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Behavioral Biases within Defense Acquisition

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Behavioral Biases within Defense Acquisition

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Abstract

This paper contributes to the process of building knowledge about what we term as *behavioral acquisition*, which explores defense acquisition from a behavioral standpoint, including the impact of psychology, organizational behavior, and politics. Behavioral acquisition studies the decisions acquisition professionals make in Department of Defense (DoD) acquisition programs. The paper focuses on one aspect of these decision processes in the defense acquisition environment: behavioral biases. In three defense acquisition programs studied, we find strong evidence that planning fallacy, difficulty in making trade-offs, over-optimism, and recency bias affected the management and decision-making within these programs. This research helps us better understand and predict how acquisition professionals and senior leaders think and make decisions about program strategy, managing resources, and leading people. A key element in this perspective is that important insights into these decisions derive from models in which agents are not fully rational. Behavioral acquisition is analogous to behavioral finance, which has successfully applied social science theories—especially from psychology—to improve the accuracy of predictions about the behavior of actors across the entire financial landscape.

Keywords: behavioral acquisition, systemic biases, program management, decision making, defense acquisitions, culture, leadership, hierarchies

Introduction

Program managers (PM) are at the center of the defense acquisition process, yet there are substantial gaps in our knowledge about how PMs actually make decisions about the programs they manage on behalf of the defense community. Given the size of the defense acquisition portfolio in the United States, better knowledge of the intricacies of decision-making by PMs might be highly valuable for informing improvements in defense acquisition processes in the future, including for PM training and education. This paper contributes to the process of building knowledge about what we term as *behavioral acquisition*, which explores defense acquisition from a behavioral standpoint, including the impact of psychology, organizational behavior, and organizational politics.

Our paper focuses on one particular aspect of these decision processes in the defense acquisition environment: behavioral biases. These biases can be categorized into cognitive and emotional biases, but their common root is in the ways in which human brains use their limited capacities to process information. The results are decision-making capabilities that are, at times, stunning in their elegance and effectiveness in real world environments (Gigerenzer et al.,1999; Klein, 2009) and, at other times, shockingly flawed and error prone (Kahneman et al., 1982). That both outcomes are possible is one of the geniuses of the human brain. We provide a detailed treatment of four well-known behavioral biases and their scope to occur in acquisition programs. We examine the scope issue by doing a deep-dive into three significant acquisition programs using a case study-based approach to determine whether there is prima facie evidence that behavioral biases play a role in decision-making in acquisition programs. The programs are

- Enhanced Combat Helmet (ECH) program: Joint rapid acquisition effort executed in response to urgent warfighter needs leveraging new technologies.
- Joint Common Missile (JCM) program: Joint major defense acquisition program executed as a development effort with a deliberate acquisition approach with approved requirements.
- Ground Combat Vehicle (GCV) program: Service-specific major defense acquisition program executed as a development effort with a deliberate acquisition approach with approved requirements.

A key observation we make is that there is a lack of research studying the effects of behavioral biases on decision-making in the defense acquisition environment. Kiesling and Chong (2020) studied decision biases within acquisition programs by tracing the presence of keywords indicating specific biases from Government Accountability Office's (GAO) summary documents of the acquisition programs. However, the research did not study primary source program data (Kiesling & Chong, 2020). Therefore, at this point, it is sensible to motivate research on this topic with two basic questions: (1) How do behavioral biases affect decision-making in acquisition programs? And (2) to what extent do behavioral biases affect acquisition outcomes? The three acquisition programs studied were all wide-open to bias creeping into them in the forms of the planning fallacy, difficulty in making trade-offs, over-optimism, and recency bias. What the empirical cases illustrate best is that acquisition programs are environments where there is abundant opportunity for behavioral biases to play a significant role in decision-making; they are a perfect setting where one would expect to see these biases occurring. Furthermore, in some instances, the data is more suggestive. Not only was the opportunity in place, but there is at least some evidence that these biases were playing a role in program decision-making in ways that probably affected program outcomes. The data here is circumstantial but, when pieced together, the fact-pattern is suggestive of this conclusion. We cannot say anything more definitive than this based on the case data we have available, but certainly the patterns we see are consistent with biases playing a role.

It is worth pointing out that in our study we focused on the setting in which real acquisition managers do their work rather than the acquisition manager role in the abstract. This means we look at the acquisition challenge of juggling performance, schedule, and budget from a pragmatic perspective rather than as some kind of abstract rational optimization game. Recent acquisition reform directives and statutes require data-driven analysis and decisions, which put an emphasis on rational optimization. But whatever technologies of analysis are the fad or fashion of the day (and in the defense acquisition profession there have been many, over the years) decision-making inevitably still consists of boundedly rationally individuals operating inside a collective entity (a program) trying to make better decisions that deliver improved organizational outcomes (Levinthal, 2018). Hence, despite calls for more rationality, the organizational and political dimensions of decision-making still matter very much, and we shall see that these dimensions interact with behavioral biases in particular ways.

Background and Literature Review

Defense Acquisition Overview

Defense acquisition professionals facilitate the development, testing, procurement, and fielding of capability to warfighters. The program manager (PM) is at the center of defense acquisition, whose purpose is to deliver warfighter capability. The PM is responsible for cost, schedule, and performance (commonly referred to as the "triple constraint") of assigned projects—usually combat systems in the Department of Defense (DoD). The PM has a hierarchal chain of command (or authority) through the DoD in the executive branch. PMs report directly to a program executive officer, who reports to the service acquisition executive (an assistant secretary for that service—either Army, Navy or Air Force), and who reports to the defense acquisition executive (the Under Secretary of Defense for Acquisition and Sustainment). Depending on the program's visibility, importance and/or funding levels, a program's milestone decision authority (MDA) is assigned to the appropriate level of the chain of command.

Programs within defense acquisition require resources (primarily funding) and contracts (for execution of work) with industry. Congress provides the resources for the defense programs through the annual enactment of the defense authorization and appropriations acts, which become law and statutory requirements. The PM, through warranted contracting officers, enters contracts with private companies within the defense industry. As a backdrop to this complex acquisition environment for PMs, three decision support templates exist to guide programs: one for the generation of requirements, a second for the management of program milestones and knowledge points known as the Adaptive Acquisition Framework (often referred to as little "a"), and a third for the allocation of resources. Each of these decision support systems is fundamentally driven by different and often contradictory factors. The requirement generation system is capability needs-driven based on an evolving threat—requiring a responsive acquisition system. The resource allocation system is calendar-driven, with Congress writing an appropriations bill and the president signing the bill every fiscal year—providing control of funding to Congress and transparency to the public and media for taxpayer money. The Adaptive Acquisition Framework is event-driven by milestones—based on commercial industry best practices of knowledge points and off–ramps supported by the design, development, and testing of the systems as technology matures and integration and manufacturing challenges occur. The combination of the PM triple constraint, chain of authority, acquisition environment, and decision support templates provides a framework to view U.S. defense acquisition, referred to as the Defense Acquisition Institution (or big "A") and depicted in Figure 1.

