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**Transaction Costs
from a Program Manager's Perspective**

28 September 2009

by

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Abstract

This project continues ongoing efforts by the authors to understand transactions costs within DoD acquisition. Past studies by the authors have been constrained by the data available. As part of continuing effort to acquire more data and take advantage of first-hand knowledge of the issue, this study analyzes results from a survey of US Air Force Program Managers undertaken in 2008 by the National Research Council (NRC, 2009).

The theoretical foundations of our supporting inquiry come from Transaction Cost Economics (TCE) and Agency Theory—well-established fields of study. In particular, we are concerned with the complications and costs of dealing with partners both outside DoD (TCE) and within (Principal-Agent Problem).

The number of oversight reviews has steadily increased, with increasingly higher-level involvement. Accordingly, the resources and management attention devoted to these reviews has also increased. Within that context, the NRC study attempted to assess program reviews with respect to value added and various costs incurred. Our analysis of the survey results distinguishes between technical and programmatic reviews. Technical reviews are conducted by the program manager (as principal) to monitor technical progress of the system contractors (agents). Programmatic reviews provide management oversight of the program manager (as agent) by higher-level authorities in DoD or Congress (principals).

Our results suggest that program managers found some real value in some of their programmatic reviews, despite the common perception that reviews create excessive and burdensome levels of oversight. In addition, we found that program managers gave relatively less value to technical reviews, a result some might find counterintuitive.

Keywords: Acquisition, program management, transaction costs, principal-agent, technical reviews, management oversight



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I. Introduction

Transaction cost economics (TCE) emphasizes transaction costs (coordination costs and motivation costs) in addition to traditional production costs and provides a useful framework for studying defense acquisition. In this study, we focus on the costs of monitoring and oversight incurred by the program management process within the context of TCE and the principal-agent model (agency theory).

We use data from a survey conducted by the National Research Council (NRC, 2009) to understand the costs and benefits of monitoring and oversight from the program manager's perspective. In this NRC survey, program managers were asked to subjectively assess the impact/value of different programmatic and technical reviews. We test the assumption that program managers are more likely to view technical reviews as less costly/more beneficial and view programmatic reviews as more costly/less beneficial.

In the first section of this report, we present the basic theoretical foundations for our study: transaction cost economics and the principal-agent model. We discuss efforts to measure transaction costs and the application of the principal-agent model to the program manager's role in the acquisition process. Next, we discuss the program manager's perspective in terms of program oversight and program reviews. We conclude this section with a summary of the NRC study. In the last section, we present the results of our analysis of the NRC survey data—which yielded some counterintuitive results.



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II. Theoretical Foundations

A. Transaction Cost Economics

Conventional economic analysis focuses on production costs (input costs, competition, learning curves, economies of scale and scope, etc.). Coase (1937) was the first to ask why some firms produce goods and services themselves at higher production costs than can be purchased in the marketplace. The answer is that using the market involves “transaction costs,” and that these costs can more than offset production cost advantages from outsourcing. In making outsourcing decisions, it is important for management to consider not only the internal and external production costs of providing the good or service, but also the cost of managing the transaction internally or externally. For example, consider DoD’s Defense Contract Management Agency (DCMA). This \$1.1 billion organization is made up of 10,500 Civilians and 600 Military whose exclusive responsibility is to help manage and coordinate some 300,000 defense contracts valued at nearly \$950 billion.

Transaction cost economics (TCE) emphasizes transaction costs (the cost of carrying out a transaction) in addition to traditional production costs. Transaction costs typically encountered organizations dealing with outside suppliers or sub-contractors include the costs of source selection, periodic competition and renegotiation, contract management, and measuring and monitoring performance. Examples of transaction costs that occur inside an organization include the costs of hiring and managing employees and selecting and controlling equipment and materials. TCE views organizations as a web of contractual relationships. Each relationship—the acquisition of an input, employment of a worker, the exchange of a product or service between supplier and customer—is a transaction.

Transaction costs can be classified into two categories: coordination costs and motivation costs. Coordination Costs include: 1) Search and Information



Costs—to identify options and acquire timely, accurate and relevant information to evaluate alternatives; 2) Bargaining and Decision Costs—to choose an alternative and negotiate and write a contract; and 3) Monitoring and Enforcement Costs—to make payments and measure, monitor, and evaluate performance. Motivation Costs include: 1) Costs to promote productive effort and incentives to encourage investment (better, faster, cheaper) and 2) Costs to deter unproductive bargaining and costs of opportunistic behavior renegotiation).

Four key characteristics of transactions can make them more costly: complexity, uncertainty, frequency, and asset specificity. TCE suggests that an understanding of the key characteristics of a transaction can help decision-makers improve the design of contracts, organizations, and other governance structures that reduce transaction costs and improve the gains from an exchange between buyers and sellers. In other words, understanding transaction costs may help the firm achieve results “faster, better, and cheaper.”

While TCE offers an attractive theoretical foundation for competitive sourcing decisions in the private sector (e.g., Coase, 1937; Williamson, 1971; 1979; Alchian & Demsetz, 1972) it has been applied less often in a government setting (e.g., Pint & Baldwin, 1997; Williamson, 1999). Many goods and services required for government operations can be provided through commercial markets. The Department of Defense (DoD) relies heavily on outsourcing, particularly when producing weapon systems. Franck & Melese (2005) apply TCE to federal outsourcing and note that transaction costs vary widely and depend in known ways upon the attributes of the outsourcing action.

Although often used to refer to major weapon system programs, the term acquisition can cover all DoD purchases from the development and procurement of weapon systems, to purchasing of services and support for the military. Franck, Melese & Dillard, (2006) extended the application of TCE to defense procurement. They examine the effect of “asset specificity” on acquisition programs. The “lock-in” effect achieved by contractors that invest in specific assets, while benefiting the



government in the short run, can haunt the government in the long run. The risk is that, after winning a bidding competition, a contractor that invests in specific assets might eventually become a sole supplier that “holds up” the government, resulting in higher costs, schedule delays, or disappointing performance.

