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Maturing Cost Estimation in a Rapid Acquisition Environment

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Introduction

The Department of Defense (DoD) acquisition community is increasingly pursuing means to introduce new capabilities to the warfighter as quickly as possible. When facing emerging threats, the warfighter cannot wait for a new, critical capability to work its way through the rigid and time-consuming traditional acquisition process. In an era of tightening federal budgets and increased demand for new technology to help meet mission requirements, agencies are searching for ways to deliver critical mission functionality faster and with less risk.

The traditional acquisition planning process, with its numerous maturity milestones and decision gates, was designed to reduce risk and field a mature, sustainable capability, and is not suitable for obtaining smaller, innovative technologies that may have shortened technology life cycles, or for helping users counter emerging threats. The DoD is challenged to quickly address urgent operational needs (UONs) that could endanger military personnel or lead to mission failure (Wizner, 2013). During the Global War on Terror (GWOT), the Secretary of Defense (SECDEF) promoted and implemented a decision process to shorten existing budget planning and procurement cycles, to create rapid acquisition methods to equip the warfighter, and to fulfill UONs. However, this process was implemented in an ad hoc manner across the Services. Critical review of these rapid methods provided insights regarding shortfalls of a shortened process, and revealed a need to mature and formalize a rapid process.

Circumventing the traditional acquisition process to field capability more quickly affects requirements, cost, and affordability planning. Therefore, the DoD is challenged to generate confident and credible cost estimates where programs may have less definition and/or greater uncertainty in a rapid acquisition environment. The military sector strives "to be an innovation leader in developing technology to protect troops on and off the battlefield" (DoD, 2017). When utilizing rapid methods, the DoD must ensure that it understands the total costs of a capability to make informed decisions about the capability and systems being acquired. To make effective decisions, it is essential to establish a repeatable process and assess initial costs, as well as the potential enduring impact on costs, as solutions move from rapid processes into traditional Programs of Record (PoRs).

Cost estimating plays a critical role in a rapid decision-making process by providing decision makers a deeper understanding of cost implications in rapid acquisition environments. Embedded in the traditional capability planning process are well-documented

and recognized best practices for developing credible cost estimates to support DoD decision planning. However, new rapid acquisition approaches, with their short timelines, challenge the cost-estimation community. Therefore, the cost community needs to understand and mature estimation techniques to adapt and operate effectively when using rapid acquisition approaches. The DoD needs to be able to deliver accurate and credible cost estimates on rapid acquisitions to make better informed decisions.

This research provides the acquisition, cost, programmatic, and system engineering communities a deeper understanding of the impacts on cost estimating processes and cost approaches. This will help the DoD understand key areas where cost estimation should be adapted, and areas where there is increased uncertainty. This research focuses on all aspects of rapid acquisition to help program offices develop credible and confident cost estimates needed to make informed, data-driven decisions. This research will generate key insights that programs need to fully understand both near-term and long-term cost challenges of a rapid acquisition process compared with capabilities developed and acquired using traditional acquisition procedures. Results of this research on maturing cost methods in a rapid acquisition environment will improve the ability of program offices to estimate the cost of implementing rapid capability in a consistent and repeatable way.

Understanding the impact that a rapid acquisition process has on generating credible cost estimates helps to prove this research proposition and deliver outcomes that are impactful for programs and the defense acquisition community. This research will impact programs by improving the ability to make informed, data-driven decisions in a rapid acquisition environment. It will also benefit the DoD, Joint, and Services' portfolios at an enterprise level, where the research will help cost communities and program leadership assess and evaluate cost implications of capabilities acquired when using rapid acquisition methods.

Terminology

This report uses the following terminology specific to the rapid acquisition landscape:

- **Deliberate planning** is the traditional acquisition approach, which is based on three principal decision-making processes. Specifically, the DoD uses
  - As the requirement process: Joint Capabilities Integration and Development System (JCIDS)—the formal DoD procedure that defines acquisition requirements and evaluation criteria for future defense programs
  - To deliver a mature capability to an end user: Defense Acquisition System (DAS)—an event-based acquisition management process governed by milestone reviews and other decision points
  - To allocate resources to satisfy requirements: Planning, Programming, Budgeting & Execution Process (PPBE)—a cyclical process to determine DoD funding requirements and affordability
- **Rapid acquisition** is a non-traditional acquisition approach used to acquire and field urgent capability in response to adversarial threats, or to leverage new market technologies quickly.
- **Urgent need(s)** refer to capability required to remedy shortfalls that could endanger military personnel or lead to mission failure, as well as to the DoD's need to leverage emerging and relevant technology to bring innovations to the field, and protect troops. Urgent needs may be Service-specific (referred

to as UONs), or joint across multiple Services—Joint Urgent Operational Needs (JUONs) or Joint Emergent Operational Needs (JEONs).

- **PoR** is a term used in this research to describe a program that has approved funding across the defense program, achieved through the Program Objective Memorandum process, and resulting in an official line in the budget.

- **Project** is defined as a stand-alone effort outside a PoR (which might transition into a PoR); or, alternatively, a project can be a sub-set capability within a PoR.

- **Cost estimate** is defined as the summation of individual cost elements, using established methods and valid data to estimate future costs of a program, based on what is known. The cost estimate is continually updated with actual data, revised to reflect changes, and analyzed by calculating differences between estimated and actual costs (GAO, 2009).

