

**The Acquisition Program Risks of
General Purpose Bomb Budget Requirements Instability:
A Qualitative Descriptive Case Study**

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12 February 2021

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Abstract

This strategic qualitative descriptive case study with accompanying research and analysis investigates general purpose bomb warhead procurement program acquisition risks induced by budget requirements instability. The munitions requirements process is investigated as part of this research. Linkages and gaps between the DoD's munitions requirements process and follow-on budget submissions within the department's planning, programming, budgeting, and execution process are described. In addition, historical budget documents for general purpose bombs warheads are analyzed for trends. Publicly available performance and risk data were used to highlight challenges induced by instability in general purpose bombs budget requirements. It was found that DoD's munitions requirements process contributes to budget requirements instability, but that it is only one of a variety of contributing factors. Other factors such as the unfunded requirements process and OCO or supplemental funding requests also affect budget requirements stability. Additionally, it was found that ammunition budget requirements stability influences acquisition program risks for general purpose bomb warheads in a variety of ways. Continuing consistent engagements throughout the munitions requirements process and budget requirements process while expanding engagements within the defense industrial base may help improve budget requirements stability with the result of reducing acquisition program risk. Themes of consistency and collaboration between government and commercial participants in the defense industrial base emerged as potential steps to begin resolving the above challenges.

Chapter 1 - Introduction

This chapter provides an overview of the research project's background as well as historical context contributing to the evolution of the Department of Defense (DoD) munitions requirements process (MRP) and how conventional ammunition budget requirements are derived from MRP. Several key terms and definitions are provided as well as historical references outlining ongoing challenges pertaining to the research topic. The background is used to generate and present the problem statement followed by the purpose for this study. Additionally, the significance of the research is discussed as it relates to the ongoing professional dialogue surrounding the problem. An overview of the research methodology followed by presentation of research questions helps to refine the scope of this project. Finally, objectives and expected outcomes as well as research limitations are presented.

Background

In accordance with DoD Directive (DoDD) 5160.65, the Secretary of the Army is assigned the Single Manager for Conventional Ammunition (SMCA) responsibility within the Department of Defense. Further policy guidance is provided by DoDD 5160.68 which establishes on SMCA responsibility to acquire conventional ammunition, upon receipt of funded programs, to meet Military Service and United States Special Operations Command (USSOCOM) requirements (DoDD 5160.68, 2018, p.11). This policy guidance also directs the development of Joint Conventional Ammunition Policies and Procedures (JCAPP) through a Joint Ordnance Commanders Group (JOCG). Within the current version of JCAPP, the United States Air Force (USAF) Hill Air Force Base (Munitions Division (EBH), Hill AFB, UT), acts as “the principal Air Force agency for munitions management” and retains overall budgeting

authority (JOCG, 2017, p.122). In support of budget activities, the SMCA provides “updated pricing for each budget submission” (JOCG, 2017, p. 37) and the Joint Program Executive Office Armaments and Ammunition (JPEO A&A) is chartered as the executor of the SMCA mission. Baseline pricing to support budgeting to execution is derived from a variety of sources to include known contract pricing information, historical procurement activities, or suitable inflation indices (JOCG, 2017, p. 34).

As procuring agency for munitions requirements, the SMCA responds to budget requirements provided by the USAF program management office. Responsibility for shaping acquisition strategy to meet the needs of the USAF resides with the SMCA and is informed and developed with the support of a multi-disciplined Integrated Product Team (IPT) and includes USAF representation (JOCG, 2017, pp. 38-39).

Budget requirements are currently generated through the application of the MRP. This process was initially codified in 1997 as formal, and now cancelled, guidance in the form of Department of Defense Instruction (DoDI) 3000.4, ‘Capabilities-Based Munitions Requirements (CBMR) Process’. The most recent version of the MPR, DoDI 3000.04, dated August 2018, establishes the Total Munitions Requirement (TMR) as a combination of War Reserve Munitions Requirement (WRMR), training requirements, and testing requirements (DoDI 3000.04, 2018, p.11). Calculations result in requirements that are “point estimates of the quantities of munitions the services would buy to arm their planned forces if sufficient funds were available” (Kassing et al., 1991, p.1). In other words, MRP calculates the unconstrained full quantity requirement and does not consider constraints such as funding availability or industrial base limitations.

The Kassing et al. (1991) study identified variation in the models used for estimating conventional munitions quantity requirements across the Military Services. These included, but were not limited to, level of detail assumed in combat scenarios, the treatment of resupply, the role of cost competition, and variation in the use of target value (Kassing et al., 1991). The role of cost competition is emphasized when commonality exists between Military Services conventional ammunition configurations. Such is the case for legacy general purpose bomb warheads. Commonality exists between USAF and United States Navy (USN) managed air-delivered munitions in the form of general purpose bomb warheads. One key objective of the SMCA and DoD components, to “achieve the highest possible degree of efficiency and effectiveness” in the DoD operations required to acquire top quality conventional ammunition (DoDD 5160.65, 2018, p.2), is designed to resolve the role of cost competition between Military Service procurements of common items. The result is that the SMCA coordinates and consolidates conventional ammunition requirements as outputs of the Military Service’s MRP and budgeting processes while striving to ensure efficiency in procurement activities.

A follow-on report to Kassing et al. (1991), issued by the Office of the Inspector General, summarized the continued dialogue related to the DoD process for developing quantitative ammunition requirements. This report concluded that systemic problems persist, and were summarized by the following problem areas (Steensma, 2000):

- “Development, use, and validation of the *Outyear Threat Report* and the phased threat distribution;
- Inconsistency of processes among and between the Services;
- Use and validation of modeling assumptions (factors);
- Unclear guidance
- Verification, validation, and accreditation of the Service models used in the requirement determination process; and
- Use of required data formats” (Steensma, 2000, p.i)

The above findings led to the development and implementation of a revised process in the form of the DoDD 3000.04, ‘DoD Munitions Requirements Process (MRP)’ in 2003 which has evolved while retaining the intent to “establish policy, assign responsibilities, and prescribe procedures for generating, developing, and disseminating DoD MRP products” (DoDI 3000.04, 2018). This revised guidance shifted focus from a capabilities-based approach to a threat-based approach while guiding Combatant Commanders to generate near-year and out-year phased threat distribution (PTD) assessments (DoDI 3000.04, 2018). Out-year munitions quantity requirements are used as inputs to Program Objective Memorandum (POM) munitions investment recommendations (DoDI 3000.04, 2008).

The POM is one of the first outputs of the programming phase of the annual Planning, Programming, Budgeting, and Execution (PPBE) process. The POM “presents the services and defense agencies proposal on how they will balance their allocation of available resources” (AcqNotes, 2018). As noted above, outputs of the MRP inform POM deliberations, and outputs and assessments generated during MRP “should be used by the Military Services and OSD to make informed decisions during POM deliberations and the Planning, Programming, Budgeting, and Execution process” (DoDI 3000.04, 2018, p. 12). It is noteworthy that although the PPBE process occurs annually, the DoD MRP, occurs by policy every even-numbered calendar year (DoDI 3000.04, 2018). Off-year MRP assessments are conducted on an as-needed basis per DoDI 3000.04 (2018).

The following paragraphs provide high level definitions for relevant terminology of key terms used throughout this research. Within the context of this research, unless otherwise

specified, the term requirements shall be associated with budget requirements and not technical or performance requirements.

Munitions Requirements Process (MRP)

The Munitions Requirements Process is the process by which the TMR is defined. The TMR is the sum of War Reserve Munitions Requirement (WRMR), training requirements, and testing requirements (DoDI 3000.04, 2018). Key outputs from the MRP include near-year and out-year constrained and unconstrained requirements for operational plans. This policy establishes the TMR to enable execution of assigned military missions and ensures that munitions requirements as outputs from MRP are “visible, accessible, and understandable to the rest of the department” (DoDI 3000.04, August 2018, p. 2).

Conventional Ammunition

The current definition of conventional ammunition is as follows:

“...an end item, complete round, or materiel component charged with explosives, propellants, pyrotechnics, or initiating composition for use in connection with defense or offense (including demolitions) as well as ammunition used for training, ceremonial, or non-operating purposes. This includes inert devices that replicate live ammunition, commonly referred to as dummy ammunition, which contain no explosive materials.” (DoDD 5160.65, 2018, p.6)

General Purpose Bomb Warheads

This research focuses on three specific line items within the USAF’s general purpose bomb budget exhibits: BLU-109, BLU-117, and MK 84. It should be noted that several other commodities are identified as procurement items within the ‘general purpose bombs’ nomenclature category of USAF P-1 and P-40 budget exhibits. However, the three commodities

identified above represent conventional ammunition items which have been transitioned to the SMCA by the USAF in accordance with previously discussed JCAPP guidance. Also, all three configurations are all two-thousand pound bomb warheads. The BLU-109 is a hard target penetrator warhead and the BLU-117 general purpose bomb warhead is described as a “slender body made of steel with a well in the nose section” for sensors, fuzes, or penetrating plug (JPEO A&A, 2017, p. 211). The MK-84 is a two-thousand pound bomb warhead “designed to attack soft and intermediately protected targets” (JPEO A&A, 2017, p. 212).

Problem Statement

Persistent general purpose bomb warhead budget requirements instability (spikes and decrements) introduces acquisition program risk. Within the context of strategic acquisition planning, it is important for program managers to understand long-term budget requirements for the conventional ammunition they are responsible for delivering. This understanding enables informed development of acquisition strategies as well as investment in industrial base resources to more effectively align capability with those requirements. The Single Manager for Conventional Ammunition’s insight into the United States Air Force budget requirements planning process is limited, specifically with respect to large volume budget requirements for legacy configurations of general purpose bomb warheads. This limitation, along with budget requirements instability, results in acquisition program risk.

Purpose of This Study

The purpose of this study is to investigate and understand how historical processes for munitions budget requirement planning of legacy configurations of general purpose bombs impacts overall acquisition program risk from a cost, schedule, and performance perspective. In

seeking to understand these impacts, a qualitative descriptive case study of historical budget requirements, informed by the munitions requirements process, will be investigated along with accompanying acquisition risks.

The qualitative descriptive case study methodology was chosen for a variety of reasons and seeks to understand the ‘how’ and ‘why’ acquisition program risk is influenced through the munitions requirements process. This exploratory approach will also investigate how processes have evolved over time and why those processes influence acquisition risk. Historical reviews of USAF budget submissions as well as past program performance data will be used to support the research data and analysis.

The intended audience for this research includes program managers and program office representatives within the United States Army (USA) and USAF chains of command. Additionally, acquisition professionals chartered with translating operational needs into actionable program execution strategies will benefit from an understanding of the overall munitions requirements process. Insight will be provided as it relates to how outputs of the munitions requirements process may drive acquisition decision making and introduce program risk.

Significance of This Research

This research has potential broad significance with respect to cross-service and cross-organizational efficiency and effectiveness. Insight into MRP outputs for conventional ammunition beyond the purview of organizations chartered with procurement responsibility can result in improved communication, improved contract planning processes, and a better

understanding of acquisition program risk related to the commercial and organic industrial base relied upon to produce and deliver conventional ammunition.

As program managers interpret outputs of the MRP, it is crucial for them to understand how those outputs relate to capabilities needed to achieve desired result. Requirements should drive capability, capability should not drive requirements. Indeed, within the scope of JCAPP, the SMCA is responsible for prioritizing “available industrial base resources to effectively meet the Military Services” conventional ammunition requirements (JO CG, 2017, p.30). By establishing an understanding and awareness for how MRP drives budgeting decisions, program managers may become better equipped to identify and implement more efficient strategies for achieving the ammunition budget requirements objectives.

Overview of the Research Methodology

This research seeks to understand how ammunition budget requirements stability (or instability) and outputs from MRP contribute to acquisition program risk. In order to accomplish this objective, the research focuses on legacy configurations of general purpose bomb warheads. The overarching objective is to describe the effectiveness of budget requirements planning processes and how those processes contribute to acquisition program risk for legacy configurations of general purpose bomb warheads.

In conducting this research, the qualitative descriptive case study methodology will be utilized. A variety of tools and historical results will be examined in an effort to characterize historical munitions budget requirements planning processes in order to achieve the outcome. In support of this research, the literature review and data analysis will focus on legacy munitions

budget requirements process planning output for general purpose bomb requirements followed by assessments for how fluctuations in those requirements impacted acquisition program risk.

Several variables and processes will be examined in support of this research. Some of the variables are inherent within processes used to estimate historical munitions requirements, as those processes have evolved over recent history.

One key assumption within the context of this analysis is that Military Services are applying the munitions requirements processes appropriately and accurately. The focus is not how to improve MRP, but how to interpret the output of MRP to appropriately identify and mitigate risks while ensuring sustained program success within the program parameters of cost, schedule, and performance.

Research Questions

This section highlights the research questions posed during execution of the research project. These questions will be used to guide the literature review, data collection, and data analysis. Throughout the analysis, the research will focus on the practical application and output of the MRP as well as seek to identify how strengths, weaknesses, or gaps in those processes contribute to acquisition program risk.

The central research question investigated is: How does general purpose bomb warhead budget requirements instability (spikes and decrements) introduce acquisition program risk? In researching this overarching question, several specific research questions will be asked as follows:

- What is the role and importance of MRP activities for general purpose bomb warheads for the purposes of budget requirements planning?

- What defines and affects budget requirements stability in the context of ammunition budget planning for the purposes of legacy ammunition?
- How does budget requirements stability impact acquisition program risk and organizations chartered to manage acquisition planning of legacy general purpose bomb warheads?

Objectives and Outcomes

As stated in the overview and research methodology section, above, the overall objective of this research is to describe the effectiveness of budget requirements planning processes and how those processes contribute to acquisition program risk for legacy configurations of general purpose bomb warheads.

One key outcome of this research is to understand the historical general purpose bomb warhead munitions requirements process and budget requirements outputs. A second outcome is to understand and describe how outputs of the MRP are used in the acquisition environment supporting procurement activities. A third outcome is an understanding of specific risks areas associated with or induced as a result of applying munitions requirements process outcomes to budget and acquisition planning activities. Finally, as strengths, weaknesses, and acquisition program risks are better understood, opportunities for improvements designed to reduce acquisition program risk within the process may be uncovered.

Limitations

This research is limited by a variety of factors. First, in order to maximize the usefulness of the research output while limiting the scope to a manageable level, this research will focus on USAF legacy general purpose bomb budget requirements. This limitation in scope is intended to

ensure the project is manageable and viable within the time and resource constraints while considering other demands of the Senior Service College Fellowship.

Another potential shortcoming of this research is that it does not consider direct commercial sales (DCS) or foreign military sales (FMS) of general purpose bomb warheads as supplied by the United States commercial industrial base. Therefore, impacts of the DCS or FMS marketplaces on the ability of the industrial base to produce and deliver ammunition to support DoD budget requirements are not considered. Two factors serve to overcome this shortcoming. First, Defense Production Act of 1950, Title 1, states “President is authorized to require that performance under contracts or orders (other than contracts of employment) which he deems necessary or appropriate to promote the national defense shall take priority over performance under any other contract or order” (Defense Production Act of 1950, as Amended, 2018, p. 3). It is assumed that US Military Service requirements take priority over the commercial marketplace and the risk of the DCS marketplace impacting assured readiness is not an issue. Second, actual delivery performance data for programs was not publicly available or investigated. Therefore, the risk of actual performance being skewed by DCS or FMS programs or requirements has been eliminated.