B. Measuring Transaction Costs

The primary insight of TCE is that correctly forecasting economic production costs of government purchases or acquisitions is necessary, but not sufficient. TCE emphasizes another set of costs—coordination and motivation costs, such as search and information costs; decision, contracting, and incentive costs; measurement, monitoring, and enforcement costs, etc. (Melese, Franck, Angelis & Dillard, 2007). A focus on transaction costs can improve cost estimation for DoD acquisitions by (1) helping to explain the systematic bias observed in initial cost estimates, and (2) increasing the general explanatory power of cost estimations. The traditional work breakdown structure (WBS) approach may overlook some important variables, resulting in initial cost estimates that are (1) not accurate and (2) biased toward being unrealistically low. Unlike the production-function approach of the WBS, the TCE approach focuses on coordination and motivation costs and other key components of major weapon system acquisitions (Angelis, Dillard, Franck & Melese, 2007).

While there are several ways to define and characterize transaction costs, actually measuring them can be difficult. Wang (2003) discusses a variety of empirical studies that attempt to measure transaction costs. Some studies measure transaction costs directly by measuring the economic value of resources used in locating trading partners and executing transactions. For example, for six months in the early 1990s, Ambassador Henry F. Cooper (1993; as cited in Spring, 2002, May), then director of the Strategic Defense Initiative Organization, tracked the costs to support the attainment of one decision point in a single program, which was then called the Theater High Altitude Area Defense (THAAD). Ambassador Cooper found



that it took 75,000 government labor hours, 250,000 contractor labor hours, more than one ton of supporting documents, all at a cost of \$22 million dollars.

Unfortunately, such costs are not routinely tracked by DoD. Dillard (2005) noted that while some representatives from program management offices keep an accounting of travel and labor costs associated with program reviews, the evidence is mostly anecdotal. His research suggests that a substantial amount of program office funding is expended on such items as government agency or support contractor assistance with supporting analyses and documentation, presentation materials, frequent travel to the Pentagon, and other associated expenses in preparation for high-level reviews.

In earlier work (Angelis et al., 2007), we attempted to directly measure transactions costs for defense acquisition programs using the expenditures of the Program Management Office (PMO) as an approximate measure of the amount of transaction costs present in an acquisition program. We found that DoD does not track PMO costs separately; therefore, measuring transaction costs directly or by proxy from the existing DoD data may not be possible. As an alternative, it is possible to directly measure contractor Systems Engineering/Program Management (SEPM) costs as an indication of contractor transaction costs (Angelis et al., 2008). We calculated the ratio of SEPM to total costs for two case studies (Javelin and ATACMS) for which ex-ante indicators of transaction costs had been assessed. The results are consistent in that the program with ex-ante indicators that suggested higher transaction costs also had a significantly higher SEPM ratio.

Other empirical studies do not attempt to measure transaction costs directly. Instead, they use a variety of proxies, such as complexity, uncertainty, frequency, and asset specificity. For example, Brown, Flowe and Hamel (2007) examine the role of complexity by measuring the difference in cost and schedule breaches between System-of-Systems (SoS) and single-system defense acquisition programs. SoS programs are defined as independent systems that are integrated into a larger system to provide unique capabilities. The identification of a program



as SoS can be seen as a proxy for complexity. We extended that work (Angelis et al., 2008) to coordination costs by comparing programs managed jointly by several services to programs managed by one service. Joint programs can be seen as proxy for coordination costs. The use of these proxies provides useful insights into the effect of transaction costs.

C. Principal-Agent Model

Another way to look at transactions is to consider the problem that occurs when cooperating parties have different goals and division of labor (Jensen & Meckling, 1976; Ross, 1973). Agency theory examines the interaction between the party that delegates or contracts for work (the principal) and the party that agrees to perform the work (the agent). The focus of the principle-agent model is on determining the optimal contract between the two parties. There are two main problems that can arise in agency relationships: (1) the goals of the principal and agent are not aligned, and (2) the principal cannot easily verify what the agent is actually doing. The theory can suggest which contract type is most effective under different assumptions.

In the simplest case, the model assumes that principals and agents have conflicting goals & objectives, but an easily measured outcome. This case also assumes that the agent is more risk-averse than the principal, since the agent has only one contract (with the principal), while the principal can diversify his/her investments with several contracts. The type of contract used can depend on the amount of information available to the principal (see Demski & Feltham, 1978).

In many cases, there is information asymmetry because the principal does not know exactly what the agent has done. In this situation, the agent (who accomplishes the work) has an information advantage over the principal. This can lead to two problems discussed in agency theory: adverse selection and moral hazard. Adverse selection can occur if agents misrepresent their ability to accomplish the work. This might provide one explanation for why contractors often



fail to deliver weapon systems on time, within budget and as specified. A moral hazard can arise if the agent chooses not to perform as promised and the principal has no way of knowing. For example, a contractor may bill for a service that was not actually rendered or bill for an amount in excess of actual costs. The moral hazard occurs because the principal is unable or unwilling to verify the agent's effort.

One way the principal can deal with lack of information is to invest in data-collection systems such as budgeting systems, cost-accounting systems and performance-measurement systems. The principal can also establish reporting procedures such as programmatic and technical reviews, as well as additional layers of oversight, as shown in Figure 1 below for defense acquisition programs.