Background

The GWOT and Iraqi and Afghanistan wars required changes within the DoD in both the requirements and acquisition planning processes to quickly address emerging capability shortfalls. The DoD promoted and implemented streamlined decision processes to shorten existing budget planning and procurement cycles to under two years. The DoD created and implemented policy in an ad hoc manner across the Services to support a top-down push for streamlined acquisition, and faster fielding of urgently needed capability. All Services established JUON and UON processes to quickly field critically needed capability.

Consequently, the United States (U.S.) Government Accountability Office (GAO) reported, "total funding for the fulfillment of urgent needs is at least $76.9 billion from fiscal years 2005 through 2010" (GAO, 2010). This included numerous programs of various sizes. Some urgent requirements grew into large, complex programs such as Mine Resistant Ambush Protected (MRAP), Joint Improvised Explosive Device Defeat Organization, and Unmanned Aerial Vehicles. Other smaller programs targeted special operations, equipping the soldier and fielding emergent technologies. One common element in these programs was the practice of rapid acquisition to meet urgent needs and field capability quickly.

The GAO (2011) criticized the ad hoc and complex processes created by the DoD, finding,

> The department does not have a comprehensive approach to manage and oversee the breadth of its activities to address capability gaps identified by warfighters in-theater. Federal internal control standards require detailed policies, procedures, and practices to help program managers achieve desired results through effective stewardship of public resources.

Further criticism from the Defense Science Task Force on the DoD fulfillment of UONs reinforced the lack of mature, repeatable rapid processes. "The department, as well as the acquisition community it depends on, has struggled in their ability to field new capabilities in a disciplined, efficient, and effective way" (Defense Science Board Task Force, 2009).

Under the 2011 National Defense Authorization Act (NDAA), Congress formally required updates in DoD policy. Interim policy was created in 2012, and by 2015, policy for rapid acquisition was recognized in Department of Defense Instruction (DoDI) 5000.2 and Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01H. These updates

formalized requirements and acquisition processes for rapid acquisition and fulfilling urgent needs.

The DoD implemented policy based on criticism and lessons learned, but a void remained in policy and guidance for creating confident and credible cost estimates in a rapid acquisition environment. Ad hoc processes resulting from urgent conditions can lead to poorly defined assumptions, failure to consider all costs, inadequate data collection, inappropriate estimating methodologies, inadequate assessment of risk and uncertainty, and indefensible estimates used in the budget planning process.

Generating confident and credible cost estimates is difficult when rapid acquisition programs have less definition and greater uncertainty than traditional acquisition progams. The rapid acquisition process should be robust enough to support decisions based on affordability, using mature cost methods grounded in a repeatable process, thereby bringing credibility to the estimate and decision planning.

Several studies have assessed a non-traditional planning process compared to the traditional process. Understanding differences between traditional acquisition planning and non-traditional methods provides insights into important factors enabling implementation of rapid acquisition methods. The following are differences identified in GAO audits and Defense Science Task Force recommendations:

- Traditional planning consists of three core components: (1) requirements validation, (2) acquisition planning, and (3) affordability planning required in the approval of a new military system. These three processes include maturity milestones and decision gates throughout system fielding to deliver a 99% solution in roughly three to 11 years.

- Traditional planning encompasses full life-cycle acquisition of a system owned by a Service in a formal PoR. This process is scalable for military solutions and adaptable to each individual Service. Deliberate planning is well documented, formal, and has repeatable processes to define requirements, acquisition, and affordability.

- Non-traditional planning responds to and encourages innovation for quick fielding of a capability or system. This approach does not focus on fielding a 100% solution, which is a critical factor in shortening procurement time. The decentralized process reduces the number of requirements and acquisition approvals through a shortened decision chain within the Services and Office of the Secretary of Defense (OSD).

- Non-traditional planning evolved in an ad hoc manner without a well-documented, repeatable process to address affordability and cost estimation. Historically, urgent needs waived affordability requirements during wartime operations.

Recent DoD policy updates define two key parameters for rapid acquisitions. The first parameter requires that the system be fielded in 24 months. The second requires that a disposition analysis be conducted within the first year of sustainment. The system disposition analysis determines (1) termination of the program, (2) sustainment for current contingency, or (3) transition to a PoR. This policy update creates a critical decision point for re-assessing requirements, acquisition, and affordability of the system. The recommendation then follows the steps for validation and approval as defined in JCIDS. This process identifies decision gates that form the foundation of a repeatable and defensible decision process. Understanding the path a system takes, and decision gates within rapid

acquisitions, allows the DoD to better understand and anticipate the total costs of a rapidly acquired system.

Consolidating the acquisition process to make it deliver capability more quickly affects requirements, cost, and affordability planning in both the near and long terms. In a rapid acquisition environment, acquiring a partial system in the near term might change the affordability and sustainment of a complete system in the long term. Recent policy updates do not provide detailed guidance on how to identify and assess the cost impacts across an accelerated program.

Rapid Acquisition Landscape

The research team conducted a comprehensive research of open sources to characterize and understand the rapid acquisition culture and community. Literature reviews and recent policy updates demonstrate the DoD's commitment to a rapid acquisition process. Recent policy updates and implemented best practices address gaps and shortfalls from the audits. However, a gap remains regarding how rapid acquisition processes address affordability. The DoD has not provided specific guidance on how to develop cost estimates to support rapid acquisitions. Critical to understanding a program's affordability is a credible cost estimate grounded in repeatable processes. Open source literature identified factors that affect both near-term and long-term program costs. This research assessed and characterized these factors to provide a better understanding of their impact on cost-estimating methods in a rapid acquisition environment.

