile of the sample are designated by the all-black bars in Fig. 5. The lowest quartile of cost growth performance corresponds roughly to programs that experienced 0.5% annual cost growth or less (including those programs that underran their projected cost targets or had "negative" cost growth). Programs in the highest quartile of cost growth performance experienced 4.6% annual cost growth or greater, on average, and are depicted in Fig. 5 with all-white bars. Programs experiencing cost growth between the highest and lowest quartiles are depicted in Fig. 5 with the gray bars. The programs were divided into quartiles for lack of another objective measurement system that could be used to distinguish between relatively higher- and lower-performing programs.

**Fig. 4. Rated Causes of Program Instability.**




On average, program managers rated annual budget changes, technical challenges, and changes in user requirements as the top three, respectively, contributors to program instability in their programs. While the absolute difference in mean response on the 7-point scale between the highest-ranked and lowest ranked specific sources of program instability is not great, it is interesting to note the significant variance in responses between programs in the different cost performance categories. Programs with the best program cost performance (those in the lowest quartile) rated annual budget or production changes, changes in user requirements, and changing customer acquisition priorities significantly lower as sources of program instability than did programs with poorer cost performance. Superficially, at least, this suggests that an important aspect of higher program performance involves a stable budget and consistent customer desires. On the other hand, programs with the poorest cost performance (those in the highest cost performance quartile) rated poor contractor performance significantly higher as a source of program instability than did the other programs (however, not enough information is available to ascertain whether the contractor is the actual source of the programs' problems or simply a convenient scapegoat).

In the sample of programs surveyed, the average program cost growth, or the amount by which the actual program costs exceeded the program plan, was 30.8% overall. The average flyaway unit cost in the sample increased from the program's original plan by 8.1%. The average reported program schedule slip (the amount by which the program length exceeded the program's initial planning estimates) was 36.4% (or 9.8 months) overall.

Since the baselines upon which programs reported their cost growth varied in length, the average annual cost growth was calculated for each program to normalize the analysis. The annual program cost growth and the contribution of each of the top three-ranked sources of program instability from Fig. 4 are shown in Table 7 below. The data show that funding instability, requirements changes, and technical difficulties each account for roughly 2.5% average annual cost growth. While the numbers in Table 7 appear to be low, consider that the program's plan already accounts for the impact of inflation, and that the typical acquisition program lasts for several years. So, a program with the 7.75 year mean program length from this sample would experience 18.9% cost growth due to budget instability and 21% cost growth due to requirements changes, for a total of nearly 40% cost growth cost growth due to two leading contributors to program instability. At an average rate of 5% annual cost growth from these two factors, it is easy to see that even conservative estimates of the cost benefits to be gained from acquisition reforms and process improvements can quickly be eclipsed by the costs associated with program instability. Note also that either budget or requirements changes are roughly equivalent in magnitude to technical problems as contributors to program cost growth.

**Table 7. Sources of Program Cost Growth.**

| Contributor to Cost Growth | Annual Cost Growth (%) |
|---|---|
| Budget or Funding Instability | 2.44 |
| Technical Difficulties | 2.60 |
| Requirements Changes | 2.71 |
| Other | 0.09 |
| Total (N=97) | 7.84 |

**Table 8. "Other" Contributors to Program Cost Changes.**

| "Other" Sources — Cost Growth | Number of Cases Cited |
|---|---|
| Inadequate estimate of scope | 6 |
| Schedule slips and restructures | 5 |
| Additional requirements change-related issues | 4 |
| Impacts from other programs | 3 |
| Additional technical difficulty-related issues | 2 |
| Vendor base loss | 2 |
| Poor management approach | 1 |
| Contract protests | 1 |
| Policy changes | |
| **"Other" Sources — Cost Underruns** | **Number of Cases Cited** |
| Acquisition Reform implemented | 2 |
| "Commercial" or price-based buying practice | 2 |
| COTS technology improvements | 1 |
| Production efficiency | 1 |

The "Other" category shown in Table 7 was written into the survey questionnaire as a way to identify unusual sources of cost growth. Comments written in space provided in the survey indicated specifically what the source of the cost variance was. A summary of these comments are presented in Table 8. The most common of the extraordinary sources of program cost growth was poor estimation of project scope and cost. The next two most frequently cited sources in the "other" category are probably closely related to those sources shown in Table 7. For instance, schedule slips and program restructures don't occur spontaneously by themselves. Usually, programs are restructured because escalating costs, technical problems, or numerous changes in requirements make the actual program scope significantly different from that proposed in the original program plan. On a positive note, programs reporting cost underruns cited practices relating to several current acquisition reform initiatives as significant contributors to the program's cost underruns.