A third limitation of this research is related to the methodology. As previously stated, one key assumption within the context of this analysis is that Military Services are applying the munitions requirements process appropriately and accurately. Potential failures or shortcomings within the MRP contributing to elevated risk will not be addressed as part of this research.

Summary

Chapter 1 provided an introduction to this research. A description of the background, problem statement, and purpose of this study led to several research questions. The significance of the research was discussed and an overview of the research methodology was presented. Finally, anticipated research objectives and outcomes along with a discussion of research limitations was provided. Chapter 2 summarizes the literature review conducted as part of this research.

Chapter 2 – Literature Review

“The first phase of industrial mobilization is determination of requirements.” (Lincoln et al., 1950, p. 202). According to Lincoln et al. (1950), competition for finite economic resources means that requirements determination needs to balance military and civilian needs and that “military requirements must be reviewed and adjusted *continuously* in light of changing strategy” (p. 203, italics added). Determining requirements, as an iterative process, should seek to balance requirements of weapons, ammunition, personnel, international aid, etc. within a nation’s economic framework (Lincoln et al., 1950).

Chapter 2 begins with a summary of search criteria and an overview of research documents retrieved during literature search. This summary outlines search criteria, results, and outcomes which resulted in selection of literature review content. A review of the literature follows and is divided into four sections: *Ammunition Budget Requirements Stability*, *Munitions Requirements Planning Process*, *Non-military Examples of Requirements Planning*, and *Acquisition Risk Related to Budget Requirements Stability*. Each section provides literature reviews related to discrete aspects of the research questions, and sections were defined based primarily on literature review search outcomes.

Literature supporting Chapter 2 was retrieved from ProQuest Dissertations and Thesis, ABI Inform Global, and Military Databases as well as EBSCOhost and Naval Postgraduate School Dudley Knox Library databases. Search terms included: *munitions requirements process*, *MRP*, *ammunition budget requirements*, *ammunition AND requirements*, *ammunition budget stability*, *ammunition funding stability*, as well as *budget requirements* and *bomb budget requirements (stability)* coupled with *industrial base risk*. Initial search criteria resulted in over

fifty thousand hits of journals, dissertations, theses, and articles. Review of selected abstracts and refinement of search criteria narrowed the search to twenty-one thousand hits. Overview of abstracts and titles revealed a limited number of articles available which addressed the research topic specifically. After sifting through various abstracts and titles within search results, a total of twenty-two studies were selected for the literature review. Some of the articles are dated, but themes are still relevant.

Ammunition Budget Requirements Stability

Cain (1988) conducted qualitative research to identify historical and conceptual frameworks for understanding the problem of matching defense programs with defense resources. One strength of this research is the conclusion that “most fundamental problems in defense budgeting arise out of the lag between program decisions and actual expenditures, especially for defense investment programs” (Cain, 1988, p.1). Within the context of this research, defense investment programs are considered research and development, procurement, and military construction (Cain, 1988). This research is applicable as it relates to procurement of conventional ammunition. An additional strength of this research is the historical context it provides when evaluating defense budgets while considering pending defense spending reductions. Generated in the mid-1980’s, Cain’s (1988) research contemplated future political, budgetary, and economic factors which would likely prevent continued long-term growth in defense spending. Several factors contributed to spiraling complexity of the problem, such as increasing defense investment spending creates a backlog of funds, build-ups resulting in weapon system procurement increases future liability for operations and support, and budget reductions designed to close gaps between plans and resources can create inefficiencies in production programs (Cain, 1988). Measures historically designed to deal with budgetary

constraints like increasing weapons production timelines or minimizing operations and support funding yield short term savings, sacrifice military readiness, and potentially lead to increased defense investment with accompanying decline in real military power (Cain, 1988).

Meckstroth (2010) conducted initial stage qualitative research regarding the unfunded requirements process. Initiated in the mid-1990s, this process is intended as an opportunity for the Military Service Chiefs to identify to Congress items they were unable to include in their base budget submissions, but are in fact mission requirements (Meckstroth, 2010). Unfunded requirements are not included in base budget submissions largely due to budgetary constraints and the unfunded requirements process has been referred to as a ‘wish-list’ on behalf of the Military Services (Meckstroth, 2010).

One limitation of this research is that it did not investigate the process by which the Military Services develop their unfunded requirements list (Meckstroth, 2010). This limitation is partially addressed by the research question that seeks to understand the relationships between civil-military relations and the relationship between the legislative and executive branches (Meckstroth, 2010). By definition, unfunded requirements are not included in budget submissions, but are provided to Congress directly from the Military Services. Meckstroth (2010) notes this process highlights tension between the control that the civilian Secretary of Defense exercises over the military and “the obligation that service secretaries have to provide their opinion to Congress” (p. 6). Meckstroth (2010) did not investigate opportunity or potential for Military Services to exploit this conflict by intentionally omitting requirements from their base budget submission, instead relying on the unfunded requirements process to meet their needs.

One strengths of this research is that it seeks to identify what implications unfunded requirements have on defense budgeting and what insights do unfunded requirements provide with respect to the relationship between Congressional and Department of Defense leadership (Meckstroth, 2010). With respect to both of these research questions, Meckstroth's (2010) research offered insight. For example, the unfunded requirement list for fiscal year (FY) 2003 included a sizeable request for ammunition (Meckstroth, 2010) and some members of Congress questioned why "something so essential was not adequately funded" (Meckstroth, 2010, p.15). This detail highlights a potential failure in either the output of the MRP process for ammunition or calls into question the budgeting effectiveness designed to address stated MRP need. The unfunded requirements process is a source of potential budget instability should ammunition requirements above and beyond MRP outputs be introduced as unfunded requirements.

In a peer reviewed article, Bruno et al. (2017) investigated the promise of high quality results at a fixed price and specification stability using methods of best value procurement. The research studied how specification stability and instability impacted performance of a biogas product. One strength in the findings is that due to instability in specification, additional work was required on behalf of the contractor and additional costs were realized on behalf of the buyer (Bruno et al., 2017). A weakness of this study is that it does not directly apply to the military defense industrial base or ammunition commodities, and uses a commercial biogas project as the subject for case study. Bruno et al. (2017) concluded that "narrow application of best value procurement principles is not helpful in coping with complexity" (Bruno et al., 2017, p.1465). However, the virtues of best value procurement with respect to requirements stability can be applied as a catalyst for change in the way traditional practices for procuring activities can be assessed (Bruno et al., 2017).

Brockmann (2011) presented a qualitative case study through analysis of the USA's historical procurement and research and development budgets over six years. One strength of this research is that it concluded the USA's ability to manage and defend budget requests could be enhanced by "improving the quality of congressional engagements and proposing incremental changes to program funding" (Brockmann, 2011, p.iii). Additionally, Brockmann (2011) suggested that "the Pentagon's complex acquisition process, defense industry's singular focus on profits, and traditional congressional interests in local economic benefits all contribute to volatile program funding and constrain the Army's efforts to manage and defend its budget request" (Brockmann, 2011, p.iii). Although the defense industry's singular focus on profits has led to an established community of lobbyists operating on behalf of commercial industry, Brockmann (2011) notes that defense companies contribute to individual program funding volatility, but "do not have a stronghold on the budget process" (p. 56). One weakness of this research is that it focuses on USA budget stability which is outside the scope of the USAF budget perspective and does not include reference to legacy general purpose bomb warheads. A second weakness of this research is the small historical sample size: only six years of budget data and four years of congressional engagement historical records were cited.

Skogstad (2014) used theoretical modeling and empirical analysis to provide insight into how national defense budgets are formulated. Within the context of budget requirements stability, this research is relevant because it considers external factors outside domestic borders as contributing factors to domestic defense spending. Gaps in knowledge are addressed "for how events that occur and decisions that are made in one country can ultimately impact the military spending of another country" (Skogstad, 2014, p.1). The research concludes that threats posed by foreign entities should be the primary driver for a nation's defense spending (Skogstad, 2014)

and that “it is ultimately the threat posed by foreign countries which provides the justification for any significant change in defense spending” (Skogstad, 2014, p.2). Another strength of this research is its discussion for when a country would adopt a policy of producing weapons domestically versus importing weapons (Skogstad, 2014). Each approach yields benefit and risk, and each results in varied impacts on the host and supplier nation’s defense industrial base. One weakness of this research is the presentation and reliance on counterfactual scenarios used to support the theoretical conclusions derived from assumptions and quantitative weapon systems performance data. Although data are used to support the analyses, the counterfactual approach is impossible to prove and sensitivity analyses for counterfactual scenario outputs as a function of system performance data inputs are not provided.

Munitions Requirements Planning

The problem of accurately computing military ammunition requirements is not new. Post World War II, Archer (1950) investigated the USA’s methodology for computing end item ammunition requirements. The purpose of Archer’s (1950) research was to analyze the process of the time, discover or propose alternate methods for arriving at the sum of military munitions requirements, and determine a process for meeting the munitions requirements needs of the military while minimizing the impact of defense requirements on the national economy (Archer, 1950). Economic considerations are still relevant. As of 2015, Brookings’s reported that U.S. Defense spending represents between 3.0-3.5 percent of US gross domestic product (GDP) (O’Hanlon, 2015). Although this figure is lower than that of Archer’s era, with U.S. Defense spending equating to roughly eight to ten percent of GDP in the 1950s and 1960s, it still represents a significant economic investment: roughly \$600 billion annually in 2015 (O’Hanlon, 2015).

One strength of Archer's (1950) research is the conclusion that there is "no room for precautionary over-statement of military needs" and that any "stockpile built up to allow for margin-of-error, safety factors and such contingencies would mean denying the nation some other needed asset" (Archer, 1950, p.5). Accurately identifying munitions requirements to optimize the allocation of resources becomes increasingly important when considering potential future reductions in defense spending coupled with non-defense economic strategic policy. This conflict was summarized by Secretary of Defense Roger M. Kyes, who in 1953 noted that unrealistic requirements or poor planning result in a financial resource inefficiency, poor utilization of personnel resources, and an "unnecessary drain of materials from the civilian economy as well as inefficient use of tools, equipment, and facilities" (Archer, 2015, p.10). Although Archer's research is nearly 70-years old, several themes are still relevant. Archer (2015) identifies both modernization needs as well as foreign military aid as a complicating factors to munitions requirements planning and stocks replenishment.

Wilson (1990) summarizes a qualitative methodology for generating 'quick and dirty' estimates for military petroleum, oils, and lubricants (POL). The primary focus of this research was forecasting "POL requirements of USA units operating in different tactical environments and optimizing the transportation, distribution, and storage of bulk POL supply" (Wilson, 1990, p.iii). An obvious weakness of this research is the focus on POL instead of conventional ammunition. Additionally, the output of this research includes a computer model to assess effectiveness. Effectiveness of that model is validated through hypothetical case studies constructed to successfully validate and advocate for the model's implementation. This highlights a potential significant bias in the research. Relevance of this research to the conventional ammunition budget requirements planning process is found in the research's

conclusions. Wilson (1990) advocates expanding the database and database evolution across the Military Services and to include ammunition commodities within the database for the purpose of effectively forecasting requirements. This approach relies on the definition that conventional ammunition be considered a commodity like POL, but with unique characteristics. Additionally, a strength of this research is Wilson's (1990) advocacy for the real-time application of the techniques "for reporting unit supply and repair parts status" (Wilson, 1990, p.15).

Implementing and optimizing this approach could be used to "redefine periodic procurement, maintenance, allocation, and strategic fuel reserve requirements" (Wilson, 1990, p.15). It is unclear from the literature reviewed to date whether an optimized system for managing real-time ammunition expenditures and using those outputs to inform near-term ammunition procurement decisions was developed or implemented.

Kassing et al. (1991) examined "models and criteria used by the military services to compute their requirements estimates" (Kassing et al., 1991, p.v). This qualitative research sought to understand varied methodologies and make recommendations for improvement to the Office of the Secretary of Defense (OSD). Each Military Service's ammunition requirements development model was summarized within this research. Furthermore, observations regarding variation in analytical methods and planning factors, common considerations, and strengths and weaknesses (Kassing et al., 1991) were presented. Kassing et al. (1991) identified variation in the models used for estimating conventional munitions requirements across the Military Services. These included, but were not limited to, level of detail assumed in combat scenarios, the treatment of resupply, the role of cost competition, and variation in the use of target value (Kassing et al., 1991). One strength of this research is the analysis of the processes used by each Military Service for calculating munitions requirements. Findings of the research concluded that

the processes used to calculate munitions requirements are lengthy (Kassing et al., 1991), taking upwards of 10-12 months to complete. A second strength of this research is the overall approach to provide descriptive summaries of each Military Service's munitions planning process, identify observations on the differences, and suggest improvements for consideration. Improvements were divided into near-term recommended actions and more fundamental reform recommendations to support OSD strategy (Kassing et al., 1991).

The current DoD MRP establishes policy, assigns responsibility, and prescribes “procedures for generating, developing, and disseminating DoD MRP products pursuant to the Secretary of Defense” Guidance for Development of the Force (GDF) and Guidance for the Employment of the Force (GEF) (DoDI 3000.04, 2018, p.1). Additionally, DoD MRP establishes total munitions requirements, establishes DoD MRP steering committee as well as working group, and identifies the DoD Analytic Agenda products as the basis for generating munitions requirements (DoDI 3000.04, 2018). Both near-year and out-year munition requirements are to be based upon these products (DoDI 3000.04, 2018). Analytic agenda products are comprised of current baselines reflecting Combatant Commander plans and force management decisions as well as descriptions of “near-term to long-term scenarios, concepts of operation (CONOPS), forces, and baselines which may require DoD resources and/or capabilities” (DoDD 8260.05. 2011, p.2).

Strengths within the DoD MRP include outputs which characterize munitions requirements with consideration to ‘unconstrained’ as well as ‘constrained’ inventories. These outputs are characterized as near-year and out-year constrained and unconstrained TMR data points. As discussed in Chapter 1, TMR is a combination of WRMR, training requirements, and

testing requirements (DoDI 3000.04, 2018). The WRMR includes combat requirements, strategic readiness requirements, and current operations/forward presence requirement (DoDI 3000.04, 2018). Potential weaknesses within the DoD MRP is the development and submission timing for MRP analyses and phased threat distribution (PTD) assessments as well as clarity with respect to PTD risk assessments.

Challenges with respect to PTD assessments cross service boundaries. Widdowson (1998) proposed in a Master's thesis that historically each Military Service requests munitions while considering itself in isolation. Addressing munitions acquisition from a joint perspective, thus eliminating the inevitable outcome of excessive munitions for the DoD as a whole, were objectives of the Capabilities-Based Munitions Requirement process (Widdowson, 1998). The purpose of Widdowson's (1998) research was to develop a quantitative programming model to identify the optimal allocation based on three objectives: "minimize friendly casualties, maximize enemy casualties, and maximize adherence to the guidance delineating a proper division of labor among the services" (Widdowson, 1998, p.i). One strength of this research is that it provides an aid to PTD development in support of joint ammunition acquisition goals, potentially reducing inefficiency, eliminating redundancy in projected capability requirements, and identifying optimal PTD to support follow-on MRP. One weakness of this study is that data collection in support of the models proposed is just as cumbersome as past data collections activities required for adequate PTD analyses.