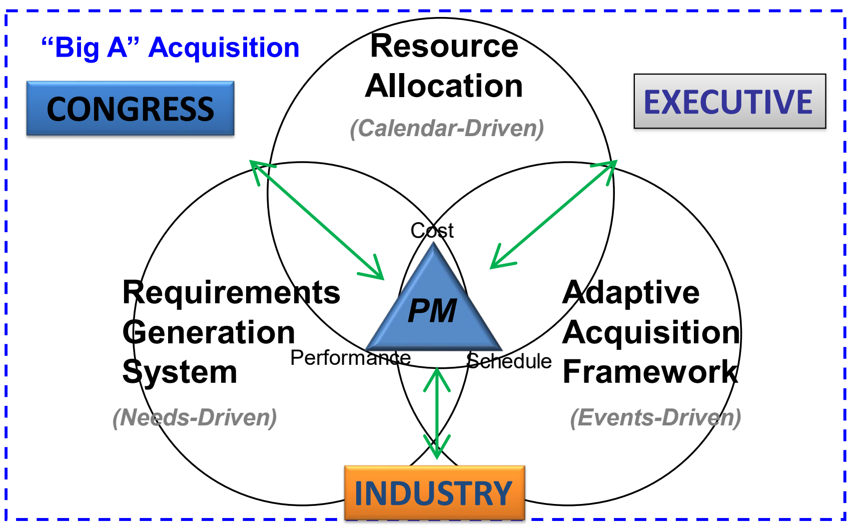

Figure 1. Defense Acquisition Institution or Big "A"

Due to the inherent complexity of the development, procurement, and fielding of sophisticated weapons systems that are required to operate reliably in challenging military environments, acquisition programs often fail to deliver required performance capabilities within cost and schedule constraints. Root causes of acquisition program failures (schedule slips, cost over-runs, or capability under-achievement) can be generally grouped into the following: ill-defined requirements, immature technology, integration challenges, poor cost estimating, unstable budgets, poor schedule planning, and schedule pressure from annual appropriation limitations. But an underappreciated reason for acquisition program failures and understudied part of big "A" is the "people part" of defense acquisition, which may have the largest effect on improving acquisition outcomes. Behavioral acquisition studies how acquisition professionals think, manage, and lead acquisition programs. Behavioral acquisition includes a study of organizations and hierarchies, and the intersection of individual behavior, leadership, culture and decision-making. In this study, we narrowly focus on how behavior biases affect acquisition decision-making at the institutional, organizational, and individuals levels. We recognize that decisions at the institutional level (DoD level) are often using a political conceptual model where decisions are a result of bargaining games. And decisions at the organizational level (Army level or PEO level) are based on the appropriateness of the actions fitting the organizations' cultural norms. Whereas at the individual level (program level), decisions use the rational conceptual model where decisions are based on logic and reasoning by assigning pros and cons (or risk and rewards) and deciding the best chance of success. We recognize that there may be important differences in how biases affect leader decision-making in organizations versus in institutions like the DoD. Figure 2 presents the overall model showing the connection of hierarchical, leadership, cultural, management, and behavior factors on decision-making and program outcomes. The model was adapted from the work of Shore (2000) who studied the effect of systemic biases within projects.

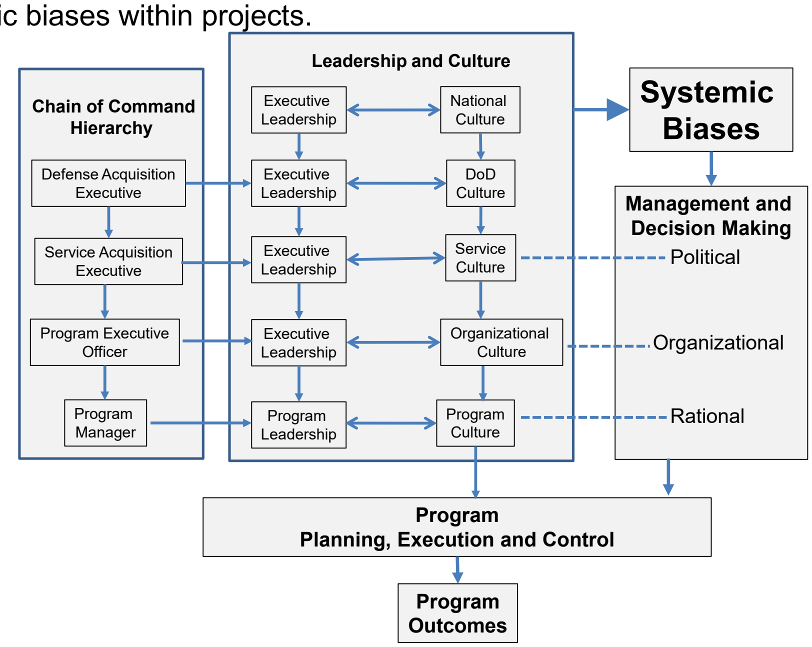

Figure 2. Connection of Hierarchical, Leadership, Cultural, Management, and Behavioral Factors on Decision-Making and Program Outcomes

Behavioral Biases Relevant to Defense Acquisition

Research centering on the acknowledgment and study of bounded rationality has long recognized that people process information in ways that may lead them to make biased judgments (Simon, 1955). Cognitive biases are a two-edged sword: On the one hand they have a positive function in helping people to make fast decisions using limited cognitive resources; on the other hand, cognitive biases also lead people to make errors in decision-making that deviate—often in important ways—from prescriptive (rational) decision-making. It is worth underlining that the baseline for making comparisons is important here: the identification of biases is based on comparisons to idealized "small world" rationality whereas in reality all decision-making is behavioral (Levinthal, 2011). Furthermore, research has also shown that at least some biases are driven by information presentation alone and may be mitigated by presenting information in ways that leverage the brain's information processing skills, rather than penalizing them (Gigerenzer, 1991). Nonetheless, a basic premise of research into biases is that as the volume and complexity of information increases, people are forced into using simplifying tactics that ration the limited cognitive resources they have available (Camerer, 2011). Hence. they adopt heuristics that ease the cognitive strain they experience. And because these heuristics involve rationing how information is processed (in a wide variety of ways) they develop systematic patterns of bias in decision-making, as compared to an ideally rational baseline (Kahneman et al., 1982).

Research on heuristics and biases is at this point a massive undertaking that has identified literally dozens of biases that people are predisposed towards (Kahneman, 2011). The objective of this paper is not to review them all but instead to focus on a handful of biases that illustrate the value of studying defense acquisition through an explicitly behavioral lens. Therefore, we focus on explaining four biases that have been widely studied in the literature under various guises: the *planning fallacy*, *over-optimism*, *recency bias*, and *difficulty making trade-offs*. These biases have different roots. Over-optimism and the recency bias are straightforwardly cognitive in nature, and their effects manifest in particular ways in acquisition programs. In contrast, the planning fallacy and difficulty making trade-offs are the result of how human cognitive factors interact with specific group and organizational processes. With all four biases, we are ultimately interested in how bounded rationality intersects with complex real world settings in ways that deviate substantially from what we might expect based on prescriptive rationality. We focus on these biases because the three defense acquisition programs we studied are wide open to being affected by all four of them.

Planning Fallacy

The planning fallacy addresses the unrealistic optimism about program management that numerous studies of program outcomes have documented across many decades in the defense, public and private sectors (Pressman & Wildavsky, 1984). Economic theory points to multi-level principal–agent issues as a key source of the gap between plans and outcomes. This leads economists to suggest that programs typically under-deliver because program managers have a vested interest in embellishing program projections to get programs approved through specific stage gates (Flyvbjerg et al., 2009). Within defense acquisitions, the Government Accountability Office (GAO) reported that PMs are incentivized to develop acquisition strategies focused on program approval at the milestone review but not acquisition strategies that could later be executed and deliver capabilities (GAO, 2015). There are also behavioral explanations for excessive optimism about programs, two of which we explain here: the planning fallacy, which occurs as the result of management practices, and dispositional optimism, which we discuss in the next section.

The main claim of the planning fallacy is that independently of other factors, planning processes themselves bias manager beliefs and lead them to make program forecasts that are too optimistic (Cassar, 2010). Of course, carefully planning projects is essential for good management and a legal requirement that establishes the acquisition program baseline of cost, schedule, and performance metrics. It is, therefore, problematic (and paradoxical) that planning induces a behavioral bias that actually undermines the intended outcome of planning. However, the explanation of this behavioral bias is quite simple. Planning processes lead managers to build an "inside view" of a project with detailed designs for the implementation of the project (Kahneman & Lovallo, 1993). These deep, well-explained designs enhance managers' perceptions of control over the project or program. Thus, they become more confident in the success of their plans (Heath & Gonzalez, 1995; Cassar, 2010). However, planning processes inevitably understate unpredictable events that will disrupt and delay the plan. Plans are always subject to the dreaded potential of "unknown unknowns" to intervene in what is otherwise carefully manicured expectations. Furthermore, the compound probability of even small individual disruptions can seriously undermine a program plan (Pressman & Wildavsky, 1984). Hence the fallacy of planning: it actually leads to control expectations and optimism that are unwarranted illusions when the context of programs is fully considered.