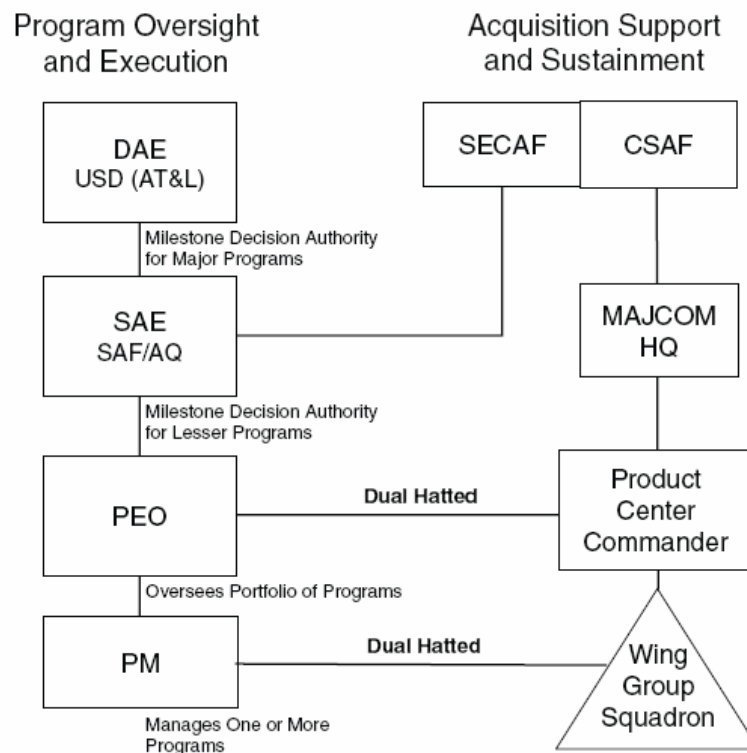


Figure 1. Four Tiers of Major Program Reporting
(NRC, 2009)

Note: The meaning of each acronym is as follows: DAE, Defense Acquisition Executive; USD (AT&L), Under Secretary of Defense for Acquisition, Technology, and Logistics; SECAF, Secretary of the Air Force; CSAF, Chief of Staff of the Air Force; MAJCOM HQ, Major Command Headquarters; SAE, Service Acquisition Executive, SAF/AQ, Assistant Secretary of the Air Force for Acquisition; PEO, Program Executive Officer; PM, Program Manager



In addition, the principal may use a contract that specifies the desired outcome (as opposed to effort or behavior) to align goals and incentives. Such an arrangement transfers the risk of performance to the agent. For example, the government can use firm, fixed-price contracts to acquire goods and services. Such contracts place the responsibility of performance on the contractor or supplier and reduce the cost and schedule risk to the government. Naturally, contractors may charge a premium to accept additional risk and, in some cases, may refuse the contract altogether. This may happen if there are too many factors beyond the contractor's control and the consequences of failure are too high.

Principal-agent theory can be applied to the buyer-supplier relationship that exists in defense acquisitions, as well as to the sponsor-developer relationship that exists between Congress and DoD. Agents are responsible for accomplishing the work, but have more information about the uncertainties of execution than the principal. Program managers (PM) can find themselves acting as both a principal and an agent. When reporting to Congress, OSD, and the Defense Acquisition Board (DAB), the PM acts as the agent, providing information on the status of the work (cost, schedule and performance) through programmatic reviews. When dealing with the contractor or supplier, the PM plays the role of the principal, receiving information through technical reviews. The relationships are illustrated in Figure 2.

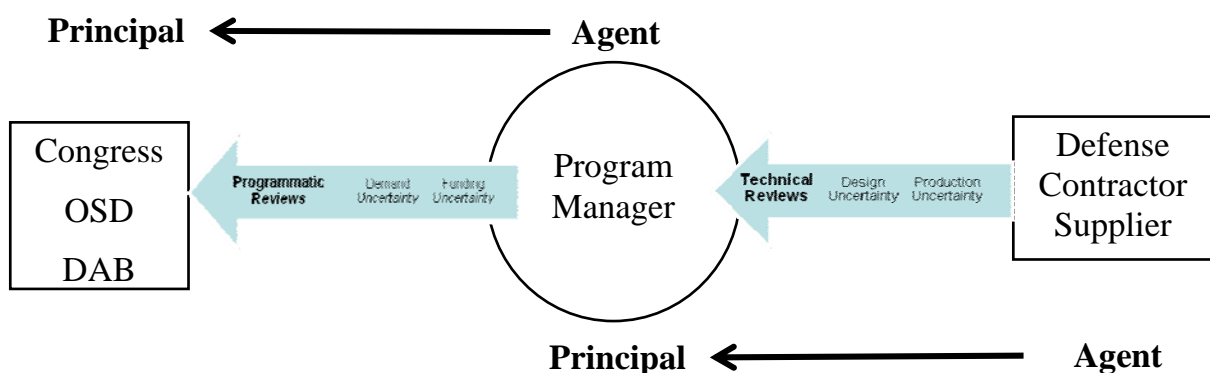


Figure 2. Principal-agent Relationships in DoD Acquisitions



As can be seen in Figure 2, the PM must respond to many principals. The existence of multiple principals strongly indicates that not all the principals will agree on goals. Goal conflict among principals makes the relationship between principals and agents exceedingly complex (Waterman & Meier, 1998). Each of the principals (Congress, DOD, and the military services) has created an intricate web of laws, directives, and organizations to control the agents' actions. Acquisition reform efforts have focused on altering these rules and organizational roles, including increasing the authority of certain players in the acquisition process to alter the incentives. In particular, reformers designed initiatives to increase the information flow to the principals and to improve the quality of the information (Biery, 1992).