Loeb (2005) provides a qualitative dissertation which proposes a capabilities based framework for analyzing Precision Guided Munitions (PGM) purchasing decisions. Within this research, an exploratory analysis is presented to understand how changes in "budget, production

capacity and preparation time affect the optimal munitions portfolio for a single war scenario” (Loeb, 2005, p.ii). This qualitative research includes several strengths, and is likely the most recent, relevant resource uncovered during the literature review. Additionally, bibliography resources from the Loeb (2005) study were identified and included as part of this literature review. Strengths of this research include its reference to cited ongoing and unaddressed problems with the existing MRP leading to the conclusion that “*requirements don’t match the reality*” (Loeb, 2005, p. 7, italics added). Additionally, this research incorporates themes identified in other research regarding decision-making techniques, concluding that consideration to budget, production capacity, preparation time, and other economic factors can result in “improved and flexible munitions portfolios that perform well across a variety of possible futures while operating within an economic framework” (Loeb, 2005, p.ii). Thirdly, this research highlights and investigates ongoing problems with MRP including the large number and type of modeling methodologies, the duration and complexity of MRP, outdated modeling assumptions, and sensitivity of MRP output to input assumptions (Loeb, 2005). One weakness of the Loeb (2005) research is that it focuses on PGM planning, not conventional ammunition. Loeb (2005) suggests that PGM stocks are more sensitive to the planning process since they are generally more expensive and complex, built by private subcontractors, are in high demand, and have a short shelf life relative to traditional unguided munitions. However, in a resource constrained environment, one could argue that capabilities-based techniques applied to improve PGM planning effectiveness may benefit planning activities for other types of munitions.

Some of the problems with the MRP cited by Loeb (2005) are discussed in the Holman (2001) Government Accountability Office (GAO) report on the limited reliability of the output of the munitions requirements determination process. Holman (2001) reiterates the importance

of MRP accuracy as the output which defines the “numbers and types of munitions necessary to defeat potential threats, affects munitions planning, programming, and budgeting decisions, and influences industrial production base decisions” (Holman, 2001, p.1). The research suggests that although DoD is improving the munitions procurement requirements determination process, there is still work to be done. Strengths of the research include discussions of ongoing efforts of the time, to include identifying weaknesses and improving the coordination of the threat assessment process, revising post-engagement enemy repair rates and assessments, improvements to the target allocation process, and increasing the comprehensive nature of the DoD’s MRP risk assessment process. The research also provides several recommendations for executive action typical with the GAO reporting output.

Persistent problems implementing MRP improvements were subsequently identified in a GAO letter to Secretary of Defense Donald Rumsfeld in 2005 (Jarmon, 2005). This letter acknowledged continued DoD efforts to establish linkages between Combatant Commanders’ needs and purchasing decisions of the Military Services, but identified persistent problems implementing DoD MRP guidance as (Jarmon, 2005):

- “The Defense Intelligence Agency (DIA) did not coordinate with combatant commanders prior to developing threat reports. According to USFK officials, updated intelligence information was not included.
- DIA Threat Reports needed by the combatant commanders to produce PTD’s were late. According to United States Forces Korea (USFK) officials, they had to develop PTD’s on prior year threat reports.
- Only the Air Force coordinated with USFK prior to modeling munitions requirements, the other services developed their requirements independent of USFK involvement.
- None of the services coordinated with USFK on the results of their individual modeling processes prior to development of Program Objective Memorandum

(POM) submissions. As a result, there were no assurances that combatant commander munitions needs were met.” (Jarmon, 2005, p.3)

Haraburda (2017) conducted quantitative research assessing the maturity of supply chain management (SCM) models at Crane Army Ammunition Activity in Crane, Indiana. Although SCM activities focus on excess inventory levels, inadequate controls, and cost overruns (Haraburda, 2017), this research reveals the “DoD continues to lack outcome-focused performance measures for its SCM initiatives” (Haraburda, 2017, p.658).

The SCM assessment generated within Haraburda’s (2017) research is outside the scope of MRP activities and focuses primarily on how organizations support “the projection and sustainment of a ready, capable force through globally responsive, operationally precise, and cost-effective joint logistics support for America’s warfighter” (Haraburda, 2017, p.658). However, one strength of this research is the direct thematic applicability to MRP through the application of metrics, understanding of requirements, and coordination throughout the Government and commercial defense industrial base (Haraburda, 2017). Research revealed several conclusions and recommendations for consideration. First, questions within the quantitative survey were based on the premise that respondents possessed a common understanding of SCM (Haraburda, 2017). Data analysis suggest that some respondent’s answers may have been based on intuition and may have been “more appropriately identified within the ‘I do not know’ selections” within the survey (Haraburda, 2017, p.674). This limitation identifies the importance of organizational knowledge and understanding in meeting the intent of the research; two of five research recommendations were related to improving workforce skills related to SCM. Secondly, the research suggested that completing continuous improvement efforts with supplier involvement is a way to improve relationships between

government and commercial suppliers (Haraburda, 2017). The relevance of relationships between government and commercial suppliers within the defense industrial base emerged as an important factor in other areas during this literature review.

One weakness of this research is the small sample size. Haraburda (2017) indicated that only forty percent of respondents provided survey responses. Distribution of responses indicated a favorable distribution of data and responses across functional areas (command, logistics, manufacturing & engineering, and staff), but the total number of responses received was not specified. Haraburda (2019) reported that the command group response represented 10.3% of data retrieved and included a population of three maximum respondents. Using these data points as a basis for analysis, and assuming all command group respondents provided input, it is calculated that a maximum 30 respondents completed the survey.

Non-military Examples of Requirements Planning

Baharmast (2004) investigated methodologies and proposed models which evaluated benefits of business process collaboration within supply chain metrics in a qualitative case study dissertation. The research aimed to “construct a decision framework for the adoption of supply chain collaboration technologies” (Baharmast, 2004, p.x) and proposed there are significant benefits, as well as difficulties, to implementing business process collaboration in supply networks. Furthermore, this research suggested that implementing supply chain collaboration technologies is “dependent upon a range of economic, technological and cultural conditions” (Baharmast, 2004, p.x). One strength of this dissertation is its inclusion of case studies which describe military supply as well as non-military supply chain models and challenges which highlight the need for and benefits to collaboration. For instance, a USAF model in adopting

business process collaboration supporting aircraft spare parts was investigated. However, within the collaboration variables investigated: microeconomic conditions, technology conditions, and cultural conditions, results were not favorable for the implementation of business process collaboration. For instance, although microeconomic conditions generally favor business process collaboration, the USAF's "large number of trading partners and desire to adopt the mass market model..." may serve as an implementation barrier (Baharmast, 2004, p. 178).

Additionally, factors related to the USAF's high degree of business process complexity as well as the hierarchical organizational structure and slow decision-making represent barriers to implementing technology and cultural collaboration techniques, respectively (Baharmast, 2004, p. 178). A weakness of this dissertation for the purposes of this study are that inert spare parts, not conventional ammunition are investigated, leaving a gap with respect to the nature of MRP.

One strategy used by commercial industry to improve effectiveness in meeting customer needs is materials requirements planning. Diehl and Armstrong (2011) assessed and summarized this strategy and noted the idea of materials requirements planning is for companies to have sufficient material and components on hand to produce subassemblies before parts are actually needed (Diehl & Armstrong, 2011). The strength in this approach is that by developing a comprehensive understanding of production capability and risks, companies generate a deeper understanding of their own environment as well as factors such as economic order quantity and manufacturing critical path (Diehl & Armstrong, 2011). One weakness of this article is that the unique environment introduced by MRP in the defense context is not considered. Admittedly, this article was not written with a focus on defense. However, ammunition budget requirements instability and varied MRP and ammunition budget outputs over time may limit effectiveness of traditional and innovative commercial tools designed to improve efficiency.

Acquisition Risk Related to Budget Requirements Stability

Accurately computing, planning, and executing ammunition budget requirements is critical for identifying capability gaps and investment opportunity within the defense industrial base. Overestimating requirements will potentially result in unnecessary investment in capability, inadvertently diverting resources from other priorities. Underestimating requirements will potentially disguise capability gaps that would otherwise manifest themselves as capability shortfalls during times of surge.

Such was the case in the early years of the 21st century when investment and modernization efforts were undertaken at Lake City Army Ammunition Plant (LCAAP) to help meet the increased need for small caliber ammunition. Modernization efforts increased production capacity from “800M rounds in fiscal year 2001 to approximately 1.2B rounds per year in July 2001” (Calvaresi-Barr, 2005, p.12). Even so, LCAAP was unable to meet fiscal year 2004 requirements, forcing the USA to source small caliber ammunition from the commercial marketplace (Calvaresi-Barr, 2005). It is estimated that DoD paid roughly \$10M more for the 313M round of ammunition procured commercially, but the GAO did not conduct a second-layer analysis for whether maintaining a more robust capability at LCAAP would have been more cost-effective (Calvaresi-Barr, 2005). The link between acquisition risk and budget requirements stability can be characterized by the defense industrial base’s ability to produce and deliver required capability in a timely manner: a resilient and sustainable defense industrial base addresses this interrelationship.

Hamid (2014) investigates the fragility of the defense industrial base in qualitative historical research that seeks to understand and identify vulnerabilities. One outcome of this

research suggests that the critical importance of the defense industrial base is poorly addressed in both threat and single point failure assessments (Hamid, 2014). One strength of Hamid's (2014) research is the conclusion that "if ammunition is the lifeblood of the fighting forces, then having the appropriate types available in the required quantities is essential to combat effectiveness" (Hamid, 2014, p.v). Appropriate ammunition procured in the required quantities in support of combat effectiveness exposes the importance of MRP in planning for and sustaining an effective defense industrial base. Another strength of this research is relevance. Produced in 2014, this research capitalizes on lessons learned since September 11, 2001 and throughout the global war on terror. One weakness of this research is that it maintains the most effective solution is consistent with the historical paradigm of government-ownership. Although commercial solutions are discussed, the research concludes that 'Limited resources coupled with a limited number of customers for military systems makes it apparent that there needs to be more than one redundant producer of a system or subsystem, and they must be government owned facilities as a commercial entity cannot operate at a loss or without limited customers indefinitely without becoming defunct' (Hamid, 2014, p.74). A notable conflict exists when considerations such as limited resources and limited customers are paired with the suggestion of redundant production capability.

Risks outlined within Hamid's (2014) research were also introduced nearly two decades prior by Nichols (1995). Nichols (1995) addressed the problem of how to manage the defense industrial base during periods of defense downsizing to ensure it is "correctly shaped to provide what is needed in the future to meet DoD's military requirements" (Nichols, 1995, p.iii). The research tested the hypothesis that DoD methods at the time were not capable of identifying critical capabilities within the defense industrial base to meet 21st century national security

objectives and proposed an analytical framework with which to evaluate DoD's current defense industrial base management methodologies (Nichols, 1995). Research concluded that processes and methodologies used by the DoD were "incapable of providing the necessary defense industrial base capabilities to meet the future requirements" (Nichols, 1995, p.iv). Nichol's (1995) recommendation was for a wholesale restructuring of the industrial base management structure within the DoD (to include data collection, analysis, and management focus) with the intent of preserving "only the most important, essential, unique, endangered capabilities of the defense industrial base" (Nichols, 1995, p.v).

Although budget requirements stability was not a focus of Nichols' (1995) research, an overall strength of Nichols' (1995) findings was related to the recommendation that it be structured to meet the needs of the DoD in the future. As discussed in Chapter 1, requirements should drive capability, capability should not drive requirements. Nichols' (1995) research suggests that the future defense industrial base be responsive to requirements, that it be "a smaller, more robust, agile enterprise that becomes almost indistinguishable from the commercial industrial base" (Nichols, 1995, p.132) and proposed an integrated and comprehensive industry standard approach to achieving this goal. It is likely that some of Nichols' (1995) findings were incorporated into the SMCA original Industrial Base Strategic Plan, yet considering the findings of Hamid (2014), there is still work to be done. Another strength of this research is its consideration for both a commercially viable model of industrial base management as well as recommendations for broader commercial engagement in supporting DoD requirements as a whole. The military-commercial industrial base structure proposed relies on civil-military integration. This integrated relationship is defined as the process of uniting the defense and commercial technology and industrial bases into a unified national technology and

industrial base where “common technologies, processes, labor, equipment, material, and/or facilities would be used to meet both defense and commercial needs” (Nichols, 1995, p.xi). This represents an evolution to the National Technology and Industrial Base (NTIB) which was shaped through provisions in the FY93 National Defense Authorization Act (NDAA).

Neither of the above literature findings relating to the historical and more current state of the defense industrial base specifically address conventional ammunition budget requirements stability. However, each of the literature findings suggest vulnerability to a variety of other factors both internal and external. In order to overcome these vulnerabilities, Nichols (1995) suggests the industrial base needs to be better positioned to ensure responsiveness to requirements.

Page (1966) conducted a qualitative study of the defense procurement program decision-making process of the time. The analysis focused on how and when procurement decisions are made in terms of what to procure, how much of an item to procure, and cost and schedule considerations surrounding those decisions. As with other research within this category, Page (1966) noted that requirements of defense materiel “have their origins in the uncertainty of the military threat to our national security” (Page, 1966, p. 1). In seeking to improve the processes by which program decisions are made, Page (1966) investigated the military, political, and economic considerations of these decisions. The overall conclusion of the research is that “defense procurement decision making is less effective than it should and can be” (Page, 1966, p1). One strength of this research is the identification of eight primary barriers to effectiveness. The barriers proposed by Page are as follows: (Page, 1966):

- “Difficulty in reducing national security policy to specific planning guidance.

- Inconsistency between the basic organizational concept of the Department of Defense and the ‘program and appropriation structures’.
- Lapsed time between the recognition of a requirement and the attainment of operational capability.
- Limitations of twelve-month program and budget periods.
- Inordinate centralization of program and financial decision making in the Office of the Secretary of Defense.
- Demands that more and more detail be furnished the Office of the Secretary of Defense and the Bureau of the Budget.
- Overemphasis and over-reliance upon quantitatively based systems analysis.
- Inadequate preparation of individuals called upon to perform the procurement programming task.” (Page, 1966, p.1-2)

Another strength of the above research is that it identifies an over-reliance on quantitative budget requirements analysis for decision making. However, the research does not sufficiently address or defend a viable alternative. Page (1966) suggests that procurement program decisions are arrived at through “complicated and esoteric routes not easily comprehended or accepted by those individuals who must make and review the decision” (Page, 1966, p. 248). The alternative proposed is one of comparative analysis and choice based primarily on economic and other financial considerations, driven by military value judgement at the appropriate decision-making level (Page, 1966). The limitation in this approach is that it ignores complications of qualitative decision making within the context of program accountability, audit requirements, and potential statutory reporting requirements.

A weakness of this research is the timeframe during when it was conducted. Page (1966) advocates for longer program timeframes while shortening the programming process. Although benefits to shortening the program process may result in greater responsiveness to changing requirements, lengthening the program timeframes introduces other complexities such as responsiveness to rapid technological improvement. For legacy systems, however, the recommended approach of shortening the programming process while lengthening program

timeframes may be considered a strength when you consider Page's (1966) conclusion that "the program-budget preparation and justification cycle is generally considered to take overly long" (Page, 1966, p. 216).