- Rapid acquisition process accepts a less than 100% solution for use in a limited definition and/or use case. This creates greater uncertainty around near-term cost estimates as well as long-term costs of the full program, because the program technical baseline is bounded by the use case and not by cost of a fleetwide implementation.

- The DoD created innovation forums to provide a better understanding of technology maturity for science and technology (S&T) and bring innovation to DoD programs. However, the new demonstration forums are not specific to a Service, program, or capability gap. This DoD process relies on limited seed funding by a Service or by the PoR that selects the technology and incorporates it into its program. If a PoR chooses to incorporate a showcased technology, its decision may affect both near-term and long-term costs associated with customizing a commercial solution to meet a specific military need, and overcoming additional acquisition barriers, such as funding governed by appropriation laws and industry sourcing.

- Rapidly acquired solutions may be viable in a rapid fielding scenario with limited production quantities. However, this drives uncertainty into a program by producing impacts on both quantities (expansion from initial plan) and lead time in cases of a limited supplier/parts base. These impacts may affect both near-term and long-term program cost estimates, as well as the new policy fielding constraint of less than 24 months. The DoD has no process in place to address gradations of programs deemed viable under a rapid acquisition process but not sustainable under a traditional process.

- Abbreviated testing is typically associated with a rapid acquisition. A traditional process requires a complete testing program to demonstrate full functionality of a system in the operating environment. The testing phase identifies risks that can be addressed prior to full production and fielding of a system. To meet urgent fielding requirements, some programs may consider

testing in parallel with fielding a system. Then, work-around solutions must be found to address issues found during the testing phase that could not be handled before fielding. Work-around solutions generate costs and schedule impacts to a program using rapid acquisition methods. Therefore, this should be taken into consideration, as it impacts total program cost and affordability of the system.

- Rapidly fielded solutions may include combinations of commercial off-the-shelf (COTS) and modified COTS solutions, thus limiting requirements for new development and potential platform-integration efforts. In many cases, COTS products require additional engineering to integrate with another system. Formalizing methods used to estimate rapid acquisitions will ensure that these additional integration costs will be accounted for in the cost estimating process.

- Limited deployment of a capability might require only a limited training and sustainment approach—one that is aimed at meeting the near-term fielding requirement. For example, MRAP is considered a successful program that has fielded thousands of vehicles to meet urgent needs, but early deployment suffered from the lack of an advance-planning timeline typically found in logistics and sustainment areas of a traditional program. MRAP had no process to establish common parts or logistic chains to support the vehicles' numerous variants. While the near-term implementation of the vehicle met critical warfighter needs, the program did not transition into a PoR because of long-term affordability and sustainment issues.

- Urgent schedule constraints have an impact on acquisition strategy for a near-term solution. Acquiring a capability rapidly requires a streamlined acquisition process and market sources for the product. Urgent schedule constraints might limit acquisition strategies and source to a single vendor to meet time constraints of the rapid acquisition. This may affect near-term and long-term costs, because the near-term solution may develop a reliance on a commercial proprietary system that may not be sustainable under a PoR. A traditional acquisition approach includes a mature process for assessing competition and sources in the marketplace.

Role of Cost Estimation

The open source review of literature did not provide specific guidance on DoD policy or processes for conducting cost estimates in a rapid acquisition environment. No open source documents described if or how any review of cost estimates should be conducted for UONs and rapid acquisition. Furthermore, the 2016 policy updates do not contain specific guidance on how rapid acquisitions across the Services and joint programs should address affordability. Yet, the GAO recognizes that cost estimating is a critical part of project formulation and execution.

Best practice processes for developing cost estimates are defined in the 2009 publication *GAO Cost Estimating Guide: Best Practice for Developing and Managing Capital Program Costs* to ensure proper stewardship of public funds, employ effective management practices, and provide reliable cost information to government officials and decision makers. This GAO (2009) guide provides processes, standards, and procedures for developing, implementing, and evaluating cost estimates for use across the federal government.

The GAO process represents a repeatable method that results in high-quality, comprehensive, and credible estimates. Twelve distinct steps are organized into four