TCE assumes that economic actors—say government “principals” and defense industry “agents” in an outsourcing relationship—are motivated to look ahead, recognize potential hazards, and factor these into contracts or organizational design. The challenge is to design contracts, incentive schemes, monitoring and enforcement mechanisms, and to adopt other governance arrangements (property rights, reputation, bonding, warranties, etc.) that allow for credible commitments ex-ante and that promote mutual compliance ex-post (Williamson, 1983). Prendergast (1999) provides a valuable overview of principal-agent models that highlights the costs and consequences of various incentive mechanisms designed to address internal coordination and motivation issues.



III. The Program Manager's Perspective

A. Program Oversight

As noted earlier, the Department of Defense, for the most part, commissions external suppliers to conduct projects for its internal use, including the development and production of major weapon systems. Naturally, there are transaction costs associated with these relationships such as search, information, decision, contracting, measurement, monitoring, and enforcement costs.

DoD relies on a cadre of military and civilian officials—known as program managers—to lead the development and delivery of hundreds of weapon systems and subsystems. The systems that program managers are responsible for range from highly sophisticated air-, land-, sea-, and space-based systems to smaller, less complex communications or support equipment that interconnects or supports larger systems. Program managers are responsible for assuring that these systems are reliable, affordable, supportable, and effective. They carry out multiple roles and responsibilities and are expected to have a working knowledge in such diverse areas as contracting, budgeting, systems engineering, and testing (GAO, 2005).

In addition to reporting to Congress, OSD and the DAB and monitoring the contractor or supplier (as shown in Figure 2), program managers must also work with other organizations that can influence the success of their program. These organizations include the Cost Analysis Improvement Group (CAIG) at OSD (which provides independent cost estimates to overcome moral hazard issues), the developmental and operational test centers, the budgeting and comptroller organizations that work with funding, the ultimate user of the weapon system (the warfighter that defines the desired capabilities), as well as other organizations, including other services interested in joint interoperability issues.



As shown in Figure 1 above, program managers report to a Program Executive Officer (PEO)—a civilian at the senior executive level or military officer at the general officer rank—who typically manages a portfolio of related weapon systems. The PEO reports to the Service Acquisition Executive (SAE), a civilian (often a political appointee) who reports to the service Secretary. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD/AT&L) is the Defense Acquisition Executive (DAE) with full responsibility for supervising the performance of the DoD Acquisition System. As the chair of the Defense Acquisition Board (DAB), USD(AT&L) is the final decision authority for major defense acquisition programs. DoD classifies acquisition programs into categories based upon a number of factors such as their size, cost, complexity and importance. Table 1 shows the major defense acquisition categories along with the corresponding decision authority.

Table 1. Major Defense Acquisition Categories (FY2000 dollars)
(DoD, 2008, December 8).

Acquisition category	Definition	Decision Authority
Category I	Research, development, test, and evaluation > \$365M Procurement > \$2.19B	1D: USD(AT&L) 1C: Head of DoD Component or, if delegated, the Component Acquisition Executive (CAE)
Category II	Research, development, test, and evaluation > \$140M Procurement > \$660M	Component Acquisition Executive or individual designated by CAE
Category III	No fiscal criteria	Designated by CAE

In 2005, GAO conducted a survey of acquisition category I and II program managers to gather information about their perceptions of factors that assist or block their success and to help define other issues in the DoD acquisition process that affect program manager effectiveness. According to the GAO, many program managers expressed frustration with the time required of them to answer continual



demands for information from oversight officials—many of which did not seem to add value. Some program managers, in fact, estimated that they spent more than 50% of their time producing and tailoring and explaining status information to others. More broadly, many program managers and program executive officials said that they did not believe that DoD’s acquisition process really supported or enabled them. Instead, they viewed the process as cumbersome and the information produced as non-strategic (GAO, 2005).

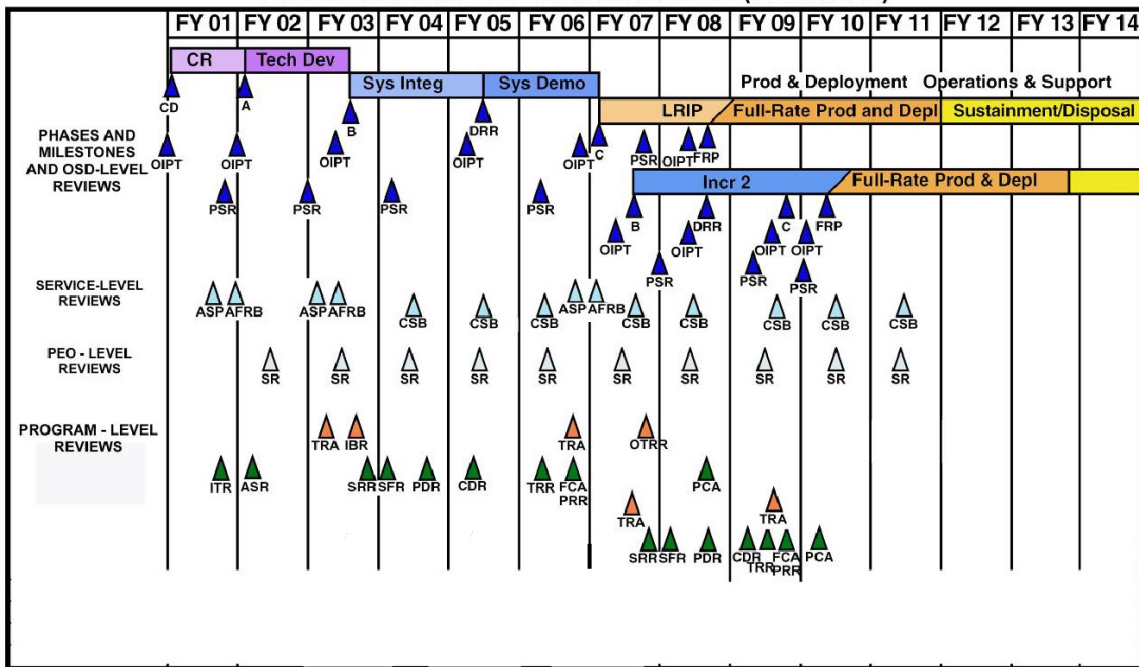
In addition, GAO found that program managers believe that they are not sufficiently supported once programs begin. In particular, they believe that program decisions are based on funding needs of other programs rather than demonstrable knowledge; they lack tools needed to enable them to provide leadership consistent with cost, schedule and performance information; they are not trusted; they are not encouraged to share bad news; and they must continually advocate for their programs in order to sustain DoD commitment (GAO, 2005).