Webb's (2003) peer reviewed journal article concluded that inadequate funding throughout time has resulted in diminishing contractor base with a "limited capacity and even less surge capacity" (Webb, 2003, p.45). The recommendations proposed by Webb (2003) suggest the USAF move beyond traditional requirements-based funding and look toward an industry-based approach. This approach would mean the USAF "continually purchase commodities at the negotiated minimum sustainable rates for industry" (Webb, 2003, p.45), thus minimizing risk while strengthening the ammunition industrial base. The problem proposed by Webb (2003) is that once MRP analyses are complete, the USAF uses the minimum quantity figures as a placeholder for *if* that particular ammunition commodity is to be purchased. Webb's (2003) conclusion is that in order "to provide stability to the munitions industrial base, the minimum quantity for each required commodity should be bought to ensure the production capability remains intact" (Webb, 2003, p.35). One strength in this article is the advocacy that the USAF "work with industry to validate the minimum quantity required to keep the production lines warm and negotiate an affordable arrangement" (Webb, 2003, p.35). This approach can help minimize risk to the defense industrial base as it relates to budget requirements instability. However, one weakness in this approach is that it prioritizes all types of required munitions. In increasingly fiscally constrained environments, everything is a tradeoff. Procuring conventional ammunition in an effort to simply maintain a production base requires resources which may be needed to procure or invest in other capabilities designed to meet alternate threats.

In a peer reviewed journal, Ferrari (2009) discusses the fragility, decline, and risk to the conventional munitions industrial base. Ferrari (2009) references that “fifty-six percent of the end items” produced by the conventional munitions industrial base have no peacetime demand and “seventy percent of the firms have exited leaving over three hundred critical single points of failure” (Ferrari, 2009, p.159). Ferrari (2009) supports an economic framework based on the argument that the current business model is ineffective due to the rational behavior of the private sector. In the article, Ferrari (2009) suggests that although revenues temporarily increased due the Global War on Terror, declining requirements as well as a constricted conventional munitions industrial base (seventy percent of firms have exited) means the military’s almost total reliance on the private sector is highly inappropriate (Ferrari, 2009). Therefore, with consideration to business, leadership, market, and investment considerations, Ferrari (2009) advocates the following in an effort to transform and protect the munitions industry: decrease “private sector involvement from ninety-five percent of production to somewhere around fifty percent” (Ferrari, 2009, p.164) Ferrari’s (2009) journal article acknowledges this approach is contrary to “decades of government policies and is the antithesis of economic theory” (Ferrari, 2009, p.166). Still, Ferrari (2009) states it must be done. Change is required due to the importance and uniqueness of the conventional ammunition industrial base as it relates to national security (Ferrari, 2009). One weakness of this research is the premise that more government involvement is the only way to sufficiently emphasize primacy of wartime effectiveness (Ferrari, 2009). This premise does not consider mechanisms currently in place such as Defense Production Act Title 1 provision (Defense Production Act of 1950, as Amended, 2018) used to influence private sector behavior.

Chou's (2011) research seeks to develop a quantitative model to assess program robustness through an understanding of technology performance and development uncertainty. Although this research does not address budget instability or legacy munitions, the relevance comes in the conclusion that "lack of robustness stems from the fact that immature technologies have uncertainties in their expected performance, development cost, and schedule that cause variations in system effectiveness and program development budget and schedule requirements" (Chou, 2011, p. xxvii). By better understanding development uncertainty and technology performance, reduction in risk related to program budget and schedule requirements may be achieved. For legacy systems, this conclusion may be reshaped to state that by better understanding overall legacy munitions budget requirements to meet known and perceived threats as well as the industrial base capability to produce and deliver those requirements, risk related to program cost and schedule requirements may be reduced.

Shin (2016) proposes a quantitative model for understanding the interrelationship between variables of "requirement changes, unit quantity changes, and cost of major programs" (Shin, 2016, p.v). Requirement changes and unit quantity changes are investigated primarily with impact to cost of programs assessed as an output. One strength of this research is that it acknowledges that "initial cost estimates for MDAPs (Major Defense Acquisition Programs) do not take into account factors such as changes in goal or procurement quantity" (Shin, 2016, p.20). Another strength of this research is that it suggests that "unit quantities on acquisitions have the highest impact on the acquisition cost" (Shin, 2016, p.25). The research highlights four MDAPs which suffered from reduced buying power as a result of decreases in unit quantities. The results of these reductions were increased system unit costs between 26 and 315 percent (Shin, 2016). One key takeaway from Shin's (2016) research is the importance of time delay

within the model's feedback loop. "Time delay from actual unit cost to cost of requirement creates an oscillating behavior to the balancing loop" (Shin, 2016, p.84). Effectively, time delay between identifying and executing requirements or procurement quantity contributes to additional instability and risk. One weakness of this research is that it focuses primarily on MDAPs and not on legacy conventional ammunition.

Conclusions

Chapter 2 contains a summary of search criteria and a summary of research documents retrieved during literature search and related to the research topic. The chapter provided literature reviews for four categories related to the research topic to include: *Ammunition Budget Requirements Stability*, *Munitions Requirements Planning Process*, *Non-military Examples of Requirements Planning*, and *Acquisition Risk Related to Budget Requirements Stability*.

Throughout the literature review, several themes emerged as they relate to the research questions. First, the MRP system is well-defined. However, several aspects of the process contribute to ongoing challenges as well as opportunities for improvement within the MRP process. Failure to account for variation in methodology for calculating munitions requirements or failing to coordinate requirements with other stakeholders introduces budget requirements instability. This instability manifests as acquisition program risk considering the condition, age, and responsiveness of the defense industrial base. Key considerations such as the overarching business model, leadership philosophy, market conditions, and investment considerations further complicate this problem with respect to the commercial defense industrial base. These considerations, in addition to uncertainty and instability, serve as disincentives for investment in capability to meet requirements or plan for surge capability. Next, collaboration between

government and commercial participants in the defense industrial base emerges as a potential mechanism to begin resolving the above challenges. Finally, the commercial sector has implemented processes such as materials requirements planning to address inefficiencies and uncertainties in their marketplace with the intent of characterizing risk and stabilizing the production environment. This theme revealed benefits to integrating commercial processes in the defense planning process with consideration to industrial base capability, economic order quantity, and materials requirements planning tools in support of improved efficiency. Again, literature review of research revealed examples of supply chain activities and models which highlight the need for and benefits to collaboration.

Summary

In summary, the literature review did not uncover research pertaining to MRP outputs and their impact on budget requirements stability for legacy configurations of general purpose bomb warheads. Some research related to air-delivered munitions was discovered pertaining to PGM, but those technologies are vastly different from the subject of this research. Therefore, it has been concluded that within the limitations of this research project as well as supported by the findings of the literature review, this research project is unique.

Chapter 3 – Research Methodology

The primary objective of this chapter is to describe the research design in sufficient detail to facilitate understanding as well as describe key research processes and methods for collecting and analyzing data.

As noted in Chapter 1, the purpose of this study is to investigate and understand how the historical processes for munitions requirements planning of legacy configurations of general purpose bombs impacts overall acquisition program risk from a cost, schedule, and performance perspective. In seeking to understand these impacts, a qualitative descriptive case study of historical output of the munitions requirements process will be investigated along with accompanying acquisition risks. Research questions were formulated to understand how general purpose bomb warhead budget requirements instability (spikes and decrements) introduce acquisition program risk. In support of research related to this topic, the following research questions were generated and introduced in Chapter 1:

- What is the role and importance of MRP activities for general purpose bomb warheads for the purposes of budget requirements planning?
- What defines and affects requirements stability in the context of ammunition budget planning for the purposes of legacy ammunition?
- How does budget requirements stability impact acquisition program risk and organizations chartered to manage acquisition planning of legacy general purpose bomb warheads?

Research Design

This research seeks to understand how ammunition budget requirements stability (or instability) and outputs from MRP contribute to acquisition program risk. In order to accomplish

this objective, the research focuses on legacy configurations of general purpose bomb warheads. In conducting this research, the qualitative descriptive case study methodology was utilized to describe the effectiveness of budget requirements planning processes and how those processes contribute to acquisition program risk for legacy configurations of general purpose bomb warheads.

A variety of tools and historical results were examined in an effort to characterize historical munitions requirements planning processes to achieve the outcome. First, numerous resources were used to conduct literature review on the research topic. During the literature review, it was determined this research is unique within the limitations of this project. Literature was drawn from a variety of sources to include ProQuest Dissertations and Thesis, ABI Inform Global, and Military Databases as well as EBSCOhost and Naval Postgraduate School Dudley Knox Library databases and was limited to theses, dissertations, and peer-reviewed journal articles.

Second, a supplemental literature search was conducted in order to identify and characterize historical outputs of the MRP process for general purpose bomb warheads. Historical budget documents were used as source data for searches related to historical requirements and were retrieved through public domain. Additionally, ProQuest, ABI Inform, and EBSCOhost web searches were used to collect additional sources of data related to research questions using search criteria similar to those used to support the literature review. Search terms included *munitions requirements process*, *MRP*, *ammunition budget requirements*, *ammunition AND requirements*, *ammunition budget stability*, *United States bombs industrial base*, *budget instability*, as well as *budget requirements* and *bomb budget requirements (stability)*

coupled with *industrial base risk*. Data obtained were analyzed and used to provide additional context to the research and findings.

Third, actual program performance and budget data were drawn from publicly available and recorded sources. Some limitations existed as they relate to performance data with the SMCA's organizational program management and performance systems. These data are not publicly releasable and therefore outside the available data within the scope of the DAU research methodology.

Finally, research themes were identified or validated and were qualitatively assessed against findings uncovered during data collection. In support of this analysis, qualitative correlations between historical budget requirements and actual program performance and data were developed. The intent of the research was to provide a qualitative assessment of performance based on historical and publicly available data.

Several variables and processes were examined in support of this research. Some of the variables are inherent within processes used to estimate historical munitions requirements and those processes have evolved over recent history. As a result, data were bound to minimize the impact to process or organizational change over time. Two important variables were key in developing the data analysis for the research questions: historical budget requirements as a function of time and actual program performance and risk data for legacy general purpose bomb warhead procurement programs.

Data Collection

As previously discussed, a variety of tools were used and historical data were examined in an effort to characterize historical outputs of the munitions requirements planning processes and achieve the desired outcome of this research. The processes and methods used to collect and

analyze data are described as follows. First, the Chapter 2 literature review informed the conclusion this research is unique within the limitations of the research project. Second, supplemental literature review was conducted in order to inform data analyses and included resources beyond theses, dissertations, and peer-reviewed journal articles. The intent of expanding data collection was to provide additional context to the research and findings. Finally, to support the data analysis, actual ammunition budget requirements and program performance and risk data were analyzed after being collected from relevant and historically factual public sources.

Bias and Error

In an attempt to reduce bias and error, actual budget requirements data were collected as a basis for analysis and only data within the public domain was considered due to the constraints of the DAU research methodology. Error, however, may be introduced based on two key considerations in conducting this research. First, actual program performance data were unavailable within the public domain. Performance data in this context is defined as time between fiscal year of program and delivery completion. Delivery completion is defined as the point in time which the last ammunition item is received at depot or final destination. This limitation may not expose program risks associated with delayed receipt of funding, nor does it consider phased, early, or partial program deliveries which may have been used as mitigation strategies to ensure readiness objectives. Second, this method did not consider deliberate delays associated with prioritizing one conventional ammunition end item over another due to capacity or infrastructure limitations within the commercial or organic industrial base. As noted above, these factors could potentially be used as mitigation strategies. Had delivery completion and actual program performance data been available within the public domain, additional insight

regarding program risks and the general risk related to the fragility of the defense industrial base could have been obtained.

Additional potential bias and error is related to the population of data selected and availability of historical records. As previously discussed, some variables are inherent within processes used to estimate historical munitions requirements and those processes have evolved over recent history. As a result, data will be bound to minimize the impact to process or organizational change over time, and will be restricted to fiscal years 2008-2019.

One final key assumption within the context of this analysis which may introduce error is that Military Services are applying the munitions requirements processes appropriately and accurately. As previously stated, the focus of this research is not how to improve MRP, but how to interpret the output of the MRP to appropriately identify and mitigate risks while ensuring sustained program success within the program parameters of cost, schedule, and performance.

Validity of Research

The following paragraphs describe steps taken to ensure validity of this research. Throughout this research, DAU resources were used extensively to ensure validity. For example, the DAU research advisor, DAU research director, and DAU librarian advised content and research literature reviews. Additionally, to the best of my ability I have exhausted all resources available to ensure a fair, accurate, and complete study of the research questions within the time and resource constraints and other demands required by the DAU Senior Service College Fellowship.

Data described in research design and data collection are relevant and appropriate for the research questions and variables of interest. Additionally, search criteria outlined in Chapter 2 as

well as the expanded search criteria described in Chapter 4 relate directly to the research questions and provide additional confidence for internal validity. With respect to external validity, the research findings have potential broad and significant impact with respect to cross-service and cross-organizational efficiency and effectiveness. Insight into munitions budget requirements process planning for organizations outside the purview of organizations chartered with procurement responsibility can result in improved communication, improved contract planning processes, and a better understanding of acquisition program risk. Findings can likely be extended or generalized across the Military Services and throughout the community of program managers responsible for reacting to MRP guidance.

The above research design and data collection plan resulted in a methodology that yielded appropriate and adequate data to address the variables and research questions. In addition, sources of data, Chapter 2 literature review, and Chapter 4 expanded literature review yielded sufficient information to address the research questions to a significant degree to ensure content validity. With respect to construct validity, this research follows the Defense Acquisition University (DAU) research standard. The DAU research standard is extended throughout the research community, and was adhered to during completion of this research. Therefore, this research satisfies both content and construct validity standards.

Finally, potential sources of bias were identified in the preceding section. Attempts to minimize bias were made by investigating military and non-military examples of budget and production requirements planning. Additionally, bias risks were mitigated through objective assessments of strengths and weaknesses during the Chapter 2 literature review. Even so, potential bias exists related to the limited scope of the research and focus on USAF

configurations of legacy general purpose bomb warheads. Additional potential bias exists since this research does not consider DCS or FMS sales of general purpose bomb warheads supplied by the United States commercial industrial base and how those requirements impact the ability of the industrial base to support the output of the Department's MRP and TMR.

With consideration to the factors outlined above, the scope of literature review and research methodology, the application of the DAU conceptual framework, cooperation with research advisor and independent research reviewer, this research is considered valid to satisfy requirements of the DAU Senior Service College Fellowship.

Reliability of Data

Several techniques were used to ensure reliability of data and internal consistency for this research. First, actual historical records of budget requirements data as well as actual program risk data were collected in order to answer the research questions. These actual data were sourced from credible and consistent sources and are based on documented historical records for legacy general purpose bomb warheads. Budget requirements data are considered highly reliable within the historic archive. As previously discussed, some performance data is not publicly available, and data reliability may be impacted based on adjustments made to available data through operational security and public affairs reviews. The anticipated result is not that data are inaccurate, but that they may be incomplete depending on the output of those reviews. For the purpose of this research however, this risk is accepted, and may highlight opportunity for further research.

Stability of this research was challenged by the vast number of data identified during the formal literature review. As discussed in Chapter 2, over fifty thousand sources were identified

during initial literature review searches. These were narrowed to a total of twenty-two sources for the literature review due to time constraints. Criteria for narrowing sources were based primarily on source title and abstract content which included reference to conventional ammunition or ammunition budgeting. Should different methods for narrowing search criteria be used, different results may be obtained. However, stability risk is mitigated through the use of the DAU research standard. The DAU research standard is extended throughout the research community, and was adhered to during completion of this research.