It is important to note that while the listed sources shown in Table 8 provide interesting insights into the various sources of program instability, one should keep their relative overall contribution in perspective. The results shown in Table 7 are based on nearly eighty individual survey responses, while the most frequently cited single source of program instability in Table 8 is based on six individual survey responses. For this reason, it is felt that the budget changes, requirements changes, and technical difficulties categories provide an appropriate level of detail for analyzing the sources of program instability.

The respective contributions of budget or funding changes, technical difficulties, and requirements changes to program schedule slip is shown in Table 9. Schedule slip (originally measured on months) is normalized by the program's current schedule length from start to IOC, less the amount it had slipped (i.e., the original program length estimate). Table 9 shows that the average program from this sample suffers 9.1% program schedule slip because of budget or funding instability and 11.9% program schedule slip because of requirements changes for a total of 20% schedule slip from start to IOC. Note also that either budget or requirements changes are roughly equivalent in magnitude to technical problems as contributors to program schedule slip.

**Table 9. Sources of Program Schedule Slip.**

| Contributor to Schedule Slip | Total Schedule Slip (%) |
|---|---|
| Budget or Funding Instability | 9.1 |
| Technical Difficulties | 9.4 |
| Requirements Changes | 11.9 |
| Other | 3.9 |
| Total | 34.3 |

**Table 10. "Other" Contributors to Program Schedule Changes.**

| "Other" Sources — Schedule Slip | Number of Cases Cited |
|---|---|
| Change in acquisition plan | 5 |
| Impacts from other programs or agencies | 5 |
| Problems with GFE or parts deliveries | 5 |
| Lengthy contract definition/award process | 4 |
| Bureaucratic/oversight problems | 4 |
| Contractor/subcontractor performance problems | 3 |
| Inadequate estimate of scope | 3 |
| Poor management approach | 1 |
| **"Other" Sources — Ahead of Schedule** | **Number of Cases Cited** |
| Acquisition Reform implemented | 1 |

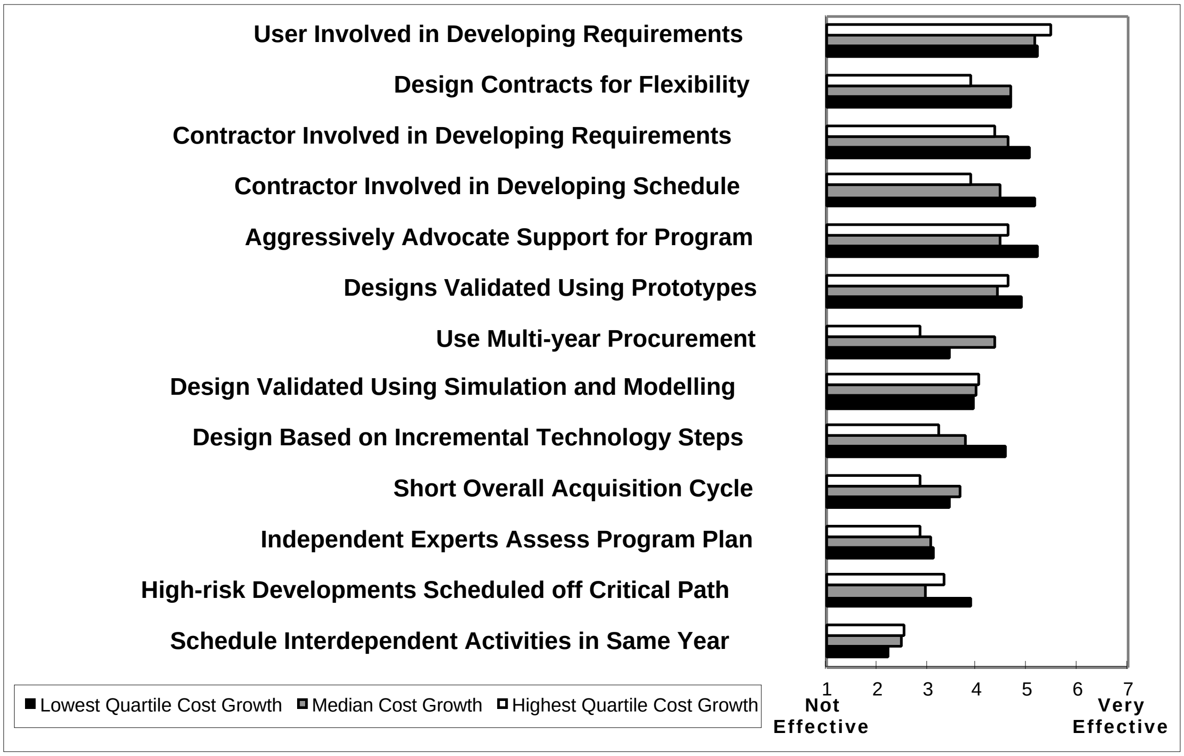
The "Other" contributors to program schedule slip are summarized in Table 10. Note that a number of the extraordinary sources of schedule slip have the common theme of difficulties arising from working within a large, bureaucratic acquisition structure (e.g., oversight, lengthy award process, difficulties arising from working with other agencies, etc.). Another common theme is related to inaccurate estimates of the scope or difficulty of the work. The same caveat cited above regarding the relative number of cases where each of these factors is mentioned applies here as well. While compelling (especially to the program manager who has had to endure these specific problems), they represent only a small subset of the overall sample.