B. Program Reviews

The DoD acquisition process is based on a series of milestone decisions that are supported by different levels of program reviews intended to give the program manager and DoD leadership the information they need to make decisions. Table 2 illustrates the review process over the life of an acquisition program.



Table 2. Example of the Timing and Levels of Reviews over the Life of a Defense Acquisition Program



Note: CD = Concept Development, CR = Concept Refinement, A, B & C = Milestone A, B & C, LRIP = Low Rate Initial Production, FRP = Full Rate Production (see appendix for a review of applicable acronyms)

In a study examining the various iterations of the *DoD 5000 Series* regulations governing acquisition programs, Dillard (2005) noted that both the number and level of reviews conducted over the years have increased substantially, particularly when taking into account the array of pre-briefs and informational meetings held in support of the formal reviews. He observed that program reviews of any kind at the OSD level have a significant impact on program management offices. Much documentation must be prepared and many preparatory meetings are conducted before the ultimate review. And while efforts to prepare for non-milestone reviews are generally considered to be lesser in scope, a considerable amount of effort managing the decision process is still expended by the program manager.



These findings were confirmed in a recent study commissioned by the Air Force (NRC, 2009). A committee of the National Academy of Sciences—which included one of the co-authors of this report (John Dillard)—found that the number of program reviews is growing and that the reviews “most certainly” add to program costs. Of most concern to the committee was that “the proliferation of reviews does not appear to have had a positive effect on program cost and schedule outcomes.” The committee also recognized that there is a significant amount of preparation and coordination required for reviews—both vertically in their conduct at multiple levels of responsibility, and horizontally across adjacent staff offices.

The program manager plays a central role in the acquisition process, participating in all reviews (and pre-briefs) for multiple principals. All of the reviews, both formal and informal, must be supported by the program management office and require substantial resources. Not only government resources are expended in preparing and presenting reviews, but often contractor personnel are involved as well. Although each individual review is intended to serve a specific purpose, the overall magnitude of the review efforts not only significantly increase the workload of the program office in terms of direct support, but also divert attention from day-to-day management of the program (NRC, 2009).

There are two basic categories of program reviews: technical and programmatic. Technical reviews are focused on the performance of the system being acquired, while programmatic reviews are more oversight in nature.

The Defense Acquisition University (DAU) defines a technical review as an event at which the progress of the technical effort is assessed relative to its governing plans and technical requirements. Technical reviews are key decision events used to measure technical progress and maturity in system development. *DoD Instruction 5000.02*, Enclosure 12, paragraph 4 (DoD, 2008, December 8), directs that technical reviews of program progress be event driven and conducted when the system under development meets the review entrance criteria as documented in the Systems Engineering Plan.



The *Interim Defense Acquisition Guidebook* (DAU, 2009), chapter 4, section 4.3.3.4, lists the following technical reviews as part of the systems engineering process:

- Technology development phase:
 - System Requirements Review
 - System Functional Review
 - System Preliminary Design Review
- Engineering and manufacturing development phase:
 - Integrated Baseline Review
 - Critical Design Review
 - Test Readiness Review
 - Flight Readiness Review
 - System Verification Review
 - Functional Configuration Audit
 - Production Readiness Review
 - Technology Readiness Assessment

Technical reviews serve as forums for problem discovery and assessment of technical progress toward system performance goals. Sharing of information horizontally is key in these integrative reviews. They are typically chaired by the program manager and conducted locally—often in the prime or system contractor location—and are scheduled and conducted at the program manager’s discretion when appropriate (event or progress-based vs. calendar-based). Technical reviews are also used as oversight tools by the program manager (as principal) to monitor the technical progress of the system prime contractor and subcontractors (agents).

DAU defines “programmatic” as pertaining to the cost, schedule, and performance characteristics of an acquisition program (2005). This definition would distinguish programmatic reviews from technical reviews in that technical reviews are primarily concerned with performance issues of the system, while programmatic reviews are concerned with the performance of the acquisition process. Programmatic reviews can be thought of as those reviews dealing with non-technical issues such as cost, schedule, budget, quantities, contracts and program management, as well as performance. Programmatic reviews consider performance



issues, but at a higher level and in the context of the overall program management process.

Although programmatic reviews are often scheduled and conducted according to prearranged milestone dates or per an “acquisition baseline” established by program manager and multi-level staffs well in advance, they can be held “on call” or ad hoc as program issues arise. They are formal in nature, convened and chaired by higher echelons (program executive officer, service-level acquisition executive, Office of the Secretary of Defense staff, and Milestone Decision Authority/Defense acquisition executive), and information within them flows vertically. Programmatic reviews are designed to inform key staff members in the Pentagon and Congress (the principals) about the business and technical progress of programs. Decisions based on programmatic reviews can determine the fate of a program—allowing it to proceed on course, sometimes directing a change in course, or in some cases, catalyzing the termination of the program. These types of reviews have increased significantly in both frequency and in their level of management oversight.

In 2005, GAO noted that DOD program managers operate under many layers of oversight—both internally and externally. While much of the oversight is necessary for carrying out stewardship responsibilities for public money, GAO’s researchers pointed out that studies conducted by a variety of commissions assessing acquisition problems through the years have consistently found that there are opportunities to reduce oversight layers and streamline oversight processes. Program managers (as agents) understand the need for oversight, but responding to oversight demands can take too much of their time. The next section discusses the findings of a recent study that tried to address the same issues.