evolutionary phases for developing a cost estimate. The GAO observed that, when an agency did not incorporate all 12 steps, its estimates were unreliable. Furthermore, when an agency lacked an overall comprehensive process, its ability to create credible cost estimates was impaired. Therefore, the GAO recommends that each step be followed to ensure that a quality estimate is used when making decisions. The GAO describes four phases and the corresponding steps included in each phase (see Figure 1).
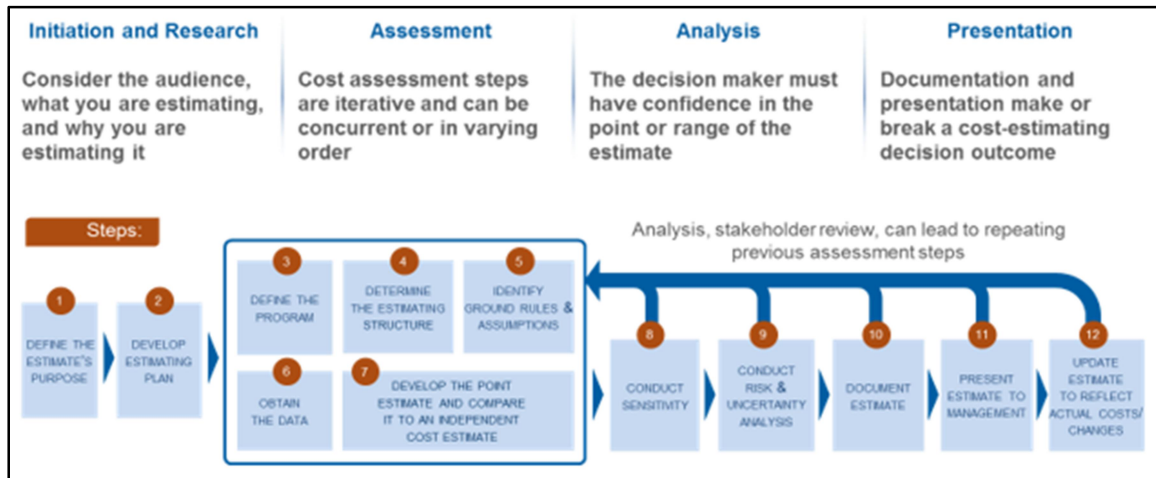
Figure 1.   GAO Cost Assessment 12-Step Process
(GAO, 2009)

The GAO (2009) presents the diagram in Figure 1 to illustrate how the phases and steps are related. The GAO emphasizes that the fundamental scarcity of resources and growing budget demands make it imperative that government acquisition programs deliver as planned, "because every dollar spent on one program will mean one less available dollar to fund other efforts" (GAO, 2009).

The rapid acquisition process accepts a less than 100% solution in order to provide capability in a shortened timeline. Consolidating a traditional process to deliver capability more quickly affects requirements, cost, and affordability planning in both the near and long term, and thus requires a repeatable cost estimating process that provides reliable cost information to government officials and decision makers operating in a rapid environment. The GAO understands that "an estimate that meets all these steps may be of little use or may be overcome by events if it is not ready when needed. Timeliness is just as important as quality. In fact, the quality of a cost estimate may be hampered if the time to develop it is compressed" (GAO, 2009).

Relying on a standard process that emphasizes pinning down the technical scope of work, communicating the basis on which the estimate is built, identifying the quality of data, determining the level of risk, and thoroughly documenting the effort should result in cost estimates that are defensible, consistent, and trustworthy. In a rapid acquisition environment, it is important to have a credible cost-estimating process to ensure that limited resources are allocated effectively to meet the warfighters' need (GAO, 2009).

In the literature review and findings of this research, the research team identified several key cost processes used in rapid acquisition environments that deviate from the traditional process. These differences, reflected in the case study research, provided the foundation for recommendations to mature and improve cost estimation methods and processes in a rapid acquisition environment. From these insights and recommendations,

the research team created guidance that offers the acquisition, cost, and programmatic communities a deeper understanding of the cost implications of rapid acquisition for service programs and the DoD enterprise.

Research Methodology

This research used a case study approach to characterize and classify findings on cost methods employed in rapid acquisition environments, and compared these characterizations with cost processes used in traditional processes, as defined in the *GAO Cost Estimating and Assessment Guide* (GAO, 2009), through a formal case study research design.

Fundamental to case study research is its design. It is a linear and iterative process that requires planning to conduct valid and thorough research. To model the case study research, the research team employed research and design methods described in "Case Study Research Design and Methods" by Robert K. Yin (2014). Yin's methods provide necessary rigor by capitalizing on the strengths and compensating for limitations of case study research. Yin provides strategies and methods that the team used to construct and conduct this case study research.

Characterization of the problem, and findings from literature reviews, raised questions about the credibility of cost estimation methods in a rapid acquisition environment. An examination of the rapid acquisition community reinforced the relevance and importance of examining "how" cost estimates are conducted and "what" is different in a rapid acquisition environment compared to a traditional one. Key research questions relevant to rapid acquisition are as follows:

- What are the overarching factors and characteristics that affect cost processes and methods?
- What are the key programmatic and technical differences compared to a PoR?
- What are the impacts on cost approaches and processes?

Research questions help to form the hypothesis and boundaries of the research. The research team developed a hypothesis focused on factors that affect cost estimation of a rapid acquisition. Effects of these factors depend on solution maturity, type of program, type of system, and size of system acquired through rapid methods. The hypothesis also considers processes surrounding rapid acquisition, and characteristics like number of resources, types of resources, and variations from the traditional approach. The research hypothesis is as follows:

Cost estimates for rapid acquisition projects will improve in reliability and credibility by using a proven and repeatable approach specific to the rapid acquisition environment.

The research team collected and examined relevant evidence from case studies to better understand and support the research hypothesis. The collected data and information provided insight into how costing methods used in rapid acquisition cost estimating differ from methods used in traditional processes and PoRs.

Pre-screening of case study candidates was conducted to provide further insight into the rapid acquisition community and identify case study candidates. Interviews with 35 subject matter experts (SMEs) across 25 programs helped the research team characterize rapid acquisition in the DoD, and identified future opportunities for validating the research outcome. Additionally, the research team used data obtained during the pre-screening

phase to refine their characterization of rapid acquisition environments and address these findings during the data-collection phase.