It is important to realize that the planning fallacy has deep roots in what are perceived to otherwise be good management practices, as well as in cultural characteristics that have their origins outside of project management. Control perceptions are central to these roots: managers are groomed to believe that their own actions substantially determine the results they get. Our accountability systems depend on these beliefs as well as their enforcement through bureaucratic oversight hierarchies. Program planning efforts are based on—and tend to reinforce—these idealized perceptions of control, resulting in managers typically perceiving they have more control over processes and outcomes than they have in reality. These control illusions may also lead them to believe they will avoid problems in a project or be able to easily overcome problems. What seem like good management practices may just compound the planning fallacy. For example, intuitively it seems like a good practice to focus intently on the specifics of a particular program, yet this tends to reinforce the "inside view" problem, which increases bias. Using incentives also seems like a good idea, yet research indicates that incentives also tend to encourage people to focus more intently on their plans, which increases bias (Buehler et al., 1997). In reality, the planning fallacy creates biased expectations that mask a control gap that will exact a price over the course of most programs.

Optimism Bias

In this section we discuss dispositional optimism, which is the tendency of individuals to see the world through "rose-colored glasses" or, more formally, their "tendency to expect positive outcomes even when such expectations are not rationally justified" (Hmieleski & Baron, 2009). The extant evidence suggests that in general individuals are over-optimistic, in the sense that their expectations for the future are more favorable than they will eventually experience (Cassar, 2010). Healthcare studies suggests that a degree of optimism bias is natural and healthy, since it tends to be correlated with psychological health and overall well-being. In other studies of the general population (Maltby et al., 2008), optimism has been found to be related to perceptions of luck (e.g., in global self-assessments luck beliefs are correlated strongly with optimism). Optimists *expect* good things to happen to them; they believe that chance events will break in their favor. Furthermore, when chance events happen, optimistic people tend to perceive them in a positive light. For example, optimists interpret an event such as narrowly avoiding an accident as lucky, whereas pessimists view the same event as unlucky (Hales & Johnson, 2018).

We don't know of any research that specifically examines the dispositional optimism of defense acquisition managers. However, we know that higher than average levels of optimism are present among individuals working in other domains that could broadly be construed as project or program management. For example, entrepreneurs are involved in start-up projects and studies have shown that on average entrepreneurs are distinctly over-optimistic, with some studies finding them to be off-the-scales on optimism (Hmieleski & Baron, 2009). Scholars have related these results to a willingness to initiate action, observing that individuals high in dispositional optimism are more willing to forge ahead in the face of daunting obstacles. This suggests a distinct selection bias in which optimism bias leads individuals to enter into activities for which they have little evidence to base beliefs about their eventual success (Meza & Southey, 1996). More difficult programs are more likely to attract more optimistic managers because these managers are more likely to believe everything will work out favorably for them, independently of having a plan to achieve success (Scheier et al., 2001). This suggests that some degree of optimism bias may be a prerequisite to becoming a program manager, with more difficult programs attracting the more optimism biased.

However, optimism is a double-edged sword. Research suggests that a curvilinear relationship between optimism and performance, with a distinct sweet spot. Individuals that are low in optimism believe that disaster awaits them in whatever they do. This makes them less likely to select into activities with uncertain outcomes in the first place and, if they are selected, it leads them to focus on negative information and have low motivation to complete tasks. On the flipside, over-optimistic individuals tend to focus only on positive information (they pick out good news stories), see positives in ambiguous situations (always look on the bright side), make suboptimal decisions such as setting unrealistic goals (the now infamous “stretch” goals), are less likely to learn from failure (i.e., update their beliefs), are more likely to persist with failing courses of action for longer periods (thus wasting resources) and be more at risk of escalation of commitment (another infamous problem in projects). Fundamentally these propensities tie optimism bias to less effective program performance. However, the extant evidence does also suggest that the same bias contributes positively to resiliency (Hmieleski & Baron, 2009).

Recency Bias

If you have ever had a project or presentation go badly right before your annual review is due, you already intuitively understand the recency effect: the widely recognized bias where recent data is given disproportionate emphasis in judgments (Beach & Connolly, 2005). Recency effects tend to occur when individuals process large amounts of information over time, which leads them to use heuristics to make judgments. This heuristic processing aids in sorting through the information but also introduces biases with regards to which information individuals pay the most attention. Because of this systematic variation in attention, with only a recent subset of all the available information getting the most attention, individuals make suboptimal decisions.

There are a number of explanations for why the recency effect occurs. It is more difficult to remember information that is older because of memory decay. In order to access or reconstruct information stored in memory, people rely of categorization processes. If information necessary for deciding has been stored in faulty or irrelevant categories, it may affect an individual’s ability to recall it. Over long time spans, these issues become more pronounced compared to the accessibility of recent information, which suggests that this bias worsens if recent information is processed alongside much older information. It is worth noting that social processes that legitimate newer as compared to older data as more relevant and worthy of consideration may add to recency effects deriving from individual bias. In these cases, the bias may derive from social, political, and organizational factors, as well as personal ones.

While we do not know of any study that has examined the recency bias in defense acquisition, there are relevant studies that investigate this bias in the management literature. Recency bias has been most studied by accounting scholars interested in the effects that information presentation has on accounting judgments. Researchers widely use Hogarth and Einhorn’s (1992) belief-adjustment model in these studies. The model proposes that people revise their beliefs using an anchoring and adjustment process. Current opinion is the anchor and new data potentially causes adjustments. In essence, the model suggests that when evaluating mixed information, individuals average the current piece of data and anchor. This results in more weight being placed on the latest information received (e.g., a recency effect). Accounting scholars find that many accounting judgments do seem to exhibit this effect, unless there is some mitigating factor. One review found that 21 out of 25 studies found some evidence of recency bias (Kahle, 2005). Studies have searched for factors that mitigate recency bias.

Some research has suggested that experience may mitigate recency bias but results of studies are inconclusive on this factor. Other studies (e.g., Kennedy, 1993) have found some support for accountability as a mitigating factor (e.g., recency effects are reduced when subjects are required to justify your decisions to others by explaining your reasoning in writing). These mitigating factors should be considered in understanding the complete effects of recency bias in the defense acquisition environment.

Trade-Offs Bias

Central to program management are trade-offs between program cost, schedule, and performance. Normative decision theory has proposed various methodologies for making such trade-offs by confronting them systematically and holistically, typically through some version of cost–benefit analysis. But as we already observed, the reality is that all decision-making is behavioral (Levinthal, 2011), and therefore models premised on idealized rationality quickly bump-up against the realities of bounded cognition in organizational settings, which is the setting in which defense acquisition processes actually have to work. Under these circumstances, it is germane to ask how acquisition managers actually make decisions. A basic understanding among behavioral researchers is that individuals avoid making trade-offs wherever possible (Slovic, 1975) because conflicting options are difficult to evaluate (Irwin & Davis, 1995). The lack of internal capability for judging trade-offs in the ways prescribed (e.g., by cost-benefit analysis) is a key reason that these analyses are typically externalized in the form of spreadsheets, diagrams, and tables (Clark, 2008). These “decision tools” often involve formulating trade-off criteria in numerical values, in order to make options easy to compare. This assists in making trade-offs that are otherwise too perplexing for individuals to make based on their cognitive capacities. However, behavioral research also notes that the assumptions made in financial models are also subject to biases (Lautliev & Menter, 2014).

Behavioral research suggests that individuals make trade-offs according to a different model: reason-based choice (Shafir et al., 1993). In this approach, individuals make conflicting choices easier to evaluate by constructing reasons for choices. If necessary, they make a list of reasons for choices (a relatively simple mental task) rather than trying to trade off costs and benefits across options (a much more complex mental task, typically significantly beyond human short-term memory limitations). By constructing reasons, individuals turn difficult-to-reconcile characteristics of options into a problem that is more readily comprehensible. Instead of making trade-offs, they use the heuristic approach of framing and re-framing an issue until they find a dominant option, which avoids the cognitive effort that real trade-offs require. In some cases, dominance may be based on a prominent attribute of the options. Hsee (1996) discusses how individuals find it easier to evaluate a good reason for purchasing an asset than whether they paid the right price for it, which is much harder to discern. If a good reason is not currently available for a choice, individuals may simply delay choosing or they may add other options that help clarify a dominant option. The essence of reason-based choice is that the human mind naturally prefers to find a dominant reason for a choice rather than delving into the complexities of cost-benefit analysis.