C. National Research Council Survey

In 2008, the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering asked the National Research Council (NRC) to (1) review and assess the increasing number of prescribed program reviews and assessments that US Air Force space and non-space acquisition programs in all Department of Defense (DoD) acquisition categories are required to undergo, and (2) to recommend ways to improve the effectiveness and efficiency of those program reviews in terms of their goals, objectives, content, and requirements. The Committee on Optimizing US Air Force and DoD Review of Air Force Acquisition Programs was formed in May 2008 to conduct this review (NRC, 2009).

The committee was asked to address a key question: Can changes in the number, content, sequence, or conduct of program reviews help program managers more successfully execute their programs? Specifically, the committee was tasked by the Air Force to: review the program management and the technical reviews and assessments that US Air Force space and non-space system acquisition programs are required to undergo; assess each review in terms of resources required and its role and contribution; identify cases in which different reviews have common or overlapping goals, content, or requirements; identify and evaluate options for streamlining, tailoring, integrating, or consolidating reviews of programs to increase cost-effectiveness and to lessen the workforce impact of the reviews as a whole; and recommend changes that the Air Force and the Department of Defense should make.

Because data and metrics on program reviews are not collected by DoD, the committee was unable to determine the overlap or duplication of different reviews. The committee was also unable to determine specific resources required to accomplish each review, although answers to the survey and information gathered from the interviews suggested that 10-30% of a PM's time is spent supporting reviews.



The committee gathered information from presentations, interviews, and previous studies. It also developed a detailed qualitative survey that went out to over 80 USAF program managers to gauge their participation in and overall assessment of both programmatic and technical reviews, focusing upon the value as well as the costs of reviews.

In surveys and interviews conducted by the GAO in 2005, program managers and program executive officers frequently commented that they spend too much time preparing data for oversight purposes that are not strategic or very useful to them. GAO noted that more than 90% of survey respondents said they spent either a moderate, great, or very great extent of their time representing their program to outsiders and developing and generating information about program progress.

After reviewing studies conducted over the past decade, the committee reported that it could find no evidence of earlier work that focused on the impact of the overall formal and informal review process on the acquisition system in terms of resources spent by the program office or the effect of diverting a program manager's attention from the day-to-day management of his or her programs. Accordingly, the committee decided to examine the costs of reviews in terms of the amount of time the program manager spends supporting reviews.

The committee surveyed Air Force PMs and PEOs to collect quantitative and qualitative information on the impact of external reviews on program execution—including the time and effort spent preparing for, participating in, and following up on actions resulting from tasks from higher-level AF and OSD reviews—that would not otherwise have had to be spent for the purpose of good program management. The survey also asked about PM and PEO assessments of the value of the reviews.



The survey was divided into four sections:

- Section 1: Demographic Data (information on program manager and program)
- Section 2: Program Activity Overview (information on pertinent external reviews/reporting accomplished by the program)
- Section 3: Questions on Specific Reviews (information on time/effort spent on specific reviews/reporting accomplished by each program manager taking the survey)
- Section 4: Optional Section (to comment on streamlining, tailoring, integrating and consolidating opportunities)

The committee concluded that there may not be sufficient data to permit a quantitative response to the key question raised in the summary—namely, can changes in the number, content, sequence, or conduct of program reviews help the program manager more successfully execute the program? Instead, the committee made five recommendations which it believes will provide greater control of the review process.

D. Implications of Theory

Transaction cost economics and the principal-agent model suggest several interesting questions that might be addressed by analyzing the data gathered in the NRC PM survey:

1. Can we use the PM survey to quantify oversight and monitoring costs?
2. Is there a difference in the perceived cost/benefit of oversight and monitoring activities when the program manager acts as the:
 - a. Principal (technical reviews)?
 - b. Agent (programmatic reviews)?



This study attempts to answer these questions. In our analysis, we assume that subjective perceptions of relative cost/benefit of reviews provide useful insights into transaction costs. We start with the assumption that program managers are more likely to:

- View technical reviews as less costly/more beneficial
- View programmatic reviews as more costly/less beneficial

The results of our analysis are presented in the next section.



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IV. Data Analysis

A. Survey Data

The data used for this analysis is based on responses to the AF NRC Program Manager Survey (NRC, 2009). The only data available from the survey report is in summary form (i.e., the total response count for each question is available but not the individual responses). We limited our analysis to Section 2 of the survey—Program Activity Overview—which provided information on pertinent external reviews/reporting accomplished by programs. This was the only section of the survey that lent itself to meaningful analysis given the limitations of summarized data.

Each of the questions selected for our analysis lists the nine reviews in Table 1 and asks the respondent to answer in terms of those reviews. Survey participants were also allowed to write-in other reviews, but to make the data more comparable, we did not use the write-in answers in our analysis. We divided the survey data into two categories: technical reviews and programmatic reviews (as shown in Table 3).



Table 3. Technical and Programmatic Reviews

Technical	Programmatic
Technology Readiness Assessment (TRA)	Defense Acquisition Board (DAB) Milestone Review
Technology Maturity Assessment (TMA)	Defense Space Acquisition Board (DSAB) Milestone Review
Manufacturing Readiness Review (MRR)	Defense Acquisition Board (DAB) Status Review
System Engineering Assessment Model (SEAM)	Defense Space Acquisition Board (DSAB) Status Review
	Overarching Integrated Product Team (OIPT) Review
	Independent Program Assessment (IPA) *
	Program Support Review (PSR)
	Logistics Health Assessment (LHA)
	Air Force Review Board (AFRB)

* The AF study categorized IPA as technical, but our subject-matter expert felt that the IPA had enough business aspects to be more accurately characterized as Programmatic.