Seven case studies were conducted using an established case study protocol and framework for collecting data. Four of the case studies were conducted using a detailed questionnaire and interview. Three of the case studies were conducted using a high-level questionnaire and response. Cases varied from responses to urgent cyber threats to PoR technology insertion of hardware and software solutions through rapid acquisition methods. Program managers, engineers, and cost analysts participated in the case studies.

As part of the interview process, the research team input developed a data-collection questionnaire for analysis. The data-collection questionnaire needed to address and collect data on all steps in the GAO process. Each question was assessed and mapped either to a single step or to multiple steps. Some questions addressed all steps in the GAO process. Each question was also assessed for the type of data being collected. Almost all data collected was "qualitative" or "open-ended." Key areas on the data collection questionnaire included the following:

1. What overarching factors do you think most affect rapid acquisition costing?
2. What are the key programmatic and technical differences in a rapid acquisition (e.g., testing, training, documentation, maintenance, etc.)?
3. How is a traditional cost estimating process changed to adapt to a rapid acquisition environment?
4. What are the main rapid acquisition cost estimating challenges?
5. What rapid acquisition cost estimating process recommendations would you suggest?

To analyze qualitative data, the research team assigned an identifier to information collected during an interview. They recorded data from the interviews in a Microsoft Word file, then grouped it by question. They also assigned codes to information collected against a step in the GAO process and used additional codes to identify challenges and recommendations for a rapid acquisition environment. Once they had coded all data against the 12 steps, the research team consolidated and grouped the findings by step. Through discussion and consensus on the findings throughout the analysis process, the research team identified themes, patterns, and trends in the data. Further analysis triangulated the findings with insights from literature and pre-screening interviews.

The research team used a multilevel review process to validate results. One level involved reaching out to 25 SMEs representing a wide variety of rapid acquisition programs, approaches, and experiences. The research team asked these SMEs to review key findings and recommendations, and provide feedback on each key finding, stating whether they agreed, disagreed, or had recommended changes. Nine of the 25 SMEs provided validation feedback. For the second level of validation, the research team used detailed SME reviews. Four SMEs participated in a detailed review and discussion session, and provided comprehensive feedback on the full set of results. The research team incorporated feedback received from all SMEs into the final set of findings and recommendations.

Results

The research team analyzed qualitative data collected from open source materials, ancillary interviews, high-level case studies, and detailed case studies. Through an assessment of this information, they identified themes, patterns, and trends which they organized by "findings" and "recommendations." They mapped and coded each finding and recommendation to one of the 12 steps in the *GAO Cost Estimating and Assessment Guide* (GAO, 2009). The GAO's 12 steps are recognized as best practices by the cost estimating community, and served as the overarching theoretical framework for the research. The research team identified key findings and recommendations to highlight results with the greatest impact and importance.

The research team identified several rapid acquisition characteristics that impact cost methods, and provide context in which recommendations are made. These characteristics include the following:

- Rapid acquisition emphasizes delivery of a capability quickly, which causes very short acquisition timelines.
- To achieve these shortened timelines, rapid programs operate at a fast pace, and have a great concurrency of efforts.
- Schedule is the top priority; cost and capability are flexible to support desired schedule.
- There are many rapid acquisition approaches that vary in solution maturity, size, type, and timeline, as well as acquisition strategy.

Rapid acquisition, with its compressed timelines, pose unique challenges to the cost estimating process. Specific challenges identified during the findings assessment are shown in Figure 2. The research team made recommendations in this report to specifically address these challenges, while considering the constraints of rapid environments.

Little time to collect data
Quick turnaround initial estimates
Adjusting for abbreviated processes
Fast pace
Increased uncertainty/risk
Many trade-offs required
Technical baseline maturity
Documentation not top priority
Transition planning varies

Figure 2.   Cost Estimating Challenges in a Rapid Environment

The research team identified, organized, and aggregated key results to highlight the most important findings and recommendations among detailed results. Six major themes emerged:

1. cost estimating process
2. cost analyst
3. documentation
4. uncertainty/risk

5. trade-offs
6. scope/baseline

Overall, the research team identified 10 key findings and 15 key recommendations across these six major themes. Key findings and recommendations maintained the mapping to the GAO 12-step process, and mappings are shown in parentheses following each result. In some cases, the result is mapped to "All Steps" as the result applies across the entire 12-step process. The team selected key recommendations to specifically address the most important challenges to the cost estimating process in a rapid environment, while also considering constraints imposed by rapid environments.

Theme: Cost Estimating Process

Key Findings:

- Cost-estimating processes, approaches, and constraints vary (All Steps).
- Initial estimates are typically developed quickly to obtain funding then continue to be refined over time (All Steps).
- Cost data collection is especially challenging in shortened timeline (Step 6).

Key Recommendations:

- Initial and follow-on estimates should follow the GAO 12-step high-level process at an appropriate level, given time constraints and the demands of rapid acquisition (All Steps).
- Initial estimates should be broken out into life-cycle phases (development, production/procurement, and sustainment), and investment phases broken out to WBS level 3, where feasible (All Steps).
- Begin data collection early, and allow for as much time as possible to collect desired data; where possible, consider identifying and collecting data that can be used for future rapid acquisitions (business intelligence; Step 6).
- Identify cost drivers and conduct sensitivity analyses on them as soon as possible. Initial estimates should identify high-level cost drivers and conduct some level of sensitivity analysis on them (Step 8).
- Conduct cross-checks and cross-verification of at least major cost elements and cost drivers (Steps 7 and 8).
- Conduct high-level schedule analysis to ensure capability can be delivered as planned (Steps 7 and 8).