Furthermore, it is likely that reason-based choice may be even more important when groups are making decisions than when individuals make them. This is important in the acquisition world, since programs inherently involve numerous stakeholders and significant organizational oversight that means many decisions have to be justified to groups. Therefore, while individuals choose using reasons because of cognitive limitations, groups may also prefer reasons because of social dynamics (Barber et al., 2003). Accountability and group conflict are two explanations why reason-based choice may be affected by social dynamics. Work on accountability suggests that reasons become more important when individuals have to justify their choices to groups whose respect and approval are important to maintain (Lerner & Tetlock, 1999). No one wants to look foolish in front of a group, and good reasons that are simple to explain are a way of making sure they don't. Other work has suggested that reasons based on prominent attributes help avoid group conflict because prominent attributes may be less controversial (Irwin & Davis, 1995). For example, safety is a prominent and (mostly) non-controversial attribute in defense acquisition programs; therefore justifying choices based on safety (where possible) is likely to cause less group conflict. It is worth highlighting that because reasons depend on social legitimacy (i.e., what is accepted and approved of by particular groups) navigating organizational landscapes effectively requires having a detailed understanding of the nuances about which reasons are broadly acceptable to the community (and avoiding those that are likely to cause controversy).

Acquisition Program Case Studies

ECH Program

Combat helmets have evolved over time to offer improved performance because of technology advances and manufacturing capability improvements (see Figure 3). Soldiers wore the M1 helmet, nicknamed the "steel pot" because it was made from pressed manganese steel, from the 1940s through the late 1970s. The M1 helmet was heavy and uncomfortable, and it provided little blunt trauma protection. The maturation of ballistic fabrics based on para-aramid polymer technology enabled the Army to replace the M1 with the Personnel Armor System for Ground Troops (PASGT) helmet in the mid-1980s. These helmets were in the 3–4 pound range (lighter than the M1) and provided increased ballistic protection. The shell of the helmet consisted of layers of ballistic aramid fabric, the most famous of which is DuPont's Kevlar®—resulting in the "Kevlar" or "K-pot" nicknames. The ballistic aramid technology allowed helmets to provide not only fragmentation protection from explosions but also small caliber handgun protection at a reasonable weight. The Modular Integrated Communication Helmet replaced the PASGT helmet on a limited basis. By the mid-2000s, the Advanced Combat Helmet (ACH) was the Army's primary helmet. The ACH provided Soldiers important performance improvements like increased ballistic protection, reduced weight, and better blunt impact protection.

In the late 1990s and early 2000s, the Army research centers teamed with commercial industry to mature the next generation of ballistics materials, resulting in the development of high molecular weight polyethylene (HMWPE) ballistics fibers that could be weaved into fabrics with application to combat helmets. The basis of future combat helmets, both the enhanced combat helmet (ECH) and its replacement, the Soldier Protection System future combat helmet, rested in HMWPE technology.

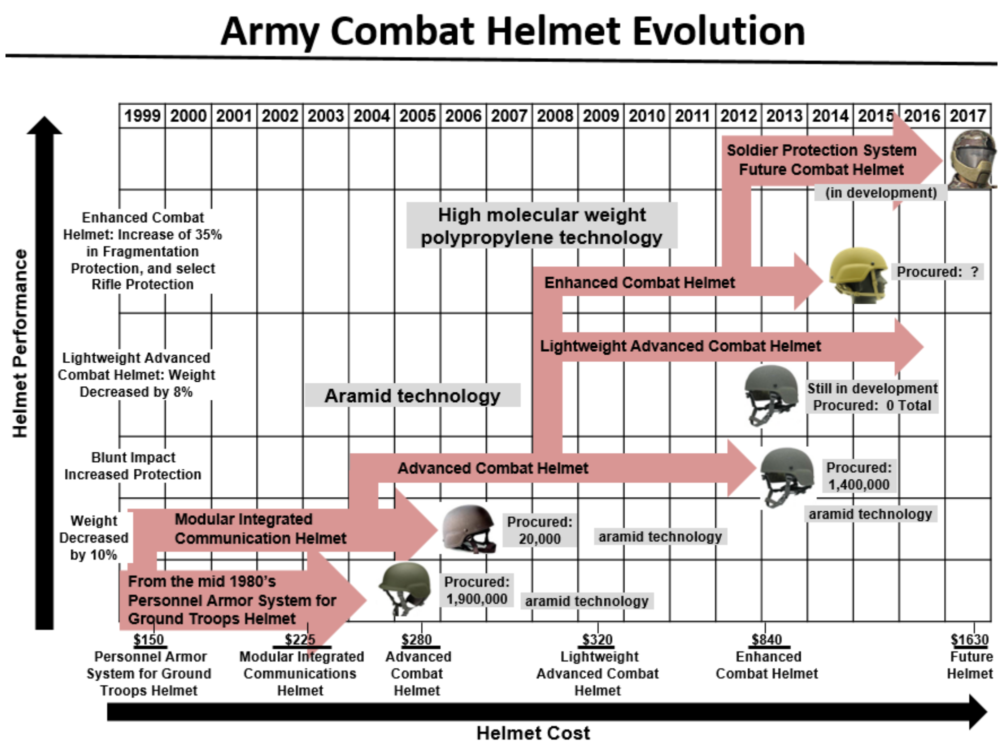

Figure 3. Evolution of Combat Helmets (Mortlock, 2018)

The ECH effort was driven by the urgent need for a new helmet to address protection for Soldiers and Marines against rifle threats in combat and reduce the combat weight. The guidance and priorities from the warfighting community and senior leaders were maximum protection and weight reduction. HMWPE technology allowed the Army and Marine Corps to consider increasing force protection by providing better ballistic protection or decreasing weight of the helmets. The basic options considered for the ECH requirements included: (1) maintain the protection levels of the current helmets with a reduced weight of up to 20%, or (2) increase the protection levels but maintain (or increase) the weight of the helmet. The helmet requirements had to balance acceptable minimum risk versus maximum safety for protective equipment, and weight reduction (combat load) versus protection (ballistic and blunt force)—not be an easy compromise for the program stakeholders. The ECH, however, would not be able to address both protection against the rifle threat and reduction in the helmet weight (*Trouble Making Trade-offs bias*).

To address the schedule aspect of the program, the Army and Marine Corps considered the options of pursuing a formal program of record through the deliberate acquisition process versus pursuing a rapid acquisition process supported by a directed or urgent requirement (*Planning Fallacy*). Establishing a formal ECH program involved a 4-year time period of contracting, development and testing. Year 1 allowed for the refinement, analysis, and approval of formal requirement documents and the development of testing protocols. Years 2 and 3 involved the development and testing of helmet prototypes resulting from competitively awarded contracts (cost-plus type contracts) to be awarded to industry companies. Year 4 allowed for the Army and Marine Corps to award procurement contracts to the successful companies for the manufacture and production of helmets. The alternative to a program of record was to use the rapid acquisition process. In rapid acquisition, the Services wrote a directed requirement (within a month) for the ECH and awarded competitive contracts (fixed-price contracts for certain quantities with production options) to industry within 6 months. Another 6 months would be required to test the helmets. So, ECHs could be on Soldiers' and Marines' heads in just over a year. With the rapid acquisition option, the new helmet's requirements would not be underpinned by analysis, and the test protocols had to rely on the protocols for current helmets because there would be no time to develop test protocols specifically for the ECH (*Planning Fallacy*). This was particularly important for the ECH, which would rely on novel HMWPE thermoplastic polymers that might perform much differently than the current para-aramid based helmets. For example, ECHs had the potential to lose their rigidity after being shot once and potentially offered less protection from multiple shots. Also, the ECH may deform excessively, leading to head trauma and skull fractures. There were legitimate testing and safety concerns that would have to be addressed during the development, testing, and manufacture of this new helmet.