The questions selected for our analysis are the following:

- 2.2 For each of these major program reviews/assessments that your program experienced, indicate your assessment of their impact on program performance (i.e., cost/schedule/ technical performance accomplishment)?
- 2.2a Which single review had the greatest positive impact on program performance?
- 2.4 Higher-level HQ AF/OSD reviews/assessments provide senior leaders information that is necessary for their understanding of program performance, to fulfill their oversight role. Please rate each of the reviews that your program experienced in terms of how effective you believe the structure/format of the review was at providing useful data to the senior AF and OSD leadership.
- 2.5 From the list below, identify the three higher-level HQ AF/OSD reviews/reporting activities that you believe have the LEAST beneficial impact on program performance. *Respondents indicated the least, second-least and third-least beneficial.*



- 2.7 From what you know from any source, identify the program reviews that have the highest potential to be combined into a single useful review. *Respondents were asked to select from the list of reviews in Table 1 and use the write-in section to show the pairings/groupings. Only a few of the respondents used the write-in section, so it was not part of our analysis.*
- 2.12 For the following major reviews, please indicate your opinion about whether the documentation required by higher authorities to support each of the following reviews is Insufficient (In), About Right (AR), Excessive but Decreasing (E-D), Excessive and Steady (E-S), Excessive and Increasing (E-I). *For purposes of our analysis, E-D, E-S and E-I were grouped into one category: Excessive.*

B. Hypotheses

The following hypotheses are tested (the survey question corresponding to each hypothesis is shown in parentheses):

1. The perceived value (impact) of technical reviews is higher than the value of program reviews. (2.2 and 2.2a)
2. Technical reviews are more likely to be rated as helpful (provide useful data) than program reviews. (2.4)
3. Technical reviews are more likely to be perceived as beneficial than program reviews. (2.5)
4. Technical reviews are more likely to be perceived as well structured (less likely to be combined with other reviews) than program reviews. (2.7)
5. The perceived cost (level of documentation required) of program reviews is significantly higher than the cost of technical reviews. (2.12)

C. Statistical Analysis

The proportions (relative frequency) of responses in the two categories (technical and programmatic) are examined in two ways:

- a) A Chi-squared test is performed on the contingency table for each question (where applicable) to determine if the counts in the rows (answers) and columns (review type) can be considered independent.



- b) A z-test of the difference between the proportions in each category is used to determine if there is statistically significant difference in the proportions at the .05 level. A one-tailed test is used to determine if the proportion of technical responses is significantly higher than the proportion of programmatic responses. The one-tailed test of the reverse (proportion of programmatic responses is greater than technical responses) is also shown.
- c) A z-test of the difference between the proportion of technical responses vs. the expected frequency (based on the number of technical reviews in the survey, 4 out of 13 or $p = .3077$) is used to determine if the level of responses is statistically significant at the .05 level.

The results of the tests are summarized in Table 4.

Table 4. Summary of Statistical Test Results
(Aggregated responses are shown in italics)

Question		Technical	Programmatic	Chi-2 p-value	one-tailed T>P p-value	one-tailed P>T p-value	one-tailed T>4/13 p-value
2.2				0.0939			
	Positive Impact	20	46		0.8402	0.1598	0.5328
	No Impact	27	34		0.0205	0.9795	0.0112
	Negative Impact	5	18		0.9216	0.0784	0.8260
	<i>Positive or No Impact</i>	47	80		0.0784	0.9216	0.0639
2.2a		10	27				0.3955
2.4				0.0907			
	Lots of Useful Data	14	25		0.3720	0.6280	0.2439
	Some Useful Data	19	58		0.9892	0.0108	0.8767
	Little Useful Data	14	18		0.0912	0.9088	0.0558



Question		Technical	Programmatic	Chi-2 p-value	one-tailed T>P p-value	one-tailed P>T p-value	one-tailed T>4/13 p-value
	No Useful Data	9	9		0.0611	0.9389	0.0386
	<i>Lots or Some Useful Data</i>	33	83		0.9859	0.0141	0.7060
	<i>Little or No Useful Data</i>	23	27		0.0141	0.9859	0.0098
2.4A				0.0572			
	Lots of Useful Data	8	31		0.9754	0.0246	0.9174
	Some Useful Data	19	44		0.7571	0.2429	0.5419
	Little Useful Data	12	14		0.0640	0.9360	0.0446
	No Useful Data	12	13		0.0445	0.9555	0.0310
	<i>Lots or Some Useful Data</i>	27	75		0.9946	0.0054	0.8266
	<i>Little or No Useful Data</i>	24	27		0.0054	0.9946	0.0500
2.5				0.4382			
	Least Beneficial	17	23		0.5014	0.4986	0.0540
	Second-least Beneficial	18	18		0.8657	0.1343	0.0062
	Third-least Beneficial	13	24		0.1353	0.8647	0.2825
	<i>Least or second-least</i>	35	41		0.1353	0.8647	< 0.0001
2.7		66	74				< 0.0001
2.12				0.1997			
	Insufficient	6	5		0.0650	0.9350	0.0438
	About Right	42	76		0.2542	0.7458	0.1281
	Excessive	40	94		0.8969	0.1031	0.5912
	<i>Insufficient or About Right</i>	48	81		0.1031	0.8969	0.0565



D. Results of Statistical Analysis

The significant results of the analysis are discussed for each of the questions:

- 2.2 Technical reviews are significantly more likely to be seen as having no impact on program performance and are somewhat less likely to be seen as having a negative impact on program performance.
- 2.4 There were two set of responses for question 2.4 (both are shown in Table 2). Both sets indicate that programmatic reviews are significantly more likely to be seen as providing some or lots of useful data, while technical reviews are significantly more likely to be seen as providing little or no useful data.
- 2.5 Of the reviews identified as being least or second least beneficial, the proportion of technical reviews is significantly higher than expected based on the number of technical reviews in the survey—indicating that technical reviews are more likely to be seen as least or second-least beneficial.
- 2.7 Of the reviews identified as having the highest potential for being combined into one review, the proportion of technical reviews is significantly higher than the proportion of technical reviews in the survey—indicating that technical reviews are more likely to be identified as candidates for consolidation.
- 2.12 Of the technical reviews identified as requiring insufficient documentation, the proportion of technical reviews is significantly higher than the proportion of reviews in the survey—indicating that technical reviews are more likely to be seen as not having enough documentation.