Theme: Cost Analyst

Key Findings:

- Trained cost analysts are often brought in after initial estimates are developed and are often not adequately resourced (All Steps).

Key Recommendations:

- Trained cost analysts should be engaged early on, and continue to be embedded within a program to handle the rapid pace of change (All Steps).
- Cost analysts need to be adequately resourced to support initial and follow-on estimates (All Steps).

Theme: Documentation

Key Findings:

- Acquisition and cost documentation are not a top priority (Step 10).

Key Recommendations:

- Cost estimate, and what is known about the programmatic approach and technical solution, should be reasonably documented <u>within timeline constraints</u> (Step 10).
  - Rapid timeline should allow for flexibility in documentation medium and level of detail (focus on the most important pieces of the estimate).

Theme: Uncertainty/Risk

Key Findings:

- Initial estimates have the greatest uncertainty and risk, but generally only point estimates are developed when cost analysts are not involved (Step 9).

Key Recommendations:

- Key areas of uncertainty and risk should be identified, and all estimates should be risk-adjusted (Step 9).
- Specific areas of uncertainty and risk to consider for rapid programs include: scope definition, GR&As, solution options, software development, integration, fielding, sustainment, and supply chain (Step 9).

Theme: Trade-offs

Key Findings:

- Trade-offs may be required; particularly on requirements (Steps 3 and 8).

Key Recommendations:

- Key cost, schedule, performance, and functional trade-offs that the program will need to evaluate should be incorporated upfront into the estimating plan (Steps 3 and 8).
- Requirements should be continuously prioritized early in order to justify trade-offs that may be needed to deliver capability quickly (Steps 3 and 8).

Theme: Scope/Baseline

> *Key Findings:*

- Acquisition and cost documents are developed in parallel (Step 3).
- Acquisition and technical efforts are abbreviated or developed in parallel in certain areas to accommodate rapid timelines and field solution quickly (Step 3).
- Transition planning to PoR varies from unknown to well understood (Step 3).

> *Key Recommendations:*

- Programs ensure a tight coupling of cost, programmatic, and technical SMEs and should hold regular GR&A discussions to ensure key program personnel agree with GR&As and to keep up with fast pace of change in rapid programs (Step 3).
- Consider cost estimate adjustments to reflect reductions in documentation, integration, testing, and training efforts in a rapid environment and plan for full efforts in these areas when programs transition to PoR (Step 3).

Overall, Step 8 had the greatest number of key recommendations, followed by Step 3 and "All Steps." Although Step 2 and Step 3 had more detailed findings (as shown in Figure 3), the most important recommendations are in Step 8, Step 3, and those that apply across "All Steps." These steps focus on the importance of defining the program's characteristics, conducting a sensitivity analysis of the cost estimate, following the overall GAO 12-step process at an appropriate level for program maturity and available time to develop the estimate, and involving cost analysts early to develop the cost estimate.
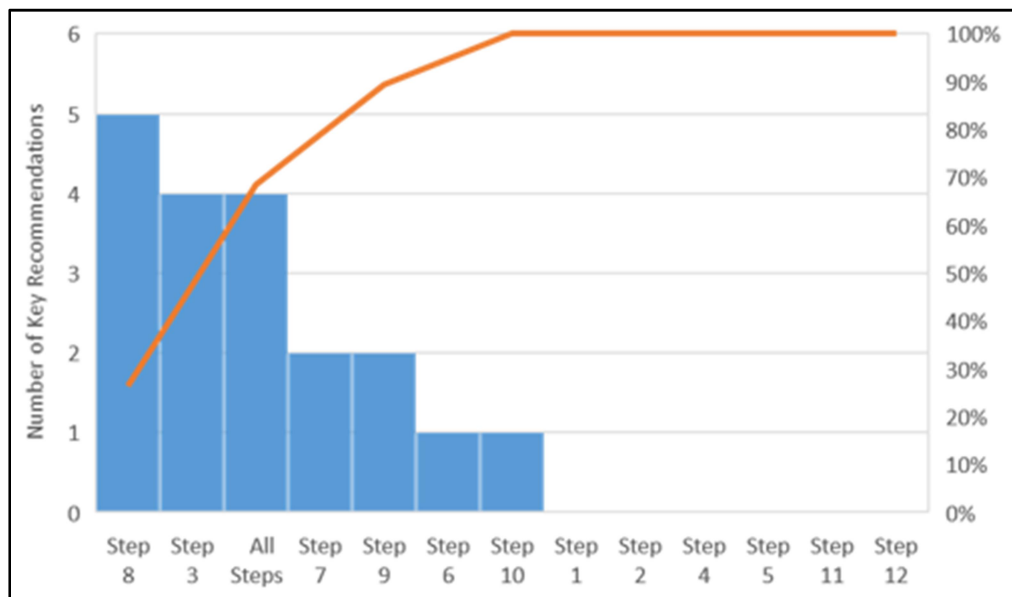