In summary, unplanned budget or funding changes, unplanned requirements changes, and technical difficulties each contribute roughly equal amounts to program cost growth and to program schedule slip. The combined effects of unplanned budget and requirement changes accounts for 5.2% average annual cost growth and an average of 20% total program schedule slip.

**Program Management Strategies to Overcome Program Instability**

The government program managers responding to the survey were asked to rate a number of program management practices for their utility in either avoiding instability so that it doesn't afflict a program, or mitigating the impact of instability once it has already struck. The lists of practices presented in the questionnaire was composed based on interviews with program managers. Broadly speaking, the practices detailed in questionnaire relate to the integration of procurement process stakeholders into the decision making process, the automation or application of computer-based information technologies to tasks, various accepted risk management strategies, and what could be considered "lean" development strategies based on research focusing on other industries. The ratings of each practice by the program managers were based on a simple 7-point scale.

**Figure 5. Ratings of Strategies to Avoid Program Instability.**

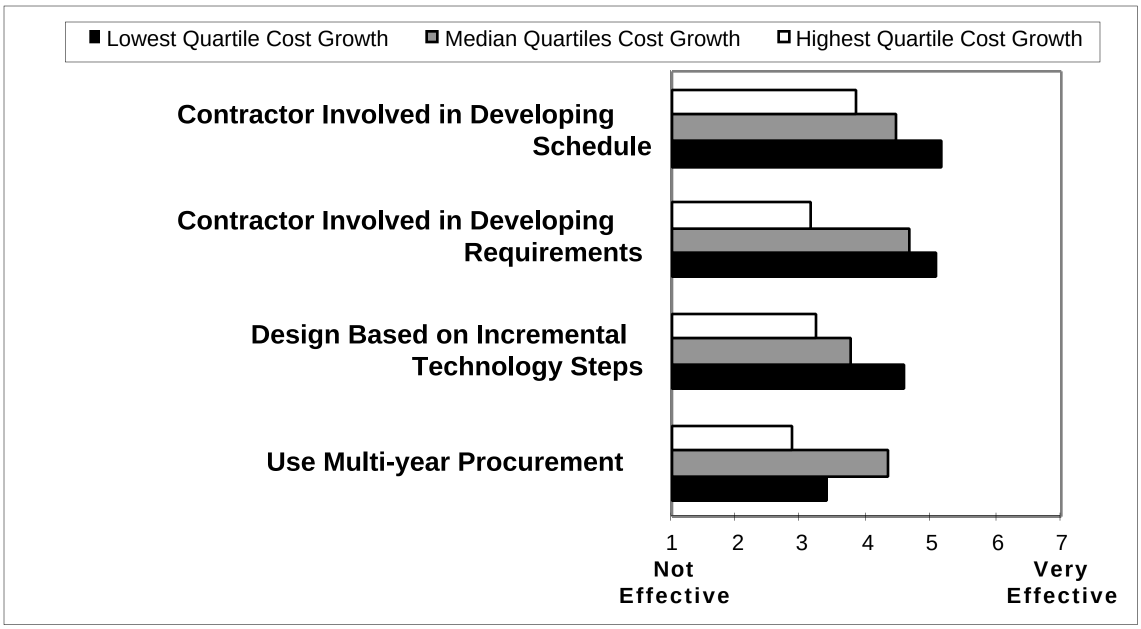



**Program Management Strategies to Avoid Program Instability**

The program manager's ratings of various management practices for avoiding program instability are shown in Fig. 5. The practices are arrayed in the order of their rating by program managers, with those rated most highly by the managers on the median-performing programs appearing at the top of the list. Most noticeable in the ranking is that four of the top five practices relate to including external