Findings are derived directly from themes identified during research. Although I have reviewed data to the best of my ability within the constraints of the DAU research methodology, additional themes or findings could be derived if additional research investigates data outside the public domain such as historical MRP data (TMR) or actual program performance data. Effort was made to remove bias by objectively applying search criteria, objectively collecting fact-based and historical information from the public domain, and applying consistent research methodology throughout. Quantitative models are not proposed as part of this research, so susceptibility of this research to random errors or other variance related to data sensitivity is sufficiently mitigated.

Summary

The importance of the MRP process as it relates to ammunition budget requirements stability and acquisition program risks cannot be understated. Complexities are introduced within the current MRP process with respect to definition and presentation of ‘unconstrained’ munitions requirements. As noted in Chapter 2, the unconstrained full requirement does not consider factors such as funding availability or industrial base limitations.

Chapter 3 discussed the research methodology for understanding how historical processes for munitions requirements planning of legacy configurations of general purpose bombs impacts overall acquisition program risk from a cost, schedule, and performance perspective. The methodology relies on a qualitative descriptive case study informed through literature reviews and analysis of actual historical budget and program performance data. Chapter 4 will summarize outputs of data collection described in the research methodology, provide additional context through supplemental literature review, and summarize results of data analysis as they relate to the research questions. Chapter 5 will present results and conclusions drawn from the data analysis as well as summarize recommendations for action and recommendations for further research.

Chapter 4 – Findings

The purpose of this study is to investigate and understand how the historical processes for munitions requirements planning of legacy configurations of general purpose bombs impacts overall acquisition program risk from a cost, schedule, and performance perspective. In seeking to understand these impacts, a qualitative descriptive case study of historical output of the munitions requirements process along with accompanying acquisition risks is presented.

Chapter 4 summarizes outputs of data collection described in the research methodology, provides additional context through supplemental literature review, and summarizes results of data analysis as they relate to the research questions and themes identified during literature review.

Data Collection and Analysis

The following sections discuss data collection and analysis conducted during this research in accordance with the plan outlined in Chapter 3. Several considerations were investigated during this research. First, the contributing role of MRP to ammunition budget requirements was further investigated. Additionally, subject data related to historical general purpose bomb budget requirements was analyzed. Third, data related to the acquisition risks associated with general purpose bomb budget instability was investigated followed by a discussion of commercial linkage and collaboration within the requirements planning process.

MRP and Ammunition Budget Requirements

The first step in collecting data to support this research is understanding that MRP outputs are the initial and key inputs into the development of ammunition budget requirements.

Per DoD MRP policy, munitions requirements are used as inputs to POM munitions investment recommendations (DoDI 3000.04, 2008). The POM “presents the services and defense agencies proposal on how they will balance their allocation of available resources” (AcqNotes, 2018) and is one of the first outputs of the programming phase of the annual Planning, Programming, Budgeting, and Execution (PPBE) process. The link between MRP and subsequent budget formulation is discussed in the following paragraphs.

Outputs of the MRP inform POM deliberations, and outputs and assessments generated during MRP “should be used by the Military Services and OSD to make informed decisions during POM deliberations and the Planning, Programming, Budgeting, and Execution process” (DoDI 3000.04, 2018, p. 12). Although the PPBE process occurs annually, the DoD MRP, by policy, occurs every even-numbered calendar year (DoDI 3000.04, 2018) with exception on an as-needed basis. Additionally, per policy, “Military Services *may* collaborate with appropriate Combatant Commands and the Joint Staff in developing the pre-POM and post-POM Sufficiency Assessments” (DoDI 3000.04, 2018, p. 12, italics added). However, research did not uncover objective evidence of collaboration or overarching DoD policy guidance for timing or frequency of these interactions.

The United States Department of the Air Force (DAF) addresses internal collaboration with processes designed to identify, calculate, and consolidate ammunition requirements for a variety of purposes. In accordance with Air Force Manual 11-212 (2020), the Air Force “accomplishes its obligations to DoD MRP using the Non-Nuclear Consumables Annual Analysis (NCAA) process for air-to-ground munitions and the Tactical Air Munition Program (TAMP) for air-to-air missiles” (p. 5). Outputs of the NCAA are war reserve materiel forecasts,

or combat munitions requirements outlining “near-year and out-year requirements for each theater” (DAF AFMAN11-212, 2020, p. 7). The NCAA process is conducted on an annual basis to support TMR development, and WRM combat munitions requirements are only a portion of the types and categories of USAF munitions included in TMR. Additional processes are used to calculate other types of ammunition such as testing and training ammunition (DAF AFMAN 11-212, 2020). Interestingly, DAF AFMAN 11-212 (2020) clearly outlines an expected timeline for the communication and coordination of ammunition forecasts, allocations, and expenditures. However, the variety of processes used as well as timing of outputs for communicating consumption of ammunition emphasizes the complexity of calculating munitions requirements while planning for the acquisition of ammunition.

Crawford (1989) summarized some of the complexities in research designed to evaluate the USAF NCAA process. At the time of the Crawford (1989) report, one weakness identified within the NCAA related to general purpose bomb budget requirements is that it only provided the number of air-to-surface weapons required for the first and last years in support of each five-year POM initiative (Crawford, 1989), while air-to-air weapons are addressed for all years. This weakness was apparently addressed in subsequent policy guidance, as the current DAF AFMAN 11-212 (2020) does not differentiate air-to-air and air-to-surface calculation requirements. Additionally, Crawford (1989) identifies several factors which contribute to NCAA uncertainty, to include timing and length of conflict, amount of available resource to procure munitions, and uncertainty regarding types and availability of targets. Uncertainty related to the industrial base capability to deliver requirements in support of NCAA outputs is not considered by Crawford (1989) or within DAF AFMAN 11-212 (2020).

Crawford (1989) notes the NCAA does contains an executive summary of the USAF Conventional Munitions Acquisition Plan, a document designed to “serve as a planning input for the POM and guide the procurement of munitions in the absence of complete funding for the NCAA requirement” (p. 40). Beyond reference to this summary, however, Crawford (1989) found “little formal connection between the NCAA and munitions acquisition process” (p. 40). Based on review and analysis of the current NCAA process (DAF AFMAN 11-212, 2020), it appears as though opportunity exists to continue closing the gap between the munitions requirements planning and acquisition processes.

As discussed by Blickstein et al. (2016), the POM is a statement of intent and “portions past the first year or two are less certain to reach the execution phase than they are to reach budget submission” (p. 11). This apparent uncertainty induces limitations on the ability to define stability in the context of budget requirements planning. Inputs to the POM reflect the Military Service Chief’s priorities and “provides a defensible rationale for the Service’s overall requirements” (Blickstein et al., 2016, p. 8). The key takeaway is that the programming phase strives to balance and correct shortfalls identified as capability needs, gaps, and excesses identified within the prior planning phase (Blickstein et al., 2016). In other words, the primary focus of MRP and follow-on POM activity is on addressing capability needs and gaps identified during strategic planning activities in an effort to communicate Military Service priorities.

Although POM and budget submissions are outputs of discrete phases of the PPBE system, operate on different time frames, and deliver different products (Blickstein et al., 2016), their linkage lies in the nuance that priorities in the POM drive budget priorities and decisions. Budget support for a program in the out-years is not guaranteed if that program is included in the

POM, however “failing to appear or having underfunded support in the POM telegraphs a priority that does not bode well for the program” at the OSD or Congressional level (Blickstein et al., 2016, p. 11).

An important data point for consideration is the fact that MRP directs the Military Services to use out-year unconstrained requirements as inputs to the POM (DoDI 3000.04, 2018). Unconstrained requirements are defined within the MRP as “the munitions requirement, not limited by projected inventory or funding” (DoDI 3000.04, 2018, p. 17). However, the unconstrained requirement “*may* be limited by reasonable production capacity; weapon system capabilities (integration); and externally defined caps on procurement (outside the TMR provider) (DoDI 3000.04, 2018, p. 17, italics added). Although addressed within policy guidance, MRP does not guarantee factors such as industrial base capability, overall inventory objectives, or affordability will be considered when generating MRP (and by corollary POM and budget submission) outputs.

Now that the linkage between MRP and budget submissions has been established, the second step in collecting data to support this research is to investigate historic budget submissions for USAF general purpose bombs in an effort to understand what defines and affects requirements stability in the context of budget planning for general purpose bomb warheads. Historic budget documentation is retained and archived by the Undersecretary of Defense (Comptroller) in a searchable and publicly accessible online database.

Historical General Purpose Bomb Requirements Analysis

For the purposes of this study, data collection was limited to raw data from P-1 exhibits and P-40 budget exhibits for BLU-109, BLU-117, and MK 84 general purpose bomb market

basket commodities. The P-1 exhibits represent overall procurement program budget and P-40 exhibits represent budget item justification sheets for each commodity within the market basket. Data collection was limited for a variety of reasons. First, time constraints as well as the scope of this research limited full analysis of all procurement items listed in the USAF budget exhibits; only selected commodities under the ‘general purpose bombs’ budget exhibit nomenclature were investigated. Second, the selected commodities represent all of the two-thousand USAF general purpose bomb warhead configurations included in the SMCA portfolio of transitioned conventional ammunition. Third, investigating summary data within P-40 documents was necessary due to the number and variety of weapon system procurement items represented within the P-1 line item defined as ‘general purpose bombs’. For instance, the P-1 general purpose line item includes procurement items such as the MXU-650 fin assembly kit and Guided Bomb Unit GBU-49 Paveway kit. These two commodities are both general purpose bomb market basket commodities, yet are outside the scope of this research. The above factors, as well as the desire to maintain a strategic view within the qualitative case study methodology and scope of this research, resulted in the decision to limit data collection.

Table 1: Actual USAF historic total obligation authority (base and overseas contingency operations) for general purpose bombs (USAF Comptroller, n.d.)

USAF General Purpose Bombs Budget Year	Total Obligation Authority Base & OCO (Dollars in Thousands)
FY08	147,809
FY09	183,444
FY10	281,748
FY11	250,787
FY12	150,942
FY13	177,234
FY14	241,198
FY15	204,907
FY16	633,987
FY17	569,482
FY18	341,501
FY19	810,170

The above table shows FY08 through FY19 total actual obligation authority for the entire set of procurement items within the general purpose bomb market basket as presented within the USAF Comptroller historic budget archive (USAF Comptroller, n.d.). Based on budget information formatting, data were obtained for each fiscal year by analyzing the USAF ammunition procurement budget for two fiscal years beyond the budget year. For example, the USAF FY16 procurement ammunition budget submission reflects the FY14 actual base and overseas contingency operations (OCO) funding data. The methodology to capture actual total obligation authority for every fiscal year depicted above was typical, and utilized USAF Comptroller (n.d.) as the consistent source. The below figure depicts the previous data in graphical format.

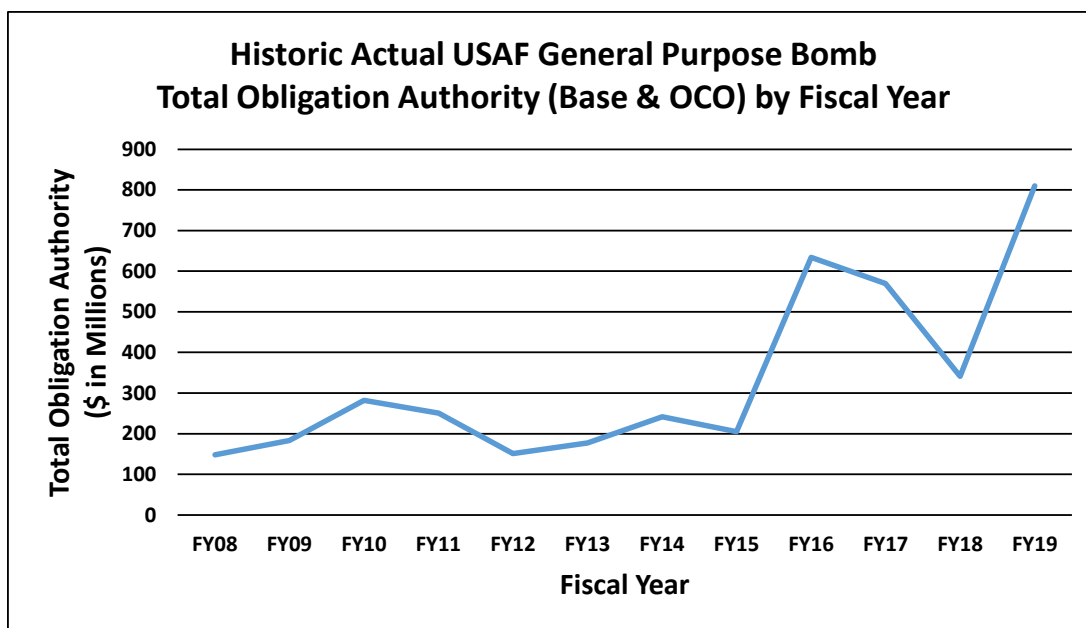


Figure 1: Graphical depiction of actual USAF historic total obligation authority (base and OCO) for general purpose bombs (USAF Comptroller, n.d.)

Historic actual USAF total obligation authority appears relatively stable throughout the years FY08 through FY15. However, it should be noted that the total obligation authority nearly doubled between the years FY08 and FY10, dipping back to prior levels by the FY12 budget cycle. These early fluctuations would be magnified in graphical format if the significant increases shown for FY16 and beyond were omitted from the data and the figure was scaled appropriately.

One key challenge in interpreting these data in the context of the research questions is related to the definition of ‘stability’. Codified metrics for defining budget requirements stability were not identified during the course of this research. Therefore, although source data used to generate Figure 1 are objective, characterization of stability (or instability) is subjective. From a qualitative standpoint, however, one could make the argument that the upward swing of nearly

100% between FY08 and FY10, with the follow-on reduction to prior levels by FY12 could be considered budget requirements instability. Given that, it logically follows that observed trends between FY15 and FY19 do indeed represent budget requirements instability. Therefore, for the purpose of this research and qualitative descriptive case study, the remaining analysis considers the historical budget requirements for general purpose bombs as an example of program budget requirements instability.

One possible contributing factor to the apparent instability is OCO funding. Overseas contingency operation funding is discretionary budget authority and was first introduced to Congress as emergency funding for OCO in April 2009 (McGarry & Morgenstern, 2019). Prior to that date, McGarry and Morgenstern (2019) note that Congress utilized supplemental appropriations which were “initially understood as reflecting needs that were not anticipated during the regular appropriations cycle” (p. 3) and were typically enacted as requested. However, “since the FY2010 budget cycle, DOD has requested both base budget and OCO funding as part of its annual budget submission to Congress” (McGarry & Morgenstern, 2019, p. 5-6).

In order to investigate how the implementation of OCO funding requests impacted the overall budget request stability, the USAF ammunition procurement budget requests were further analyzed to highlight differences between base or continuing resolution funding requests and the requests for OCO. It is noteworthy that data shown above for total obligation authority will not correlate to historic budget requests shown below. The purpose of conducting this second-layer analysis is to qualitatively investigate how OCO may or may not drive budget stability. Within

this qualitative methodology, data are presented as reference to trends within budget submissions and do not consider follow-on enactment or actual appropriations (USAF Comptroller, n.d.).