Figure 3.   Numbers of Key Recommendations by GAO Step

In summary, the research team conducted case studies, organized the information they collected, and analyzed it for themes, patterns, and trends. They aligned results with the GAO's 12-step cost estimating process which represented a theoretical framework for analysis. Key results yielded 10 findings and 15 recommendations. Results were most

numerous in Steps 2 and 3, although all 12 steps had some findings and recommendations. Figure 4 shows a summary of key recommendations mapped against the GAO's 12-step cost estimating process. Although Step 2 and Step 3 had the greatest number of detailed results, the most important recommendations are in Step 8, Step 3, and those that apply across "All Steps." These steps focus on the importance of defining the program's characteristics, conducting a sensitivity analysis of the cost estimate, following the overall GAO 12-step process at an appropriate level for program maturity and available time to develop the estimate, and involving cost analysts early to develop the cost estimate.
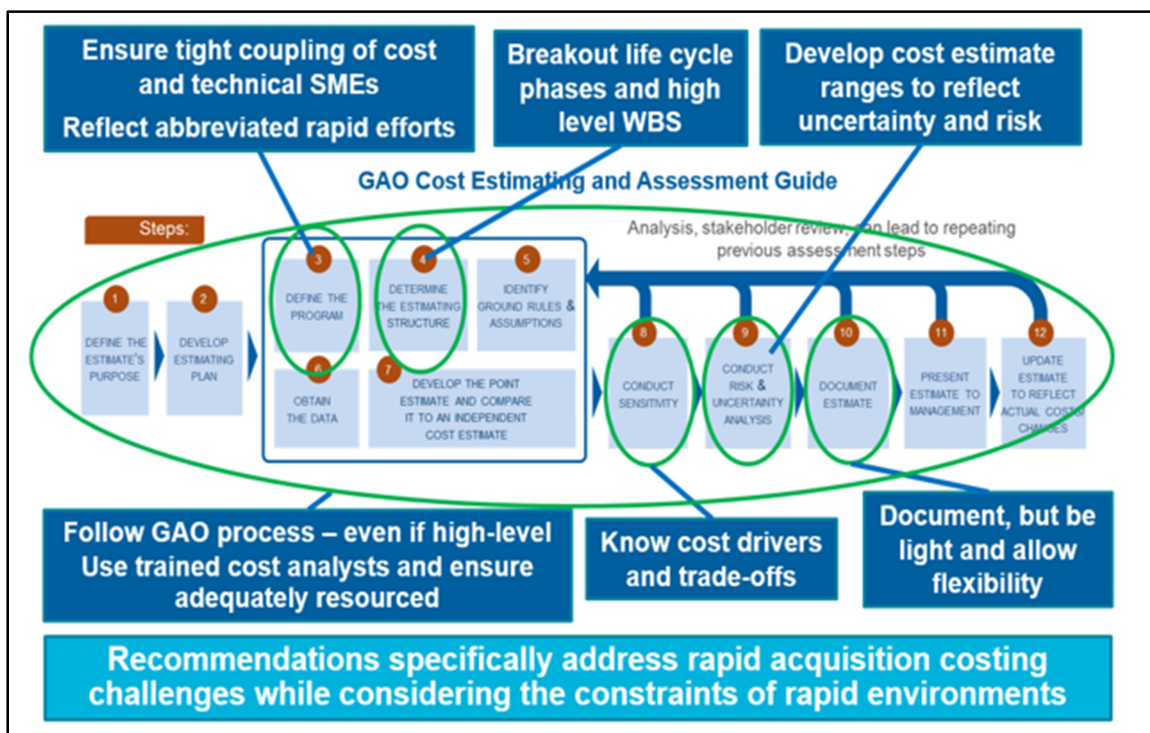
Figure 4.   Summary of Key Recommendations

Recommendations can be easily applied, are flexible, and can accommodate a variety of rapid timelines and approaches. Some factors to consider when applying the recommendations include: rapid acquisition approach, size of program (in dollars), new program start versus an established program, timeline, solution maturity, and solution complexity. The research team aligned its recommendations with the GAO's best practices to establish credibility and accommodate ease of use. Recommendations allowed flexibility in implementation to ensure broad applicability across a variety of rapid acquisition methods.

Summary

Agencies are increasingly pursuing means to introduce new technology and capabilities as quickly as possible to counter emerging threats. For critical capabilities, warfighters cannot wait for new technology or capability to work its way through a rigid and time-consuming acquisition process. Agencies are using rapid acquisition methods to help achieve these goals. Rapid acquisition approaches have challenged the acquisition community's ability to generate credible cost estimates. Ad-hoc and disparate processes have been used over the past decade, leading to poorly defined assumptions, inadequate data collection, inappropriate estimating methodologies, and inadequate assessments of risk and uncertainty.

This research set out to advance the capabilities of the acquisition and cost communities by maturing cost analysis aspects of rapid acquisition processes, and developing a proven and repeatable approach to generating accurate and credible cost estimates. The research team developed guidance to aid the cost, acquisition, and system-engineering communities who face unique challenges within rapid acquisition environments. This guidance includes findings that characterize these environments and recommendations for developing credible cost estimates, given the constraints of rapid acquisition requirements.