stakeholders in the program decision making process (e.g., involving users and contractors, reaching out to sponsors). Stakeholder involvement is generally more highly rated in this list than are the traditional risk management or risk avoidance strategies. This is consistent with the previous findings that show that technical problems account for only about a third, on average, of a program's cost growth, while changes in resources and scope (elements directly affected by external stakeholders) account for the other two-thirds of cost growth.

A quick glance at Fig. 5 also reveals that there are large differences in the ratings of a number of the practices, depending on the cost performance of the program from which the practice was rated. Those practices for which there was a statistically significant difference between programs in at least two of the cost quartile categories are shown in Fig. 6 (with the practices most highly-rated by the managers of programs in the lowest cost performance quartile appearing at the top of the list). There is some value in examining specific practices for which there is a significant amount of variance in ratings that is determined by program performance. At the very least, it may give an indication of practices that are not universally used, but which may offer significant benefits to those programs that employ them (one would expect that practices that are universally used would be rated equally by all programs, on average). All of the practices shown in Fig. 6, except the use of multi-year procurement, were rated more highly by programs with the lowest levels of cost growth than they were by the other programs. This suggests that these practices may be of benefit to those who use them.

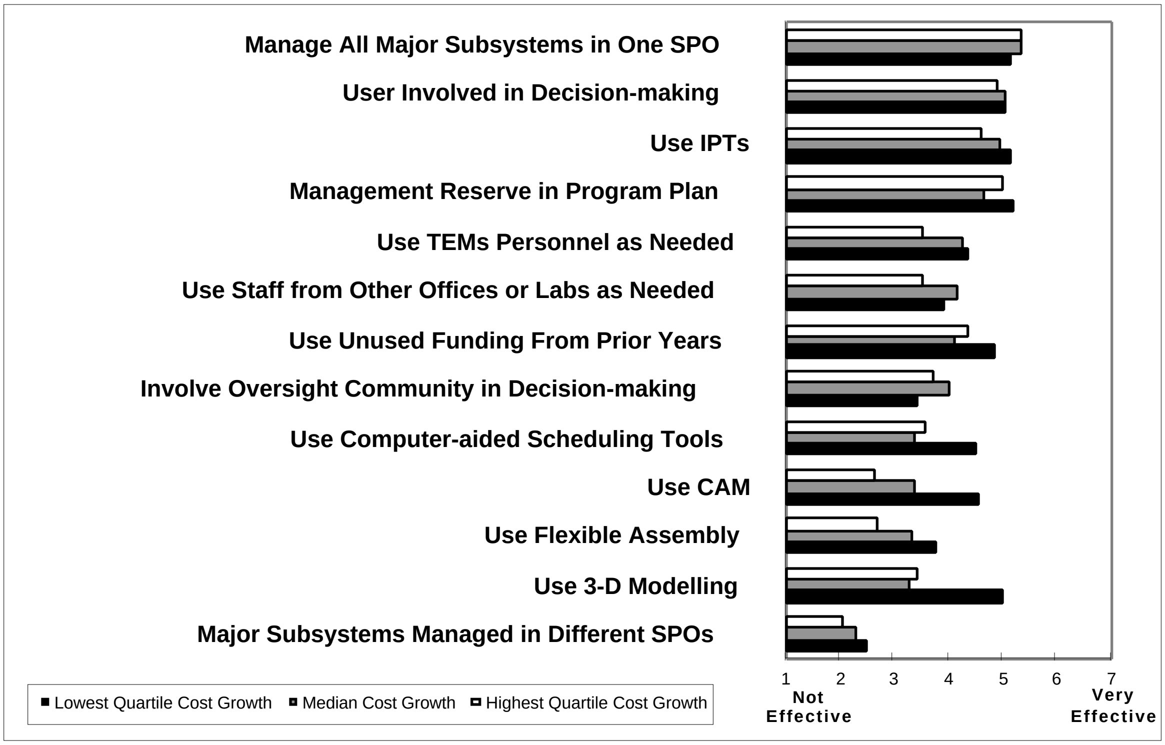
**Figure 6. Ratings of Strategies to Avoid Program Instability.**