The ECH program began in early 2009 (as shown in Figure 4) as rapid acquisition effort (*Planning Fallacy and Over-optimism*). The Army and Marine Corps approved urgent requirements based on the need for increased protection against enemy rifle threats and set broad requirements to include an increase in fragmentation and pistol protection, and rifle threat protection—all at the same weight of the current combat helmets. The acquisition strategy was a single step development in which competition was encouraged among industry manufacturers. The original request for proposal asked for each vendor to deliver test data validating their claim that their design met the new ECH requirements for rifle protection. Four vendors submitted proposals; however, only one vendor's design was acceptable. At the end of 2009, this vendor received a firm fixed price (FFP) contract to produce ECHs to undergo government validation testing with contract options for production deliveries after successful first article tests. In late 2010, after successful developmental testing, the Army and Marine Corps approved the program milestone to enter into low-rate initial production with the selected vendor. The decision permitted the production of a small number of helmets to undergo testing in order to validate that the contractor could successfully produce the helmets to performance requirements. The use of FFP type contracts for the development of the ECH was heavily influenced by Better Buying Power (BBP) 1.0, which encouraged a greater use in acquisition efforts (*Recency Bias*). Generally, however, for programs with only top-level warfighter operational requirements and with new technology, the use of cost plus–type contracts provides industry greater flexibility to innovate, allows the refinement of requirements based on knowledge learned in the development, and increases the chance of successfully producing a manufacturable, high quality product. In late 2011, the ECH passed the second round of first article testing after testing protocols were adjusted appropriately. To meet an aggressive production schedule for the Army and Marine Corps, the vendor submitted an engineering change proposal for a second and third production line. It took all of 2012 for the vendor to successfully pass the third round of first article testing.

The testing results demonstrated that the ECH met its requirements and offered Soldiers and Marines the potential for greater protection compared to current helmets. After passing testing and 4 years since program initiation, in the summer of 2013, the ECH successfully received a full rate production decision. The setting of requirements and testing protocols in the absence of quantitative analysis led to prolonged schedule, especially important with limited funding, intense scrutiny on program cost/schedule overruns, and pressures to field new capabilities to the warfighters quickly (*Difficulty Making Trade-offs and Planning Fallacy*).

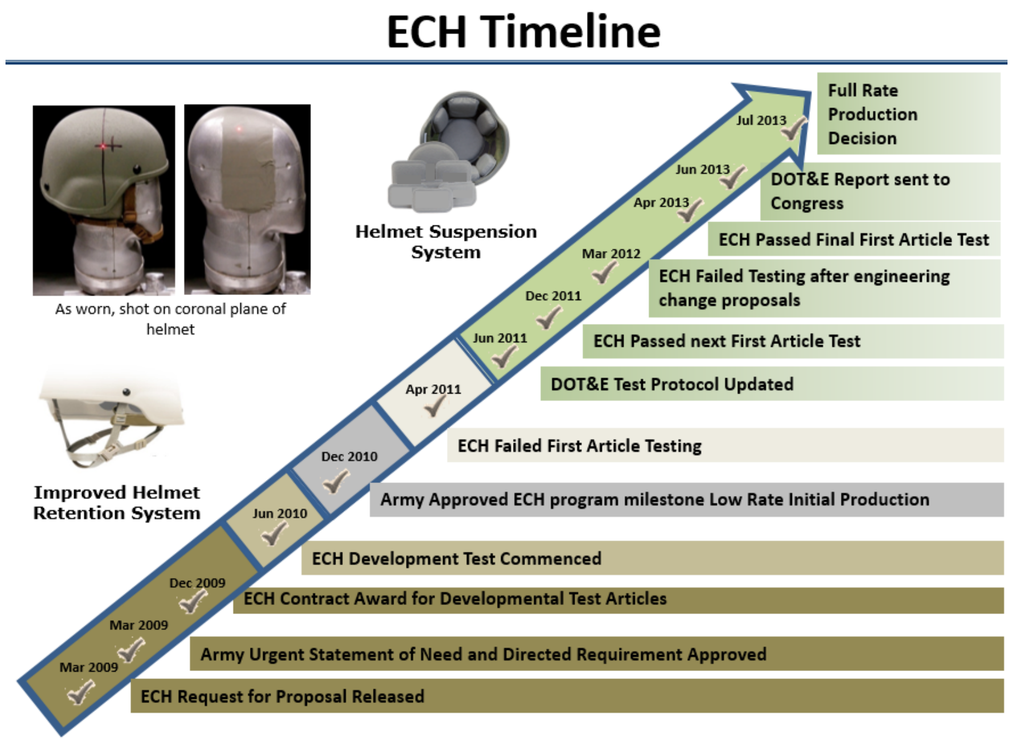

Figure 4. ECH Program Timeline (Mortlock, 2018)

The rapid acquisition program required that a directed requirement be written without a complete analysis of performance requirements. The new technology leveraged in the ECH could provide a 20% lighter (about a ½ pound) helmet while maintaining current protection, or could provide limited rifle protection at current helmet weights, or could strive for a substantial increase in rifle protection but with added weight. Pressure existed to lighten the fighting loads of warfighters in combat with benefits being improved speed and mobility, less fatigue and more endurance, and fewer long-term injuries. At the same time, there was the push for more capability (in this case, rifle protection), which meant increased weights. The Army and Marine Corps struck the easiest most expedient balance of increasing protection while constraining the weight to that of current helmets (*Difficulty Making Trade-offs and Planning Fallacy*)—essentially pushing the "easy button" attempting to "go fast" in a schedule-driven effort.

The testing protocols were important because they were placed in the helmet specification in the signed contracts for helmet deliveries and told industry the government requirements to be met. This was a typical "chicken or egg" scenario. Helmets with the new technology had never been manufactured. The testing protocols can only be established after making helmets and fully characterizing those helmets through design limit testing. However, a full-scale research and development effort required time and money. The testing protocol for the current helmets was refined after more than a decade of development, testing, and manufacture. The new technology in helmets behaved differently than the previous technology after being shot with a bullet. Thus, the required testing protocols differed. With nothing else to go on initially, the ECH testing protocols were set the same as current helmet test protocols (*Difficulty Making Trade-offs and Planning Fallacy*). The subsequent schedule slips in the ECH program were partially a result of a refinement of the test protocol learned over time in the development effort.

Programs that involve the application of a new technology inherently include high levels of integration, manufacturability, producibility, and quality risk. These programs should guard against being primarily schedule-driven (*Over-optimism*). Time is required to optimize the requirements and testing protocols while also encouraging the widest possible participation in the program by interested and innovative helmet manufacturers. In this case, an effort that originally planned to field helmets within a year took 4 years to reach a production decision—not so rapid. The industrial base suffered as the program relied on a sole-source vendor without the benefits of competition to keep costs and schedule in check. A program that is knowledge–driven from a research and development effort that includes many competitors from the industrial base may have proven more beneficial and had a similar execution timeline. The Services must be realistic about the risks associated with development efforts involving new technology and must avoid being primarily schedule–driven rather than knowledge–driven for acquisition decision-making.

The ECH program was initiated as a 1-year rapid acquisition effort that resulted in a 4-year effort to field a helmet (better than the current helmets) but with less than the theoretical possible optimal level of performance at a cost three times that of current helmets because of limited competition and low manufacturing levels of a capability and capacity (industrial base concerns). The Service's and the PM's decision-making in this program was greatly affected by *Trouble Making Trade-offs, Planning Fallacy, Over-optimism,* and *Recency Bias*.

JCM Program

The Joint Common Missile (JCM) program was initiated in the late 1990s. It was a Joint (Army, Navy, Marine Corps) effort to replace Hellfire, Maverick, and aviation-launched, tube-launched, optically-tracked, wire-guided (TOW) missiles fired from both rotary wing (AH-64 Apaches, AH-1 Cobras, and MH-60 Seahawks) and fixed wing (F/A18 D/F Super Hornets) aircraft. The JCM program had a successful milestone (MS) B in early 2004 with an approved capabilities development document (CDD) and subsequently awarded an Engineering and Manufacturing Development (EMD) contract for a planned 4-year EMD phase. The approved JCM acquisition strategy had a planned single-step development approach to meet all required capabilities (*Difficulty Making Trade-offs, Planning Fallacy, Over-optimism Bias*).