E. Interpretation of Results

Based on our initial analysis, we can draw the following conclusions from the test results:

- 1. Program managers do not see significantly more value in technical reviews than they see in programmatic reviews. However, they do seem to feel that technical reviews are somewhat less harmful (have less of a negative impact on program performance) than programmatic reviews. When acting as principals in technical reviews, they probably see the review as necessary for making sure the program stays on course; thus, it should have a positive impact on program performance.



On the other hand, the programmatic reviews may be more likely to reveal negative information such as cost overruns or schedule delays that have a negative impact on program performance. In addition, when they are acting as agents providing information to senior leadership, the program managers may feel that programmatic reviews are more likely to expose the program to higher-level criticism or interference.

2. Program managers were asked to rate the usefulness of information provided by reviews to senior leaders. Thus, they answered question 2.4 from the perspective of the senior leadership. From this perspective, it makes sense that senior leaders would find programmatic reviews more useful and technical reviews less useful. Senior leadership is more interested in the overall program performance, including cost and schedule as well as technical issues. At the higher levels of OSD and AF, the technical issues are left to the program manager to fix; they only become important when they significantly impact the overall performance of the program.
3. In terms of reporting to higher-level authorities, program managers see technical reviews as providing less benefit to their programs. This makes sense given the previous finding that the information provided by technical reviews is less useful to senior leaders than the information in programmatic reviews. Less-useful data leads to lower impact and less benefit to the program.
4. Given that program managers see the information in technical reviews as being less useful to senior leaders, it makes sense that they would identify more technical reviews as those needing to be consolidated—perhaps to increase the usefulness of the information provided, or perhaps to simply reduce the amount of information reported and make the reviews more efficient.
5. Program managers believe higher-level authorities do not require sufficient documentation for technical reviews. This may be related to the usefulness of the information. Perhaps more documentation is required to properly explain and illustrate the technical issues so that higher-level authorities can fully appreciate them. Or it may be that program managers are much more involved in managing the technical issues and, therefore, are more aware of ways to document and support technical reviews vs. programmatic issues.



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V. Conclusion and Further Research

This study continued ongoing efforts by the authors to understand and measure transactions costs within DoD acquisitions. The principle-agent model was presented to help understand the program manager's role in defense acquisitions. We analyzed data from an NRC survey of USAF program managers to gain insights into oversight and monitoring costs both when the program manager acts as a principal and as an agent.

One of the interesting observations from our analysis of the NRC survey was that program managers found some real value in some of their programmatic reviews, despite the fact that such reviews are usually viewed as excessive and burdensome levels of oversight. While surely much will be relative to individual project circumstances, program managers may find themselves genuinely pleased and relieved when such reviews are over and the needed decisions have been obtained. Insofar as they may be spending more time on the decision bureaucracy than overseeing the technical and business efforts of their program, this management of government requirements and resources is, nonetheless, essential to program success. Thus, when bureaucratic reviews for decision-making become as critical as other items of scope in the project, they can easily be perceived as valuable when completed. In essence, programmatic reviews (being off-core activities to the more central scope of the project) evolve into actual scope—with a budget (or at least a cost) and a schedule to accomplish each review, and with measures of performance (or effectiveness) dependent upon their outcome.

The lesser value given to technical reviews was counterintuitive. Our expectation was that since program managers use the information in technical reviews on a day-to-day basis, they would find such reviews more useful than programmatic reviews. A possible explanation is that they are typically deliverable products under the program's system development contract, and the measure of quality in performance might vary between programs depending upon how much



emphasis the government-industry management team applies to them. While the program manager typically chairs each review, the presentations are made by the system prime contractor and his subcontractors. If, in fact, technical reviews serve to usefully inform the development team at the various points at which they are conducted, they will have served their intended purpose. But if, in fact, the reviews are conducted as mere formalities to “check the block” on their fulfillment, they will be regarded as such—particularly if the program manager is well aware of the issues presented.

Unfortunately, we were not given access to the raw data gathered through the NRC survey, only summarized responses. Without the raw data, it was impossible to analyze important information about specific reviews gathered in Section 3 of the survey. Section 3 asked the respondent to answer more questions for a selected review (based on answers to Section 2). This is the most interesting set of answers, but basically useless in summary form because a reader can’t determine to which review the answers correspond.

The raw data would allow us to do further research into the cost/benefit of specific reviews—such research may provide insights into the effectiveness of incentives and the principal-agent relationships in DoD acquisitions.



Review Acronyms

AFRB	Air Force Review Board
ASP	Acquisition Strategy Panel
ASR	Alternative System Review
CDR	Critical Design Review
CSB	Configuration Steering Board
DRR	Design Readiness Review
IBR	Integrated Baseline Review
ITR	Initial Technical Review
FCA	Functional Configuration Audit
OIPT	Overarching Integrated Product Team
OTRR	Operational Test Readiness Review
PDR	Preliminary Design Review
PSR	Program Support Review
SFR	System Functional Review
SR	System Review
SRR	System Requirements Review
TRA	Technology Readiness Assessment
TRR	Test Readiness Review



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