**Program Management Strategies to Mitigate the Impact of Program Instability**

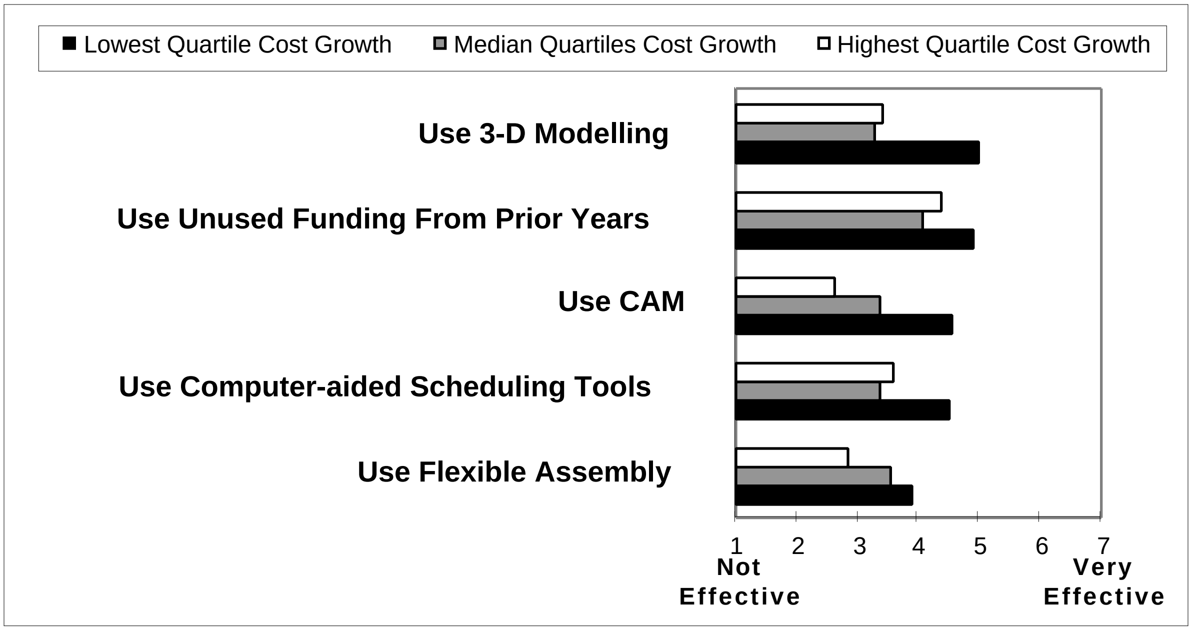
The program manager's ratings of various management practices for mitigating the impact of program instability are shown in Fig. 7. These practices are oriented around reducing the negative impact (e.g., the cost of program restructuring) of program instability. The same rating scheme used in the previous two charts is continued here, with programs segregated into three categories based on their cost growth performance. The practices are also displayed from top to bottom based on the ratings of manager from programs with cost performance in the median quartiles.