The Army and Navy planned the JCM program for a decade prior to the 2004 Milestone B or official designation of the program of record and start of the EMD phase. The science and technology (S&T) communities matured the underlying missile technologies through S&T objectives and a technology maturation and risk reduction phase. A high-level government work breakdown structure described the missile design and used to assess a medium risk assessment for the JCM development effort as well as technology readiness level (TRL) determinations of 6 for the critical technology elements (CTE) of the missile in support of the Milestone B decision. During this same time, the requirements generation system completed both a capabilities-based assessment (CBA) and analysis of alternatives (AoA). The CBA and AoA supported the approval of the JCM capability development document (CDD), which contained key performance parameters (KPP), initial operational capability (IOC) dates, acquisition objective (AO), and an average unit procurement cost (AUPC). Simultaneous with the technology maturation and requirements solidification, the resourcing plan for a JCM program was being worked and funding was planned and programmed. The JCM business case analysis supported the JCM program office estimate, the Army and Navy program objective memorandum (POM) submissions, and the JCM program was deemed affordable by the Army and Navy. However, the independent cost estimate (ICE) by Cost Analysis Improvement Group (CAIG) that supported the JCM Milestone B decision determined that the effort would take considerably longer than planned (from 74–144 months in EMD rather than the planned 48 months) and cost considerably more than planned (an AUPC of $153,000 rather than the planned AUPC of $108,000) (*Planning Fallacy, Over-optimism Bias*).

Despite the ICE conclusions, the JCM acquisition strategy recommended by the Army and Navy, supported by the warfighters, and approved by the defense acquisition executive (DAE) in the spring of 2004 after a successful Milestone B was a single-step development effort that planned to meet all the KPPs (*Difficulty Making Trade-offs, Planning Fallacy, Over-optimism Bias*). Late in 2004 (approximately 6 months after program approval), the JCM program was canceled as a program of record, and the effort was eventually renamed as the Joint Air to Ground Missile (JAGM) program. In 2015, the JAGM program applied the key lesson learned from the failed JCM effort—adoption of an incremental development approach. The JAGM program was approved as a program of record and successfully awarded an EMD contract after a Milestone B approval in 2015 (11 years after the JCM Milestone B approval). The capabilities to be delivered under the JAGM program were greatly reduced from the capabilities desired in the JCM program. Figure 5 displays the differences between the JCM and JAGM programs. The documented lessons learned emphasized the avoidance of extensive unprioritized requirements, multiple threshold platforms, and the fixed-wing F18 platform. The Army and Navy lessons applied to the JAGM effort emphasized an incremental development of the warfighter's highest priorities, reduced the threshold platforms, and leveraged the existing Hellfire missile warhead and motor to reduce risk, cost, and schedule (*Difficulty Making Trade-offs, Planning Fallacy, Over-optimism Bias*).

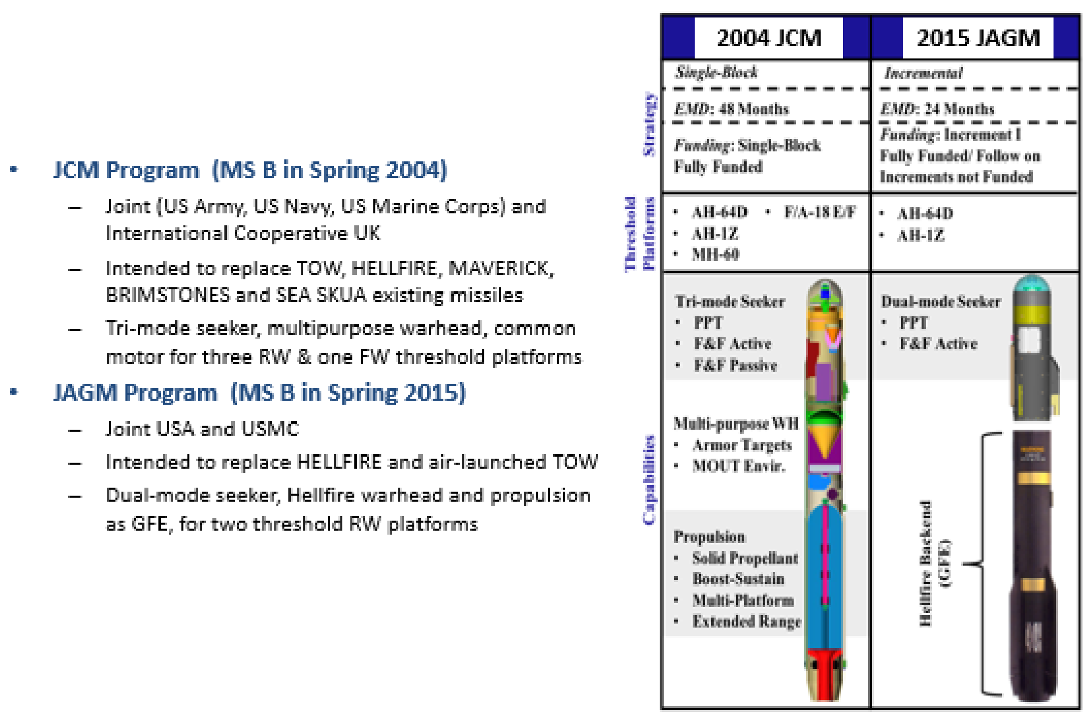

Figure 5. JCM/JAGM Acquisition Strategy Comparison (Mortlock, 2020)
[note the following acronyms: RW = rotary wing, FW = fixed wing, USA = US Army, USMC = US Marine Corps, GFE = government furnished equipment, PPT = precision point targeting, F&F = fire & forget, MOUT = military operation in urban terrain]

The plight of the original JCM program approval, subsequent cancellation, and then transition to the JAGM program offers an example supporting the GAO (2015) conclusion that the defense acquisition system often provides incentives for Services and PMs to promote *successful* acquisition strategies (defined as approved and leading to successful milestones) rather than *sound* acquisition strategies (defined as executed within cost, schedule, and performance constraints, and leading to fielding capability). *Difficulty in Making Trade-offs* bias makes it difficult for the Services and PMs to develop acquisition strategies to optimally balance near-term program milestone approval and long-term program executability in terms of maintaining cost, schedule, and performance baselines and delivering capability.

The Services and the JCM PM basically had two choices to reduce programmatic risk when formulating the JCM acquisition strategy—plan more time and money for the effort as defined by the warfighter or reduce scope (achieve less performance requirements) for the time and money planned. Allocating more money or additional schedule was not considered because JCM had a TMRR phase deemed successful and planned EMD phase aligned with funding in the Service POMs. A reduction in scope by recommending reducing performance capabilities was not considered because that risked losing the support of the warfighting communities who strongly supported achieving the full required capabilities (*Planning fallacy*, *Difficulty in Making Trade-offs*).

The JCM requirements were well established and supported by years of analysis with a set capability need date. The technologies needed to turn those requirements into capabilities for the warfighter had matured to the point that they were deemed mature (TRL 6) and ready for integration and development work. Additionally, the funding to support the JCM program of record for a development and engineering work and procurement of missiles was aligned to the required need date (IOC). The PM triple constant of cost, schedule, and performance was all synchronized and set within the planned acquisition program baseline (APB). However, for the JCM program, a single-step acquisition strategy to deliver all required capabilities was eventually canceled and the warfighter received no capability. Had an incremental development approach like the subsequent JAGM acquisition strategy been adopted initially, the warfighter could have received improved capability more than a decade sooner.

In the case of the JCM program, the cost and schedule constraints and the ICE determinations indicated the need to consider an incremental development approach and delay some capability to later increments (*Planning Fallacy*). The JCM program was canceled, and it took more than 10 years for the new JAGM program to pass an Milestone B—this time with an incremental approach that leveraged existing government furnished equipment (GFE) components and non-development item (NDI) technologies. Meanwhile, during this “lost decade,” the warfighter got none of the desired capabilities required. The defense acquisition system incentivized the Services and PMs to get an approved milestone—but with a program that was soon canceled, failed to meet performance requirements, and delivered no capability. The JCM program serves as an example of a program in which the cost, schedule, and performance constraints were unrealistically established. The Services and the PM decision-making were affected by the *Planning Fallacy, Difficulty in Making Trade-offs, and Over-optimism Bias*.