The research team performed multiple activities during the development of guidance for cost estimating communities. They performed a comprehensive literature and landscape review, and conducted an assessment and detailed characterization of the rapid acquisition environment. Qualitative data-collection methods included interviews with 35 SMEs and seven case studies representing a broad range of programs, solution types, and rapid acquisition approaches. The research team compiled and analyzed the qualitative data for patterns and trends, and used the GAO's cost estimating best practices to develop 10 key findings and 15 key recommendations. By mapping their findings and recommendations to the GAO's 12 steps, the team ensured that their recommendations could be easily applied to a variety of rapid timelines and approaches. Finally, the research team identified key findings and recommendations to highlight the most important results.

This guidance describes common characteristics of rapid acquisition environments, and unique challenges faced by cost, acquisition, and system-engineering communities operating within rapid acquisition–compressed timelines. It recognizes that there are many rapid acquisition approaches that vary in solution maturity, size, type, timeline, and acquisition strategy and presents specific characteristics that impact cost methods in rapid environments. These include emphasis on quick delivery of capability, short acquisition timelines, fast-paced environments with a high degree of concurrency of efforts, and the need for cost and capability trade-offs to meet schedule.

This guidance provides an easily usable and adaptable set of findings and recommendations aimed at strengthening the ability of the cost and acquisition communities to produce credible cost estimates for capabilities that require rapid acquisition methods. The recommendations guide program offices that are implementing rapid acquisitions to help mature their cost estimating processes and align them with best practices; decrease the variance seen today across rapid acquisition cost estimating processes; and help the cost community establish repeatable, proven processes for operating in rapid environments. The recommendations are linked to the GAO cost estimating best practices that, when implemented, help ensure that credible, reliable, and confident cost estimates are delivered—even within the constraints of rapid acquisition timelines. Ultimately, a credible cost estimate helps improve a program office's ability to make better informed, data driven decisions (at the program and portfolio levels).

Recommendations

The research team developed several recommendations for cost analysts developing cost estimates in a rapid environment. These recommendations specifically address the challenges they face, and consider the constraints imposed by a fast-paced rapid acquisition environment. Recommendations include the following:

- **Apply the GAO 12-step process, even if it is applied at a high-level.** There are multiple levels of depth at which each step can be applied. The rapid acquisition approach, solution maturity level, and timeline will constrain the depth to which each step can be applied in a given situation. Research results indicate that every step can be applied at some level in a rapid environment. Including all steps will ensure that the full spectrum of best practices is applied.

- **Use trained cost analysts and engage them early on.** The research revealed that many of the initial estimates were not developed by trained cost analysts. Although well-intentioned and limited by time, the estimates lacked best practices that a trained cost analyst would have applied. Initial estimates are often the most important in establishing budgets and baselines, so, incorporating cost analysis best practices upfront is critical.

- **Develop cost estimate ranges to reflect uncertainty and risk in rapid acquisitions**. Rapid acquisitions often have greater uncertainty and risk than traditional acquisition programs. Much less may be known about the solution and implementation. In rapid acquisitions, it is important that uncertainty and risk be reflected in a range estimate, not a single point estimate.

- **Know cost drivers and trade-offs**. Rapid environments are fast-paced. Schedule is top priority, and cost and capability trades are often required. Knowing the critical trades that may be required upfront, and key cost drivers in the estimate, help ensure that options can be examined often, quickly, and effectively.

- **Understand and reflect abbreviated acquisition and technical efforts.** There are adjustments made to efforts in the interest of faster delivery to the field. Integration, testing, documentation, and training efforts may be reduced compared to traditional acquisition efforts. The cost estimator needs to understand which efforts may be reduced, reflect these reductions in the estimate, and allow for additional efforts that may be moved to the transitioning to a PoR later.

- **Document, but be light and flexible**. Documentation is not a top priority in rapid acquisitions, and there is minimal time in a rapid environment. Research findings uncovered very limited documentation or records of key scope and GR&As. The intent of this recommendation is not to impose an unreasonable burden in a constrained environment, but to reinforce the need for flexible media to document the most important features related to the cost estimate to establish credibility and traceability.

Recommendations can be easily applied, and are flexible enough to accommodate a variety of rapid timelines and approaches. Some factors to consider when applying these recommendations include: rapid acquisition approach, size of program (in dollars), new program start versus an established program, timeline, solution maturity, and solution complexity. These recommendations are aligned to established best practices, yet allow

flexibility in implementation to accommodate ease-of-use and ensure broad applicability across a variety of rapid acquisition methods.

References

Defense Science Board Task Force. (2009). *Fulfillment of urgent operational needs*. Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.

DoD. (2017, January 5). *Department of Defense Science and Technology*. Retrieved from https://www.defense.gov/News/Special-Reports/0715_science-tech

GAO. (2009). *GAO cost estimating and assessment guide: Best practice for developing and managing capital program costs*. Washington, DC: Author.

GAO. (2010). *Warfighter support: Improvements to DoD's urgent needs process would enhance oversight and expedite efforts to meet critical warfighter needs*. Washington, DC: Author.

GAO. (2011). *Warfighter support: DoD should have a more comprehensive approach for addressing urgent warfighter needs.* Washington, DC: Author.

Wizner, A. M. (2013). *The next acquisition challenge: Transitioning enduring capability.* Carlisle Barracks, PA: U.S. Army War College.

Yin, R. K. (2014). *Case study research designs and methods*. Washington, DC: Sage.

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