**Figure 7. Ratings of Strategies to Mitigate Program Instability.**




The managers of programs with median cost performance tend to rate inclusion of stakeholders in the decision making process and the use of "buffers" (such as management reserve or unused funding) towards the top of the list shown in Fig. 7. Interestingly though, the managers of programs with zero or negative cost growth tend to rate "agility" technologies (such as computer-based information technologies) relatively higher than do their counterparts in programs in the other cost performance categories. This perhaps reflects a divergence of management strategies, where programs that do not rely on advanced technologies to minimize the cost of changing objectives and resources are forced to rely more heavily on traditional buffers like management reserve and unused funding from prior years. Management practices for which there was a significant difference in the ratings of the managers of programs in at least two of the cost performance categories are shown in Fig. 8. The managers of programs with the best cost performance, as mentioned above, tend to rate more highly the use of computer-based information technologies than do their counterparts in the other programs. These include 3-D modeling, computer-aided manufacturing, and computer-aided scheduling tools.

**Figure 8. Ratings of Strategies to Avoid Program Instability.**




# Conclusions

This report commenced with three primary objectives, namely to discuss high-level findings detailing: 1) the relative contribution of different factors to a program's overall instability; 2) the cost impact of program instability on acquisition programs; and 3) some strategies recommended by program managers for overcoming and/or mitigating the negative effects of program instability on their programs.

The government managers of military acquisition programs were asked to rate the various sources of program instability for their programs. Based on an aggregation of their ratings, the top three sources of program instability were found to be unplanned budget or funding changes, unplanned requirements changes, and technical difficulties, respectively. The contribution of each of these three sources of instability were found to be roughly equal in the cases of both program average annual cost growth and average program schedule slip. In the case of program cost growth, it was found that the combined effects of unplanned budget and requirement changes accounted for 5.2% average annual cost growth. In the case of schedule slip, it was found that the combined effects of unplanned budget and requirement changes accounted for about 20% total program schedule slip.

The management strategies rated most effective in helping to avoid the occurrence of program instability involved the integration of key resource stakeholders into the program decision-making process. These stakeholders include the contractor, users, and funders. Perhaps the utility of these practices lies in the idea that as a greater spectrum of participants in the acquisition "food chain" become involved in a program and develop a sense of ownership for it, they will be less inclined to deprive it of critical resources should a need arise.

The management strategies rated most effective in helping to mitigate the negative effects of program instability involve an interesting combination of buffer and agility strategies. The buffer strategies involve creating excess inventory (e.g., management reserve), whether within the program or within the program's immediate environment, to absorb variation in the programs resource inputs. The agility strategies seek to minimize the cost of changing or adapting to a new set of resources or requirements, and include the use of information technologies and temporary staffing. Interestingly, the managers of programs with median or greater levels of average program cost growth tended to rate the buffer strategies relatively more effective than they did the agility strategies.  On the other hand, the managers of programs that underran cost tended to rate the agility strategies significantly more effective than did their counterparts in programs with higher levels of cost growth.

# References


Anderl, Maj. Robert S. “Accelerating the Contracting Process -- A Case Study of the Small ICBM Program.” Master's Thesis. Air Command and Staff College, 1985.

Anderson, Michael G. “The Air Force Rapid Response Process: Streamlined Acquisition During Operations Desert Shield and Desert Storm.” CA: Santa Monica: Rand Corporation, 1992.

Barbera, Richard S. “The Patriot Missile System: A Review and Analysis of its Acquisition System.” Master's Thesis. Naval Postgraduate School, 1995.

Beatovich, Capt. Gary. “A Case Study of Manned Strategic Bomber Acquisition: The XB-70 Valkyrie.” Master's thesis. Air Force Institute of Technology, 1990.

Birkler, John L., and Joseph P. Large. “Dual-Source Procurement in the Tomahawk Program.” CA: Santa Monica: RAND Corp., 1990.

Bodilly, Susan J. “Case Study of Risk Management in the USAF B-1B Bomber Program.” CA: Santa Monica: Rand Corp., 1993.

Bodilly, Susan M. “Case Study of Risk Management in the USAF LANTIRN Program.” CA: Santa Monica: Rand Corporation, 1993.

Camm, Frank. “The Development of the F100-PW-220 and F110-GE-100 Engines: A Case Study of Risk Assessment and Risk Management.” CA: Santa Monica: Rand Corp., 1993.