Army Infantry Combat Vehicle Programs

The Bradley Fighting Vehicles (BFV) remains the backbone of the Army mechanized infantry warfighter formations. Developed in 1970s, the Bradley has been upgraded several times to offer Soldiers enhanced capabilities; however, since the early 2000s, the Army has been trying to replace the BFV due to size, weight, and power constraints that severally restrict any potential upgrade options. Figure 6 shows the evolution of the BFV over time.

Figure 6. BFV Over Time (Roth & Hames, 2019)

One attempt at a BFV replacement was the Infantry Carrier Vehicle (ICV) as part of a family of eight manned ground vehicles (MGV) within the planned Future Combat Systems (FCS) Brigade Combat Team construct for the Army Future Force. The FCS program entered the acquisition framework as an official program of record at Milestone B to begin engineering and manufacturing development (EMD) efforts in 2003 with a planned Milestone C (low rate initial production) in 2010, but the program was canceled in 2009. Figure 7 describes the planned ICV as presented at the preliminary design review in early 2009. Over the past decade, defense acquisition experts have referenced the FCS program as an example of everything wrong with defense acquisition—a canceled program that wasted billions of dollars and delivered no capability to warfighters (Pernin et al., 2012). The FCS program was an ambitious effort that attempted to integrate technologies using a system-of-systems approach to transform the way Army brigades would fight. Additionally, the program started as a Defense Advanced Research Projects Agency (DARPA) effort contracted through other transaction authority (OTA) with Boeing and its industry teammate, Science Applications International Corporation (SAIC). The OTA incentivized Boeing to get the Army to an approved Milestone B, to start the formal program of record and system development and demonstration phase as quickly as possible. The Army planned, programmed, and budgeted funding—at risk if the program was not executed on schedule (schedule-driven). Boeing and the Army achieved that Milestone B in 2003. The OTA also enabled Boeing to become the lead system integrator (LSI) for the FCS program of record. Despite warnings from the GAO of immature technologies and lack of adequate funding, the Army marched forward until 2009, when the Secretary of Defense canceled the FCS program because of affordability concerns, immature technologies, and requirements not reflecting the current threats faced by soldiers in Iraq and Afghanistan (GAO, 2004). The FCS program was an example of a rush to failure and resulted in no capability delivered to the warfighter (*Planning Fallacy*). The program was also hampered by *Difficulty in Making Trade-offs* and *Over-optimism* (too many requirements, too many immature technologies), as well as *Recency Bias* (use of DARPA, OTA, system of systems approach and LSI concept) to use the latest acquisition reform initiatives despite other more suitable, less risky acquisition approaches.

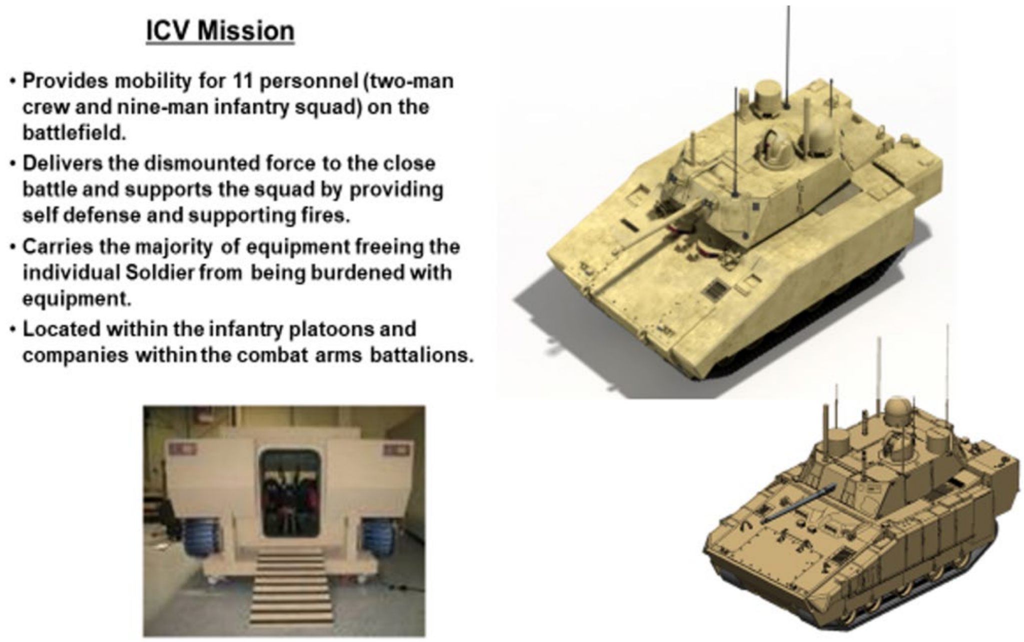

Figure 7. FCV ICV in 2009 (Adapted from PdM ICV, personal communication, 2009)

After cancellation of the FCS program in 2009, the Army embarked on the Ground Combat Vehicle (GCV) program (see Figure 8) to replace the BFV. At the time, Fort Benning served as the home of the infantry, and Fort Knox served as the home of armor. All resources that had been supporting the oversight and management of the development of a family of eight FCS manned ground vehicles were now applied to the development of the GCV. The Army designated Fort Knox as the lead in the defining the requirements for the GCV. The GCV program pushed for a materiel development decision and Milestone A in 2010 to begin awarding technical maturation and risk reduction (TMRR) contracts to industry. The same two industry partners that were teamed together in the FCS EMD phase for manned ground vehicles now competed against each other in a TMRR phase for the GCV. The Army began the GCV program and awarded FFP type research and development (R&D) contracts to BAE Systems and General Dynamics for designs and prototypes. The new vehicle's requirements called for a heavy reliance on mature commercial technologies. Better Buying Power (BBP) initiatives strongly encouraged and incentivized resulted in awarding FFP type R&D contracts (*Recency Bias*) despite the lack of appropriateness based on the level of system integration complexity and risk.

With the Armor School in the lead for defining the GCV requirements for a BFV replacement vehicle for the mechanized infantry, the requirements for GCV resulted in mixture of requirements from the BFV, the FCS ICV, the recently fielded mine resistant ambush protected (MRAP) vehicles, and the M1A2 Abrams tank. Based on the GCV requirements, the program office, the interested industry competitors, and engineers at the research, development, and engineering center (RDEC) at the Tank and Automotive Command (TACOM), determined that the GCV would weigh between 50 and 70 tons—nearing the weight of the 72-ton M1A2 Abrams tank and almost twice as heavy as the 30-ton BFV or planned 30-ton FCS ICV.

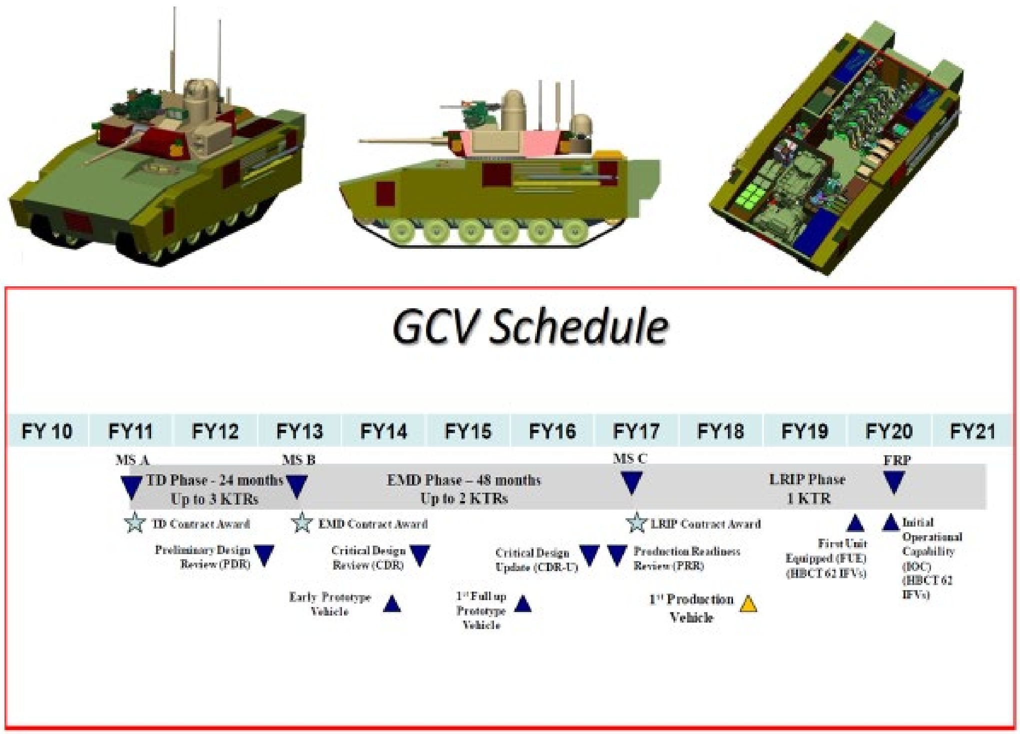

Figure 8. GCV as depicted in 2010 (Adapted from PdM GCV, personal communication, 2010)