The following table and figure illustrate how base or continuing resolution (CR) funding requests and OCO request impacted the overall USAF budget requests by fiscal year for general purpose bombs (USAF Comptroller, n.d.). The data were not segregated depending on whether a base budget request or CR request was submitted in order to maintain a broader overview of the budget submissions, and it is not expected to contribute negatively to the analysis. The data categories were designed solely to allow for inclusion of relevant high-level data associated with the analysis.

Table 2: Actual USAF historic budget request for general purpose bombs (USAF Comptroller, n.d.)

USAF General Purpose Bombs Budget Year	Base or CR Budget Request (Dollars in Millions)	OCO Request (Dollars in Millions)
FY08	150.2	0
FY09	149.7	0
FY10	225.1	34.1
FY11	237.0	53.2
FY12	168.6	17.4
FY13	163.5	23.2
FY14	187.4	37.5
FY15	148.6	56.3
FY16	637.2	17.0
FY17	581.6	7.9
FY18	321.6	7.9
FY19	259.3	551.9

The data shown above are taken from fiscal year budget requests made by the USAF (USAF Comptroller, n.d.). For each fiscal year, the base and OCO requests were identified in that respective year's budget submission with the exception of two fiscal years. For FY14 and

FY15, OCO requests were not included in the budget request. Instead, a footnote was included in the budget submissions indicating those year's requests for OCO funding would be submitted at a later date (USAF Comptroller, n.d.). In those two instances, data for OCO requests were derived from the subsequent year's budget request.

The late submission of OCO requests is an interesting footnote which will be further investigated within the general purpose bomb budget analysis. This footnote is also relevant to higher-level stability and predictability considerations for acquisition program risk related to budget requirements stability, discussed later in this chapter. The figure below illustrates data from Table 2 in graphical format.

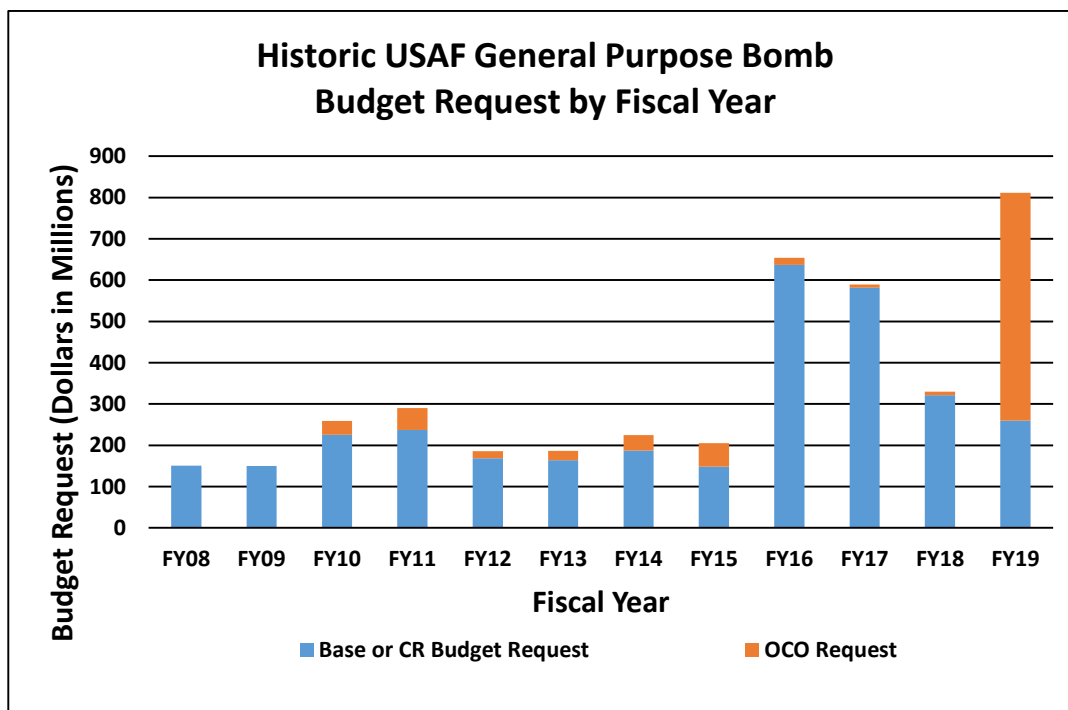


Figure 2: Graphical depiction of actual USAF historic budget request for general purpose bombs (USAF Comptroller, n.d.)

As shown above, the primary contributing factor to budget instability does not appear to be the OCO impact. Overall, general purpose bomb budget requirements appear relatively stable

until FY16. Additionally, during the years between FY08 and FY18, the maximum impact felt by an OCO request came in FY15, where roughly 38% of the total budget request was due to OCO. Even so, during that budget year, the total base and OCO requests combined were less than some prior year's base requests.

A final budget analysis related to specific commodities and procurement items considered within this research is provided below. These data are summarized in an effort to qualitatively understand whether trends observed above for the general purpose bomb aggregated items hold true at the relevant procurement item level. The below table summarizes results of budget exhibit analysis for the noted general purpose bomb warheads. Historical P-40 budget documents were used as source data for the below compilation (USAF Comptroller, n.d.).

Table 3: Actual USAF historic budget requests for specific general purpose bomb warheads (USAF Comptroller, n.d.)

USAF General Purpose Bombs Budget Year	BLU-109 Base or CR Budget Request (Dollars in Millions)	BLU-109 OCO Request (Dollars in Millions)	BLU-117 Base or CR Budget Request (Dollars in Millions)	BLU-117 OCO Request (Dollars in Millions)	MK 84 Base or CR Budget Request (Dollars in Millions)	MK 84 OCO Request (Dollars in Millions)
FY08	44.689	0.000	0.000	0.000	21.490	0.000
FY09	38.424	0.000	28.790	0.000	0.000	0.000
FY10	71.077	0.000	28.257	8.258	0.000	0.000
FY11	57.281	1.680	18.247	15.894	0.000	0.000
FY12	78.171	0.000	6.750	5.506	0.000	0.000
FY13	67.855	0.603	7.671	6.790	0.000	0.000
FY14	83.302	0.536	11.800	16.937	0.000	0.000
FY15	62.278	17.219	8.413	18.142	0.000	0.000
FY16	110.000	0.000	418.524	4.235	0.000	0.000
FY17	37.000	0.000	376.336	0.000	0.000	0.000
FY18	70.000	0.000	32.603	0.000	0.000	0.000
FY19	45.483	541.862	0.000	0.000	0.000	0.000

The data shown above are taken from fiscal year budget requests made by the USAF (USAF Comptroller, n.d.). For each fiscal year, the base and OCO requests were identified in that respective year's budget submission with the exception of two fiscal years. Similar to the aggregate data presented for general purpose bombs in table 2 above, FY14 and FY15 OCO

requests were not included in the budget request. Again, a footnote was included in each budget submission indicating those year's request for OCO would be submitted at a later date (USAF Comptroller, n.d.). In those two instances, data for OCO requests were derived from the subsequent year's budget request.

For the purposes of this qualitative assessment, MK 84 is considered to have a negligible impact on overall budget stability due to low budget quantities. However, BLU-109 and BLU-117 budget requirements, when combined, appear to represent what was observed in overall aggregate historic budget requests. The following figure illustrates the combined effects of BLU-109 and BLU-117 procurement items on budget requests for the subject fiscal years.

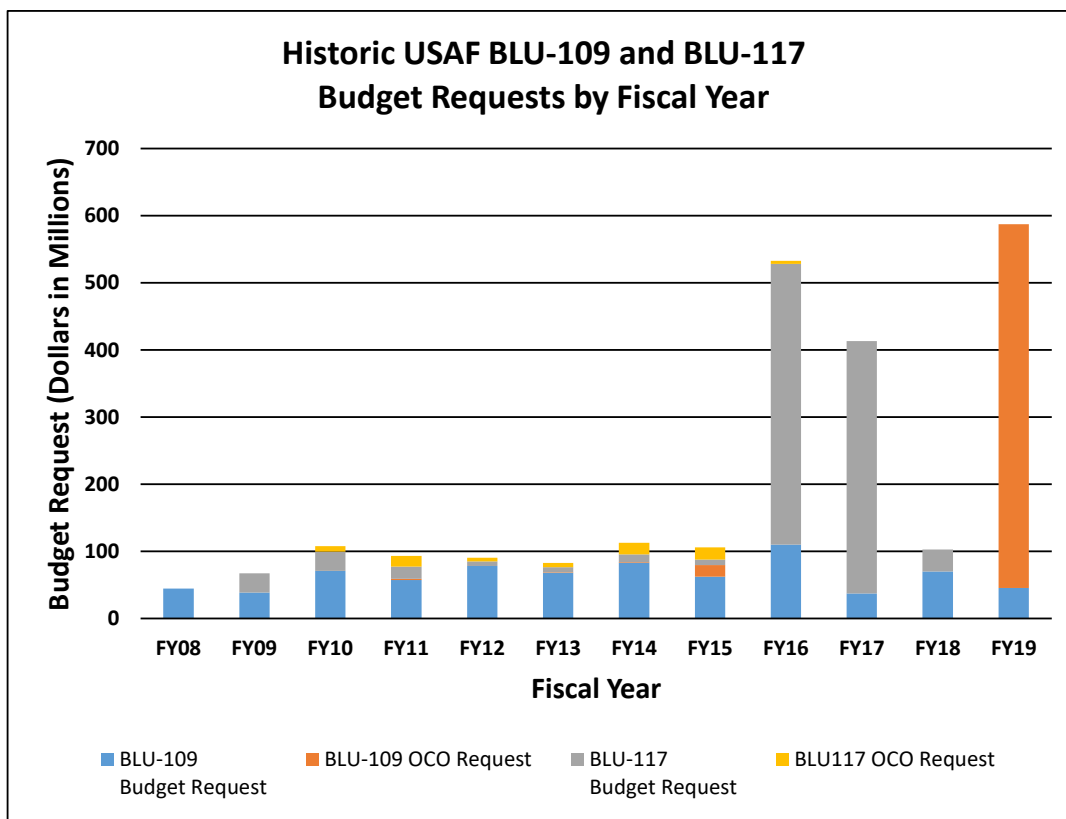


Figure 3: Graphical depiction of actual USAF historic budget requests for specific general purpose bomb warheads (USAF Comptroller, n.d.)

As shown above, detailed budget requests for BLU-109 and BLU-117 general purpose bomb warheads over time (USAF Comptroller, n.d.) notionally represent what was observed in overall historic budget requests for the general purpose bomb market basket commodities on aggregate. Data suggest that the FY16 budget request represented a significant instability in the budget requirements output, driven primarily by base budget requirements for the BLU-117 general purpose bomb warhead. This effect, however, lasted only two years, with FY18 budget requirements returning to historic levels. However, the sizeable FY19 OCO request for BLU-109 introduced additional budget requirements instability.

In seeking to understand drivers for the increases identified in FY16 and FY19, the FY16 USAF's Department of Defense Fiscal Year 2016 President's Budget Submission offers a clue. The FY16 P-40 exhibit for general purpose bombs line item notes "the Air Force procures munitions to maintain appropriate quantities in the War Reserve Materiel (WRM) Munitions and test and training stockpiles" (USAF Comptroller, n.d.). An identical justification was provided as part of the P-40 exhibit contained within the USAF's Department of Defense Fiscal Year 2019 President's Budget Submission (USAF Comptroller, n.d.). As noted in Chapter 1, the War Reserve Munitions Requirement (assumed to be analogous to the USAF's reference to WRM), is a component of TMR, which is a key output of MRP.

A GAO report by Holman (2002) provides insight as to why budget instability persists in response to evolving TMR needs and is reflected in the budget exhibits referenced above. Holman (2002) stated the DoD eliminated many of the systemic problems associated with MRP. However, Holman (2002) noted that fundamental problems remain. The key problem identified by Holman is "inadequate linkage between the near-term munitions needs of the combatant

commands and the purchases made by the military services based on computations derived from the department's munitions requirements determination process" (p. 2). Holman (2002) offers a couple of reasons for this.

First, different time horizon focuses between the Combatant Commanders' and Military Service's purchasing decisions may contribute to this inadequate linkage (Holman, 2002). The USAF NCAA process is conducted annually to support the requirements of MRP. Even so, there exists overlap between when the POM cycle is initiated and when the TMR is finalized, resulting in potential for error or little time to react to TMR surprises during POM preparation. As previously discussed, the DAF AFMAN 11-212 (2020) clearly outlines an expected timeline for the communication and coordination of ammunition forecasts, allocations, and expenditures. However, the variety of processes used as well as timing of outputs for communicating consumption of ammunition emphasizes the complexity of calculating munitions requirements while planning for the acquisition of ammunition.

Second, Holman (2002) suggested the "munitions requirements determination process does not fully consider the Combatant Commanders' preferences for munitions and weapon systems that will be used against targets identified in projected scenarios" (p. 2). These observations likely led to the evolution of MRP from a capabilities-based approach to a threat-based approach. The disconnect suggested by Holman (2002) was that MRP provided varied answers resulting in Military Service's "purchasing some critically needed munitions based on available funding and contractors' production capacity" in the short term (Holman, 2002, p. 2). Indeed, the scenario described in the budget analyses above seems to mirror the scenario outlined

by Holman (2002), so it is unclear whether the shift to a threat-based approach for MRP provided the full desired impact.

Additionally, a continuing limitation described by Holman (2002) is that the “disjunction between the department’s requirements determination process and combatant commanders’ needs is rooted in separate assessments done at different times” (p. 7). At the time Holman’s (2002) report was generated, it acknowledged that TMR is compared to available inventory, which then informed the budget programming process, but that other periodic readiness reports (addressing data such as types and quantities of munitions), were “not tied to the services’ munitions requirements or to the budgeting process” (Holman, 2002, p. 8). The inference is that munitions requirements and the impact to readiness evolves more rapidly than do outputs of processes in place to ensure budgeting processes are able to incorporate those needs. As discussed above, the MRP as an input to the budgeting process occurs by policy, to this day, every other year by exception, while the budgeting cycle is annual.

Acquisition Risk Related to Budget Requirements Stability

Acquisition program risks and impacts associated with budget conditions described in the previous paragraphs were summarized in a briefing to the conventional ammunition enterprise by Tannehill (2018). This briefing was given during the National Defense Industrial Association’s annual Munitions Executive Summit. During the Program Manager’s Panel Brief at the annual, Tannehill (2018) summarized that “increased demand for general purpose and penetrator bombs has resulted in unprecedented demand for some components above existing industrial capacity” (p. 4). This warning to the ammunition enterprise highlighted acquisition program risks that budget requirements instability may introduce at all levels. Insufficient industrial base capacity

can manifest itself as cost, schedule, or performance risks as they relate to the execution of an acquisition program.

The above findings and impacts were also telegraphed by Zimmerman (2017) during the same event a year prior. During that briefing, data were presented to indicate that RDX (a primary component of some general purpose bombs explosive fill) explosives production capacity exceeded production capacity at Holston Army Ammunition Plant. The information presented showed that “waivers to use TNT in place of RDX” (Zimmerman, 2017, p. 7) were implemented, presumably as a risk mitigation strategy to offset the acquisition program risks associated with the requirements spikes identified in Figure 3, above. This presumption was verified later that year in a briefing given by BAE Systems Inc on the Holston Army Ammunition Plant RDX expansion overview. During that briefing, BAE noted that “RDX capacity at Holston is running at maximum rates, primarily driven by high demands for CXM-AF-5/CXM-AF-7 for Air Force bombs” (BAE, 2017, P. 22). As shown in Figure 3, above, FY17 and FY16 were budget requirements spike years for the BLU-117, with BLU-109 budget requirements remaining lower and, in the case of MK 84, nonexistent.