Camm, Frank. “The F-16 Multinational Staged Improvement Program: A Case Study of Risk Assessment and Risk Management.” CA: Santa Monica: Rand Corporation, 1993.

Chang, Ike Y. Jr. “Technology Access from the FS-X Radar Program.” CA: Santa Monica: Rand Corporation, 1994.

Clay, Lt. Col. John L. “Air Force Acquisition Stability and the Program Manager.” Air War College, 1990.

Conrow, E. H., G. K. Smith, and A. A. Barbour. “The Joint Cruise Missiles Project: An Acquisition History.” CA: Santa Monica: Rand Corporation, 1982.

CSIS. “Toward a More Effective Defense: Final Report of The CSIS Defense Organization Project.” Washington, D.C.: Center for Strategic and International Studies, Georgetown University, 1985.

CSIS. “U.S. Defense Acquisition: A Process in Trouble.” Washington, D.C.: Center for Strategic and International Studies, 1987.

Delahoussaye, Perry J. “Modification of the F-14: A Case Study in Decisions Affecting a Major Systems Upgrade.” Master's Thesis. Naval Postgraduate School, 1994.

Dews, Edmund, et al. “Acquisition Policy Effectiveness: Department of Defense Experience in the 1970s.” CA: Santa Monica: Rand Corporation, 1979.

Gansler, Jacques S. Affording Defense. Cambridge, MA: MIT Press, 1989.

Gansler, Jacques S. “Defense Program Instability: Causes, Costs, and Cures.” Defense Management Journal .Second Quarter (1986): pp. 3-11.

GAO. “Defense Weapons Systems Acquisition.” Washington, D.C.: General Accounting Office, 1995.

GAO. “Defense Weapons Systems Acquisition.” General Accounting Office, 1992.

GAO. “Optimistic Estimates Lead to Billions in Overprogramming.” Washington, D.C.: General Accounting Office, 1994.

GAO. “Tactical Missile Acquisition: Understated Technical Risks Leading to Cost and Schedule Overruns.” General Accounting Office, 1991.

GAO. “Weapons Acquisition: A Rare Opportunity for Lasting Change.” General Accounting Office, 1992.

GAO. “Weapons Acquisition: Implementation of the 1991 DoD Full Funding Policy.” General Accounting Office, 1992.

Glass, G. Wayne. “Assessing the Effectiveness of Milestone Budgeting.” Congressional Budget Office, 1987.

Grace, J. Peter. “Task Force Report on the Office of the Secretary of Defense.” Washington, D.C.: President's Private Sector Survey on Cost Control, 1983.

Holubik, Maj. Thomas E. “History of the KC-10A Aircraft Acquisition.” Air Command and Staff College, 1988.

Iverson, Col. David L. “Army Programming Stability.” Air War College, 1990.

Larson, Eric V. “Technological Risk: The Case of the Tomahawk Cruise Missile.” CA: Santa Monica: Rand Corporation, 1990.

Mayer, Kenneth R. “The Development of the Advanced Medium-Range Air-to-Air Missile: A Case Study of Risk and Reward in Weapon System Acquisition.” CA: Santa Monica: Rand Corporation, 1993.

McIver, Jon E. “The F-14 Contract: A Case Study in Major Weapon Systems Acquisition and Program Management.” Master's Thesis. Naval Postgraduate School, 1993.

Packard, David. “A Quest for Excellence.” President's Blue Ribbon Commission of Defense Management, 1986.

Procurement, Commission on Government. “Report of the Commission on Government Procurement.” Washington, D.C.: Government Printing Office, 1972.

Rice, D.B. “Defense Resources Management Study: Final Report.” Washington, D.C.: Government Printing Office, 1979.

Rich, Michael, Edmund Dews, and C. L. Jr. Batten. “Improving the Military Acquisition Process: Lessons from Rand Research.” CA: Santa Monica: Rand Corporation, 1986.

Thomas, R. William. "Effects of Weapons Procurement Stretch-Outs on Costs and Schedules." Congressional Budget Office, 1987.

Wank, James A. "The Armored Gun System: An Acquisition Streamlining Model for the Army?" PA: Carlisle: U.S. Army War College, 1993.