The GCV had force protection, survivability, and lethality requirements for a mechanized infantry vehicle written by armor warfighters or tankers. In subsequent reviews with the Headquarters Department of the Army (HQDA) staff (including the Vice Chief of Staff of the Army), the potential weight of the GCV and excessive requirements were highlighted; however, the Army pushed ahead and awarded two TMRR contracts based on schedule pressure for protecting the planned and programmed resources of the old FCS MGV program (*Planning Fallacy, Over-optimism and Difficulty in Making Trade-offs*). Four years later, the Army canceled the GCV program because the vehicle was going to be too big and heavy and had excessive requirements. The GCV effort was not focused on the mechanized infantryman—it was focused on other Army priorities.

In recent years, after several failed attempts of initiating the Next General Combat Vehicle because of aggressive requirements and lack interest by industry, the Army is trying again—this time calling the BFV replacement the Optionally Manned Fighting Vehicle (OMFV). The OMFV program is susceptible to same behavior acquisition biases (*Planning Fallacy, Over-optimism, Difficulty in Making Trade-offs, and Recency Bias*) as contributed to the failures of the predecessor BFV replacement acquisition efforts. How can the design and development of a mechanized infantry vehicle be optimized for troop transport and protection, lethality, and remote autonomous operations simultaneously? The answer is unfortunately, it can't—this will require difficult requirement trade-offs to avoid the *planning fallacy* and *over-optimism* bias. A vehicle that is optimized for lethal autonomous operations would be an inefficient combat vehicle to protect the crew and protect the troops being transported. It appears that *Recency Bias* has also played a significant role in the OMFV program. Is the Army more interested on riding the autonomous vehicle hype wave? Or does the Army have other priorities like proving the value of the high-profile, newly established Army Futures Command or Next Generation

Combat Vehicle (NGCV) Cross Functional Team (CFT)? The acquisition strategy for the OMFV program appears to be heavily influenced by *Recency Bias*. The acquisition strategy leverages the newly formed middle tier acquisition (MTA) pathway to avoid forming an acquisition program of record to enter the EMD phase after a successful Milestone B. The OMFV program will use MTA authorities to rapidly prototype vehicles for experimentation and demonstration and then establish a formal acquisition program of record at Milestone C to enter low-rate initial production. This strategy is the exact opposite strategy that the GAO has recommended for more three decades for major defense acquisition programs—knowledge-based acquisition strategies. Defense acquisition programs have routinely rushed to production decisions without well-defined requirements, complete detailed design drawings, fully mature technologies, and mature manufacturing processes, and without demonstrating production representative systems in a relevant operationally environment. The OMFV program is attempting to do in an MTA rapid prototyping effort what a major defense acquisition program achieves in a formal EMD effort—a classic "schedule-driven" rush to failure.

Summary, Conclusions and Recommendations

Summary

We studied three defense acquisition programs and found strong evidence that systemic behavioral biases affected the management and decision-making within these programs. Table 1 summaries the research results. The outcomes of the ECH, JCM, and Army Infantry combat vehicles programs were affected by *planning fallacy, difficulty in making trade-offs, over-optimism, and recency bias* (except JCM).

Table 1. Summary of Biases Present in Defense Acquisition Programs

	Behavioral Biases			
Programs	**Planning Fallacy**	**Difficulty in Making Tradeoffs**	**Over-Optimism**	**Recency Bias**
ECH Program	√	√	√	√
JCM Program	√	√	√	
Army Infantry Vehicles	√	√	√	√

Conclusions

The presence of the effect of behavioral biases within the management and decision-making of acquisition programs comes as no surprise. However, the extent and frequency of the *planning fallacy, difficulty in making trade-offs, over-optimism, and recency bias* within the three acquisition programs studied sharpens the point on which biases are most relevant within defense acquisitions. For the past three decades, acquisition management has been highlighted on the GAO's high-risk list for excessive waste and mismanagement. Notable programs have failed to deliver capability, and failed to meet performance, cost, and schedule management targets. The root causes of program failure vary from ill-defined requirements, immature technologies, integration challenges, poor cost and schedule estimating, and the acceptance of too much development risk. Underappreciated and understudied is the effect that the *planning fallacy, difficulty in making trade-offs, over-optimism, and recency bias* have in contributing to root causes of acquisition program failures. The better we understand the effect of these systemic behavioral systemic biases, the better we can mitigate the risks of program failures.

The complexity of the defense acquisitions makes study of systemic biases interesting. The culture and leadership at different levels of the DoD from the institutional level to the organizational level to the program level affect the impact of the biases. In the DoD's hierarchical chain of command, the PMs are responsible for the program's cost, schedule, and performance (triple constraint). PMs make decisions for the proper management and execution of the program within the triple constraint parameters. However, the PMs do not establish the performance requirements, cost, or schedule objectives of the acquisition program baseline—the Services do. Additionally, PMs report to a milestone decision authority (MDA) who approves the program and determines overall program strategic direction. The systemic biases at the various levels of the chain of command manifest differently in the decision-making models used at different levels. *Behavioral acquisition* explores defense acquisition from a behavioral standpoint, including the impact of psychology, organizational behavior, and organizational politics on how culture, leadership, and decision-making affect the management and execution of program, as well as program outcomes.

Recommendations

For further research, we recommend rigorous study of more acquisition programs that can clearly show the distinctions we suspect are in play. We recognize that in the real world these distinctions are hard to show, even though we all know what's going on. Surveys of PMs and MDAs are an excellent way to get primary data to understand *behavioral acquisition* more fully. Figure 9 to highlights a model designed to study how the chain of command, culture, and decision-making moderate the effect of behavior biases in acquisition managers.

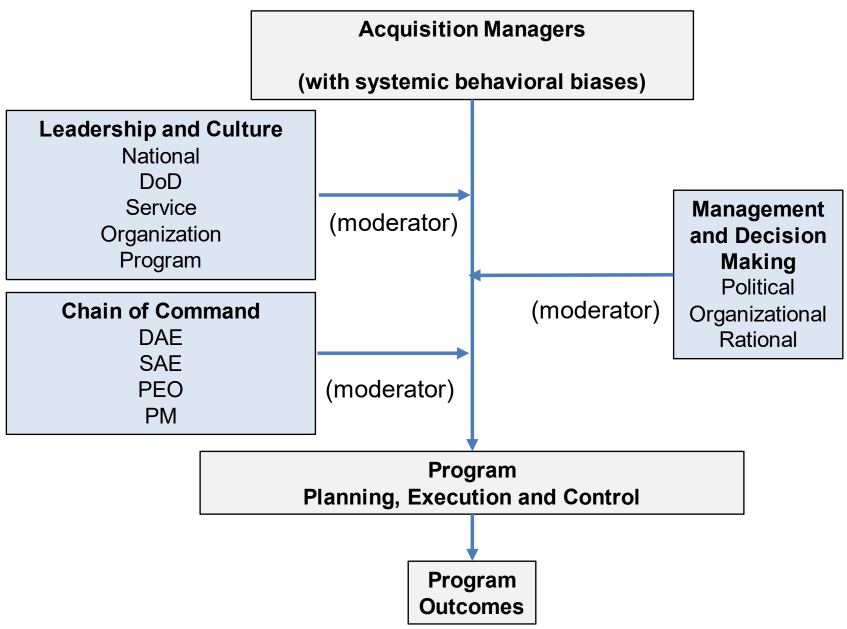

Figure 9. Moderator effects on acquisition manager behavior that affect program outcomes

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