Additionally, BAE noted during the aforementioned briefing that “demand, in total, is projected to remain high for the next several years” (BAE, 2017, P. 22). Whether this signal was directed toward or driven by anticipated future budget requirements for USAF general purpose bombs at the time is unclear, as the note suggests ‘in total’. If it were, however, this note illustrates the complexity and challenge associated with predicting future budget requirements when one realizes that actual budget request submissions for the subject general purpose bomb

warheads dropped to historic levels in FY18 to less than twenty-five percent of the overall FY17 budget request (USAF Comptroller, n.d.).

“Corporations and government program managers desire predictability” (Cornwall, et al., 2018, p. 22). In a recent publication, Cornwall et al. (2018), discuss how the past fifteen years of continuous operations have stressed the munitions enterprise. Cornwall et al. (2018) used Holston Army Ammunition Plant, bomb tail kit production, and sub-tier supplier examples to support their findings. Cornwall et al. (2018) touches on several interrelated themes identified in this research and highlights that two critical factors in programming and distributing funding across future years defense program are “minimum sustaining rate (MSR) and maximum production rate (MPR)” (p. 21), although does not go into detailed discussion of how either impact acquisition risk. However, Cornwall et al. (2018) provide interesting commentary regarding linkage between TMR, OCO, and budget stability. Regarding the TMR, Cornwall et al. (2018) advocate that program managers and programmers should consider limited budgets as well as constraints and industrial base risks when considering purchasing quantities. Regarding OCO, Cornwall et al. (2018) discuss that “reliance on OCO funds can lead to unpredictable outcomes” (p. 21) driven by the likelihood that Military Services will understate their actual munitions needs, instead relying on anticipated OCO funding to offset budget shortfalls. Cornwall et al. (2018) conclude and recommend eliminating “reliance on OCO funding to procure base budget quantities of munitions” (p. 23) by eliminating OCO for munitions. Cornwall et al. (2018) suggest this action will improve the commercial industrial base’s access to actionable demand projection and create more certainty for planning.

Additional acquisition program risks were discussed by Mehta (2018) in a Defense News article warning that the US is running out of bombs. This article summarized a report issued by the Pentagon's Office of Manufacturing and Industrial Base Policy, which concluded that the "industrial base of the munitions sector is particularly strained" (Mehta, 2018). Mehta (2018) suggests this strain is the byproduct of the "start-and-stop nature of munitions procurement over the last 20 years, as well as the lack of new designs being internally developed" (Mehta, 2018). The start-and-stop nature of munitions procurement is assumed as analogous to munitions budget requirements instability, resulting in suppliers dropping out of the supply chain (Mehta, 2018). Lack of new designs resulting from the ongoing desire of the military to optimize legacy systems has "left the industrial base with a lack of design experience" (Mehta, 2018), and Mehta (2018) cites lack of design skill for the missile sector as the primary risk factor. Although the themes identified by Mehta (2018) are relevant for the purpose of this research, the article unfortunately does not investigate bombs or the general purpose bombs outside of the article title and single photo caption.

The risks identified by Mehta (2018) likely resulted or contributed to the Trump administration's response described by Gould (2019). In this article, Gould (2019) notes that under the Defense Production Act, the administration "approved direct federal investment for suppliers of American bomb parts and chemicals" (Gould, 2019). Research did not uncover additional investment intended to address the other causes identified by Mehta (2018), discussed above.

Interestingly, this situation and response is not new. In 2007, Holmes & Seraphin (2007) described that between 1985 and 1994, an eighty percent ammunition budget reduction resulted

in approximately seventy percent of ammunition production firms departing from the manufacturing marketplace. The risks and gaps resulting from this environment led to the creation of the Munitions Industrial Base Task Force in 1993 (Holmes & Seraphin, 2007) followed by an injection of funds with the intent of stabilizing the environment. At that time, it was recommended that the DoD “must determine its long-term requirements for each product line, while industry must set the minimum sustaining rate for the required production capabilities of each area. The goal is to maintain a production rate consistent with the volumes required, which can rapidly adjust to higher demand when needed” (Holmes & Seraphin, 2007, p. 39). Recall the advocacy for MSR described by Cornwall et al. (2018) as a critical factor in programming and distributing funding across future years defense program.

The above data and analyses describe how MRP influences the programming and budgeting process for general purpose bombs. In addition, the analyses provides examples for how budget request instability may influence acquisition program risk in a variety of ways. The next several paragraphs discuss other factors and considerations uncovered during research which may add additional insight into the complexity associated with these issues.

Commercial Linkage to Requirements Planning

One concept uncovered during the research was materials requirements planning. Not to be confused with MRP (munitions requirements planning), materials requirements planning focuses on managing material manufacturing processes, inventory, and procurement processes while linking them with cost accounting processes in the interest of efficiency (Desmond, 1988). Implementation and use of these processes is consistent with recommendations from the Packard Commission, who in 1986 advised the defense industrial base utilize more commercially

available production techniques in the interest of controlling and lowering costs (Desmond, 1988). Desmond (1988) cited unreliable data management systems, contract complexity, and shortcomings in data management systems as reasons for early adoption failures for materials requirements planning within the defense industrial base. One strength of this article is that it acknowledges the uniqueness of defense manufacturing versus commercial manufacturing. “Commercial manufacturers typically comingle the common parts of different products, while closely tracking overall levels of inventory. Defense contractors must account for every part in a contract, and for every contract separately” (Desmond, 1988, p. 66). These differences and challenges led to unwarranted fees, inflated prices, and comingled inventory, leaving DoD officials skeptical of the benefits to materials requirements planning (Desmond, 1988). This article summarizes hearings resulting in a bill which includes guidelines for what a commercial materials requirements planning program should include in support of defense manufacturing. Another output, undoubtedly a result and byproduct of the hearing function, was an external agreement between DoD and the defense subcontracting community focusing on inventory accounting methods for contractors using materials requirements planning tools (Desmond, 1988). One potential value of materials requirements planning process techniques is the possibility of improved effectiveness once interdependencies of material manufacturing processes, inventory management processes, and procurement processes are better understood.

Recall Haraburda (2017) and the suggestion that improving relationships with government and commercial suppliers through completion of continuous improvement efforts is an important focus area for managing and improving supplier relationships (Haraburda, 2017). Although this research focused on supply chain management at munitions storage locations, it suggested that improvements to efficiency and effectiveness of operations was aided by the shift

from “company- or installation-only focus to a more adaptive supply chain with integrated command and control throughout the entire Conventional Munitions Industrial Base (CMIB) of commercial and government organizations” (Haraburda, 2017, p. 659). The result of this approach was that warfighter munitions requirements were provided with consideration to a variety of factors such as demand sensing, delivery capabilities, and production capabilities (Haraburda, 2017).

Additionally, examples provided by Zimmerman (2017), BAE (2017), and Tannehill (2018) verify that mechanisms are in place which support ongoing collaboration between the government and commercial sector, subject to limitations imposed through the sensitive and protected nature of contracting and/or budgetary data. What was not clear in the research, however, is the effectiveness of inter-service collaboration with respect to communicating and understanding general purpose bomb budget stability and the risk to instability related to the capability and responsiveness of the defense industrial base. Seraphin & Palaschak (2014) identify the importance related to these types of interactions. For example, Seraphin & Palaschak (2014) note that by implementing several tools such as the industrial base assessment tool and MSR database, “potential negative impacts on the munitions industrial base are identified beforehand” (p. 17). These tools were presumably developed and implemented to identify risks associated with declining budgets, as the report references a data point common with Ferrari (2009) where seventy percent of production capacity was lost between the mid-1980s and mid-1990s.

Not all ammunition items were, at the time of Seraphin & Palaschak’s (2014) article, included as part of the budget risk analyses. The SMCA “is responsible for procuring

ammunition items that are common to the services” (Seraphin & Palaschak, 2014, p. 17), and is able to analyze budget requirements for potential impacts for those items over which they exercise authority, such as the transitioned general purpose bombs. Seraphin & Palaschak (2014) suggest that items which are service unique, or non-SMCA items, “constitute a significant percentage of all munitions procured, and therefore significantly affect the industry” (p. 18). At the time of this article, the USN and USAF had not elected to participate in the SMCA assessment tools and research did not uncover whether that has changed. Certainly, these tools provide value in the SMCA’s ability to understand and plan for requirements instability across the ammunition enterprise. However, without full buy-in from all organizations that procure munitions which benefit from SMCA management, the outputs of those data assessment tools are only as good as the inputs. Furthermore, it is not clear whether or not USAF full participation would have impacted the scenario discussed above for general purpose bombs, as it appeared the budget instability was driven by late spikes in WRM and TMR as previously discussed (USAF Comptroller, n.d.). Nonetheless, the factors identified by Seraphin & Palaschak (2014) reiterate the importance of government to commercial relationships and introduce the importance of government to government relationships in balancing overall need to capability and acquisition program risk related to budget instability.

The relevance of relationships between government and commercial suppliers within the defense industrial base emerged from Harabuda (2017) and others as an important consideration. These relationships may improve the ability of the munitions enterprise to execute budget outputs as informed by MRP while considering other factors such as industrial base capability, budget requirements trends, and MSR limitations.

Summary

Throughout data collection and analysis, several themes and findings were identified or reiterated as they relate to the research questions. First, the MRP system is well-defined. However, several aspects of the process, to include timing of the MRP outputs, contribute to ongoing challenges related to budget instability. This finding was highlighted by the FY16 spike in budget requirements for general purpose bombs noted in the P-40 submissions as a response to the need to “maintain appropriate quantities in the War Reserve Materiel (WRM) Munitions and test and training stockpiles” (USAF Comptroller, n.d.) Another challenge discussed within the research, but not applicable to data shown for general purpose bomb warheads, is the reliance on OCO to supplement budget request. This factor may lead to understatement of requirements or unpredictable outcomes if Military Services rely on anticipated OCO funding to offset budget shortfalls (Cornwall et al., 2018). It is not clear whether budget uncertainty during the FY14 and FY15 timeframes influenced the decision to defer OCO funding until full support for the budget request was obtained as Cornwall (2018) suggested as a possibility.

As previously discussed, one challenge in interpreting data in the context of the research questions was related to the definition of ‘stability’. Metrics for defining budget requirements stability were not identified during the course of this research. Therefore, although source data analyzed were from historical and objective sources, characterization of stability (or instability) was subjective. Within the construct of this research and qualitative descriptive case study, the analysis of historical budget requirements for general purpose bombs was considered as an example of program budget requirements instability.

Another finding that was identified during data collection and analysis is that consistency is key. Failure to coordinate requirements in a consistent, predictable, and timely manner with other stakeholders introduces budget requirements instability. As shown by the example of general purpose bombs, this instability manifests as acquisition program risk considering the fragility and capability of the defense industrial base. As shown by Haraburda (2017) and others, themes of collaboration between government and commercial participants in the defense industrial base emerge as potential steps to begin resolving the above challenges.

Finally, the commercial sector has implemented processes such as materials requirements planning to address inefficiencies and uncertainties in their marketplace with the intent of characterizing risk and stabilizing the production environment. This finding revealed potential benefits to integrating commercial processes in the defense planning process with consideration to industrial base capability, economic order quantity, minimum sustaining rate, and materials requirements planning tools in support of improved efficiency and effectiveness.

Chapter 5 – Conclusions and Recommendations

The purpose of this study was to investigate and understand how acquisition program risks are impacted by budget requirements instability. Specifically, how historical munitions budget requirements planning processes for legacy configurations of general purpose bombs impact overall acquisition program risk. In seeking to understand these impacts and risks, a qualitative descriptive case study was presented. Research first sought to describe the munitions requirements process and its impact on budget requirements. Additionally, analysis of acquisition program risks was supported and informed through analysis of historical budget requirements for select legacy configurations of general purpose bombs.

Chapter 5 includes a discussion of the research findings as well as additional limitations, recommendations, suggestions for opportunities for further research, and a summary.

Research Questions

The central research question investigated throughout this research is how does general purpose bomb warhead budget requirements instability (spikes and decrements) introduce acquisition program risk? In researching this overarching question, several specific research questions were asked:

- What is the role and importance of MRP activities for general purpose bomb warheads for the purposes of budget requirements planning?
- What defines and affects budget requirements stability in the context of ammunition budget planning for the purposes of legacy ammunition?
- How does budget requirements stability impact acquisition program risk and organizations chartered to manage acquisition planning of legacy general purpose bomb warheads?

Discussion of Findings

During the data collection and analysis, three themes emerged as they relate to the research questions. They are: the MRP system is well-defined, consistency is key, and collaboration between government and commercial participants in the defense industrial base may help close gaps related to budget instability. The following sections discuss these findings in more detail.

MRP is Well-defined

Research revealed that MRP is not only well-defined, but that it is an important consideration with respect to ammunition budget requirements planning. Outputs of the MRP inform POM deliberations, and outputs and assessments generated during MRP “should be used by the Military Services and OSD to make informed decisions during POM deliberations and the Planning, Programming, Budgeting, and Execution process” (DODI 3000.04, 2018, p. 12). Essentially, MRP serves a function as one of the first steps in defining total ammunition budget requirements. However, MRP outputs are not translated into actionable budget requirements immediately. Additionally, MRP as an input to the budgeting process occurs by policy, to this day, every other year by exception, while the budgeting cycle is annual. This timing difference places additional emphasis on the importance of consistency and collaboration throughout the PPBE cycle as well as ensuring the relevancy and validity of MRP outputs as inputs to follow-on PPBE activity.

One key challenge in interpreting data in the context of the research questions was related to the definition of ‘stability’. Codified metrics for defining budget requirements stability were not identified during the course of this research. Therefore, although source data analyzed were from historical and objective sources, characterization of stability (or instability) was subjective.

Within the construct of this research and qualitative descriptive case study, the analysis of historical budget requirements for general purpose bombs was considered as an example of program budget requirements instability.

Relying on MRP outputs as the sole data point is insufficient for addressing ammunition budget requirements. As this research revealed, MRP is not the sole contributing factor to budget requirement instability, nor the sole driver of acquisition program risk. Other factors such as the unfunded requirements process and OCO also contribute to budget requirement instability. The unfunded requirements process was shown as a source of potential budget instability should ammunition requirements above and beyond MRP outputs be introduced as unfunded requirements. The OCO requirements process was shown as a source of potential budget instability when OCO requirements are late or not considered at all during budget preparation. Therefore, although MRP outputs could serve as a leading indicator for acquisition program risk and budget stability, MRP could easily evolve into a lagging indicator without consideration to other factors such as data validity and relevancy, OCO requests, unfunded requirements, operational expenditures, industrial base capacity and capability, and funding availability.

Finally, the United States Department of the Air Force (DAF) addresses internal collaboration with processes designed to identify, calculate, and consolidate ammunition requirements for a variety of purposes. In accordance with Air Force Manual 11-212 (2020), the Air Force ‘accomplishes its obligations to DoD MRP using the Non-Nuclear Consumables Annual Analysis (NCAA) process for air-to-ground munitions and the Tactical Air Munition Program (TAMP) for air-to-air missiles’ (p. 5). Outputs of the NCAA are war reserve materiel

forecasts, or combat munitions requirements outlining ‘near-year and out-year requirements for each theater’ (DAF AFMAN11-212, 2020, p. 7).

The NCAA process is conducted on an annual basis to support TMR development and the requirements of MRP. Even so, there exists overlap between when the POM cycle is initiated and when the TMR is finalized, resulting in potential for error or little time to react to TMR surprises during POM preparation. The DAF AFMAN 11-212 (2020) clearly outlines an expected timeline for the communication and coordination of ammunition forecasts, allocations, and expenditures. However, the variety of processes used as well as timing of outputs for communicating consumption of ammunition emphasizes the complexity of calculating munitions requirements while planning for the acquisition of ammunition. Therefore, based on review and analysis of the current NCAA process (DAF AFMAN 11-212, 2020), it appears as though opportunity exists to continue closing the gap between the munitions requirements planning and acquisition processes.

Consistency is Key

Insight into munitions budget requirements process planning for organizations outside the purview of organizations chartered with procurement responsibility can result in improved communication, improved contract planning processes, and a better understanding of acquisition program risk. Findings can likely be extended or generalized across Military Services and ammunition program managers responsible for reacting to MRP guidance. Failure to coordinate requirements in a consistent, predictable, and timely manner with stakeholders introduces budget requirements instability. As shown by the example of general purpose bombs, this instability

manifests as acquisition program risk considering the fragility and capability of the defense industrial base.

Brockmann (2011) notes that defense companies contribute to individual program funding volatility, “but do not have a stronghold on the budget process” (p. 56). “Defense contractors will do what they can to maintain stable funding for a program, but their efforts may not be readily visible in the budget review process, and their actions can also exacerbate unstable program appropriations” (Brockmann, 2011, p. 131). The actions and associated risks discussed by Brockmann (2011) revealed a variety of engagements in advocacy of several programs and it was found that successful and effective engagements by senior leaders serve to convey consistent program messaging and are honest, accurate, and timely. Brockmann’s (2011) findings and considerations highlight the need and importance of government and commercial industrial base collaboration when contemplating and making program budget decisions.

Webb (2003) also advocated for consistency in the recommendation that the USAF move beyond traditional requirements-based funding and look toward an industry-based approach. Webb (2003) recommended that a “minimum quantity for each required commodity should be bought to ensure the production capability remains intact” (p.35). This approach would result in the USAF consistently purchasing “commodities at the negotiated minimum sustainable rates for industry” (Webb, 2003, p.45), thus minimizing risk while strengthening the ammunition industrial base. Unfortunately, Webb’s (2003) approach recommended application of the methodology for all types of required munitions. Tradeoffs must be considered, especially in fiscally constrained environments. Procuring more of one commodity in an effort to simply

maintain a production base requires the harvesting of resources which could be used elsewhere. This challenge highlights the importance of the final theme, collaboration.

As discussed by Blickstein et al. (2016), the POM is a statement of intent and “portions past the first year or two are less certain to reach the execution phase than they are to reach budget submission” (p. 11). This apparent uncertainty represents a limitation on the ability to define stability in the context of budget requirements planning which is magnified when timing challenges related to the MRP and USAF’s NCAA process are considered. Blickstein et al. (2016) reiterates this uncertainty with the assessment that POM and budget submissions are outputs of discrete phases of the PPBE system, but they operate on different time frames, and deliver different products.

In the case of general purpose bombs, DAF AFMAN 11-212 (2020) clearly outlines an expected timeline for the communication and coordination of ammunition forecasts, allocations, and expenditures. However, the variety of processes used as well as timing of outputs for communicating consumption of ammunition emphasizes the complexity of calculating munitions requirements while planning for the acquisition of ammunition. Applying consistent processes and methodologies while continuing consistent engagements throughout the MRP and budget requirements processes and expanding engagements within the defense industrial base may help improve budget requirements stability with the result of reducing acquisition program risk.

Collaboration among Government and Commercial Participants

One interesting consideration revealed during this research is that MRP calculations result in requirements that are “point estimates of the quantities of munitions the services would buy to arm their planned forces if sufficient funds were available” (Kassing et al., 1991, p.1). In

other words, MRP calculates the unconstrained full requirement. The process does not consider constraints such as funding availability or industrial base limitations. In these instances, timing and collaboration become important in order to understand operational needs identified in the programming phase and achieve national military strategy objectives while considering constraints such as funding availability and industrial base limitations.

The defense industrial base does not determine budget requirements. As noted in previously, requirements should drive capability, capability should not drive requirements. However, by establishing an understanding and awareness for how MRP drives budgeting decisions, program managers may become better equipped to identify and implement more efficient strategies for achieving the ammunition budget requirements objectives. Per policy, “Military Services *may* collaborate with appropriate Combatant Commands and the Joint Staff in developing the pre-POM and post-POM Sufficiency Assessments” (DoDI 3000.04, 2018, p. 12, *italics added*). However, research did not uncover objective evidence of collaboration or overarching DoD policy guidance for timing and frequency of these interactions.

Furthermore, recent data suggest that problems identified by Holman (2002) persist with respect to general purpose bombs. Recall Holman’s (2002) findings of “inadequate linkage between the near-term munitions needs of the combatant commands and the purchases made by the military services based on computations derived from the department’s munitions requirements determination process” (p. 2). Holman (2002) suggested that different time horizon focuses between the Combatant Commanders’ and Military Service’s purchasing decisions may contribute to this problem. Although USAF NCAA process is conducted annually to support the requirements of MRP, there exists overlap between when the POM cycle is initiated and when the TMR is finalized. This results in potential for error or little time to react to TMR surprises

during POM preparation. Additionally, Holman (2002) suggested that the “munitions requirements determination process does not fully consider the combatant commander’s preferences for munitions and weapon systems that will be used against targets identified in projected scenarios” (p. 2). Although the second consideration likely references technical and performance requirements generated by combat developers, both of these factors reinforce the need and importance of internal government collaboration when determining budget requirements. Additionally, factors identified by Seraphin & Palaschak (2014) reiterate the importance of government to commercial relationships and introduce the importance of government to government relationships in balancing overall need to capability and acquisition program risk related to budget instability.

Recall Chou’s (2011) conclusion that “lack of robustness stems from the fact that immature technologies have uncertainties in their expected performance, development cost, and schedule that cause variations in system effectiveness and program development budget and schedule requirements” (p. xxvii). By better understanding development uncertainty and technology performance, reduction in risk related to program budget and schedule requirements may be achieved. For legacy systems, this conclusion may be reshaped to state that by better understanding overall legacy munitions budget requirements to meet known and perceived threats as well as the industrial base capability to produce and deliver those requirements, risk related to program cost and schedule requirements may be reduced.

The above findings highlight the need for both consistency in messaging as well as in applications of processes designed to satisfy MRP requirements which eventually inform program budget decisions. The relevance of relationships between government and commercial

suppliers within the defense industrial base emerged from Harabuda (2017) and others as an important consideration. These relationships may improve the ability of the munitions enterprise to execute budget outputs as informed by MRP while considering other factors such as industrial base capability, budget requirement trends, and MSR limitations. Expanding engagements within the defense industrial base may help improve budget requirements stability with the result of reducing acquisition program risk.

Limitations

Chapter 1 discussed several original limitations of this research. First, in order to maximize the usefulness of the research output while limiting the scope to a manageable level, this research focused on USAF legacy general purpose bomb budget requirements. This limitation in scope was intended to ensure the project was manageable and viable within the time and resource constraints while considering other demands of the Senior Service College Fellowship.

Secondly, this research did not consider DCS or FMS sales for general purpose bomb warheads as supplied by the United States commercial industrial base. Therefore, impacts of the DCS or FMS marketplace on the ability of the industrial base to produce and deliver ammunition to support DoD budget requirements were not considered. Two factors served to overcome this shortcoming. First, Defense Production Act of 1950, Title 1, states “President is authorized to require that performance under contracts or orders (other than contracts of employment) which he deems necessary or appropriate to promote the national defense shall take priority over performance under any other contract or order” (Defense Production Act of 1950, as Amended, 2018, p. 3). It was assumed that US Military Service requirements take priority over the

commercial marketplace and the risk of the DCS marketplace impacting assured readiness is not an issue. Second, and more importantly, actual delivery performance data for programs was not publicly available or investigated. Therefore, the risk of actual performance being skewed by DCS or FMS programs or requirements was eliminated.

A third limitation of this research was related to the methodology. As previously stated, one key assumption within the context of this analysis is that Military Services are applying the munitions requirements process appropriately and accurately. Potential failures or shortcomings within the MRP potentially contributing to elevated risk were not addressed as part of this research.

Additional limitations surfaced while conducting this research. First, although historical budget data for subject general purpose bomb warheads is public and retained by the USAF Comptroller (n.d.), historical MRP outputs could not be located through publicly accessible open sources. Therefore, this research was limited by an inability to directly qualitatively or quantitatively correlate historical MRP outputs to historical budget requirements for general purpose bombs warheads. In other words, it was not clear to what extent outputs and timing of the MRP contribute to budget requirements stability, just that they influence budgets in the form of TMR. The approach taken was to investigate the MRP process as a contributing factor when developing POM budget submission in the programming phase. This limitation results in a recommendation for further research, addressed below.

Secondly, objective measures or metrics for defining budget requirements stability were not identified during the course of this research. As discussed previously, although data used to support the analysis were from objective sources, characterization of stability (or instability) was

subjective. Therefore, for the purpose of this research and qualitative descriptive case study, the analysis subjectively considered the historical budget requirements for general purpose bombs as an example of program budget requirements instability.

Recommendations for Further Action

As highlighted by the research, collaboration among government and commercial participants within the defense industrial base can help improve ammunition budget requirements stability and reduce acquisition program risk. Examples were provided which highlight ongoing efforts to communicate challenges related to budget requirements stability. One example of this was the National Defense Industrial Association's annual Munitions Executive Summit. It is recommended that strategic planning sessions, like those that were highlighted as part of this research, be continued and that the audience be expanded to align with policy guidance. For example, DoDI 3000.04 (2018) states that "Military Services *may* collaborate with appropriate Combatant Commands and the Joint Staff in developing the pre-POM and post-POM Sufficiency Assessments" (DoDI 3000.04, 2018, p. 12, italics added). However, research did not uncover objective evidence of collaboration or overarching DoD policy guidance for timing and frequency of these interactions. This recommendation would serve to expand the sphere of concern with respect to ammunition budget requirements planning and integrate themes related to MRP output, production capacity and capability, and other economic factors. Optimizing this approach could build upon Wilson's (1990) advocacy for real-time data application to redefine periodic procurement requirements.

Recommendations for Further Research

Due to the lack of publicly available total munitions requirements data as the primary output of the MRP, it is recommended that further research be conducted to quantify the impact that TMR (and overall MRP output) has on budget requirements submissions. This recommendation is intended to suggest that quantifiable correlations between both timing of submissions and magnitude of impact be understood to confirm the total aggregate impact over time of MRP changes to budget changes and subsequent program risk.

This research highlighted several complexities associated with conducting MRP analyses in support of generating ammunition budget requirements. Additionally, interrelationships and extended timing between the MRP, the USAF's NCAA, and the PPBE process introduce additional complexity. It is recommended that further research be conducted on the specific complexities, limitations, and timing factors associated with a single iteration of the PPBE process with consideration to supplemental and precursor processes such as MRP and/or the USAF's NCAA. Recall findings from Kassing et al. (1991), which concluded that processes used to calculate munitions requirements are lengthy taking upwards of 10-12 months to complete. Recommend specific focus be given to gaps and overlaps within the data flow processes as well as portions of the process which require assumptions or result in redundancies.

Finally, during this research, it was discovered that the commercial sector has implemented processes to address inefficiencies and uncertainties with the intent of understanding risk and stabilizing the production environment. These processes are represented by the materials requirements planning paradigm, focusing on managing material manufacturing processes, inventory processes, and procurement processes while linking them with cost

accounting processes in the interest of efficiency (Desmond, 1988). It is recommended that additional research be conducted as to the feasibility and suitability of applying benchmark processes and procedures for material requirements planning to the defense industrial base. Strategic challenges related to acquisition strategy planning, contracting tools and techniques, and sharing information such as operational expenditures are certainly barriers, and the follow-on investigation should seek to understand benefits as well as costs. These processes may improve visibility to emerging needs of the Combatant Commands considering that MRP occurs every even-numbered calendar year with off-year assessments conducted on an as-needed basis per DoDI 3000.04 (2018).

Summary

In summary, and pertaining to the central research questions, it was found that ammunition budget requirements instability introduces acquisition program risk. In the case study presented, budget requirements instability was demonstrated through the increase in general purpose bomb budget requirements above and beyond existing industrial capacity. Research revealed that “increased demand for general purpose and penetrator bombs has resulted in unprecedented demand for some components above existing industrial capacity” (Tannehill, 2018, p. 4). Output of MRP contributes to budget requirements planning and stability, but was found to be only one of a variety of contributing factors. Other factors such as the unfunded requirements process and OCO or supplemental funding requests affect budget requirements stability. As shown by Haraburda (2017) and others, themes of consistency and collaboration between government and commercial participants in the defense industrial base emerge as potential steps to begin resolving the above challenges.

Conclusion

Accurately computing, planning, and executing ammunition budget requirements is critical to understanding and managing acquisition program risk as well as identifying capability gaps and investment opportunity within the defense industrial base. Overestimating requirements will potentially result in unnecessary investment in capability, inadvertently diverting resources from other priorities. Underestimating requirements will potentially disguise capability gaps that would otherwise manifest themselves as capability shortfalls during times of surge. Continuing consistent engagements throughout the MRP and budget requirements processes while expanding engagements within the defense industrial base may help improve budget requirements stability with the result of reducing acquisition program risk. Incorporating themes such as MRP output, production capacity (MSR/MPR), and other economic factors in these deliberations can help reduce acquisition program risk, improve program resiliency over uncertain futures, and help build viable and sustainable economic program frameworks.

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List of Acronyms

BLU	Bomb Live Unit
DAU	Defense Acquisition University
CMIB	Conventional Munitions Industrial Base
CR	Continuing Resolution
DAF	Department of the Air Force
DCS	Direct Commercial Sales
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DIA	Defense Intelligence Agency
FMS	Foreign Military Sales
GAO	Government Accountability Office
GDP	Gross Domestic Product
IPT	Integrated Product Team
JCAPP	Joint Conventional Ammunition Policies and Procedures
JM&L LCMC	Joint Munitions & Lethality Life Cycle Management Command
JOCG	Joint Ordnance Commanders Group
JPEO A&A	Joint Program Executive Office Armaments and Ammunition
LCAAP	Lake City Army Ammunition Plant
MDAP	Major Defense Acquisition Program
MRP	Munitions Requirements Process
MPR	Maximum Production Rate

MSR	Minimum Sustaining Rate
NCAA	Non-Nuclear Consumables Annual Analysis
NDAA	National Defense Authorization Act
NTIB	National Technology and Industrial Base
OSD	Office of the Secretary of Defense
PGM	Precision Guided Munitions
POL	Petroleum Oil and Lubricants
POM	Program Objective Memorandum
PPBE	Planning, Programming, Budgeting, and Execution
SCM	Supply Chain Management
SMCA	Single Manager for Conventional Ammunition
TAMP	Tactical Air Munition Program
TMR	Total Munitions Requirement
USA	United States Army
USAF	United States Air Force
USFK	United States Forces Korea
USN	United States Navy
USSOCOM	United States Special Operations Command
WRM	War Reserve Materiel
WRMR	War Reserve Munitions Requirement