INSTITUTE FOR DEFENSE ANALYSES

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Executive Summary

The Institute for Defense Analyses (IDA) was asked by the Director of Performance Assessments and Root Cause Analyses (D,PARCA) in the Office of the Secretary of Defense (OSD) to assess the effect of affordability goals and caps (collectively called constraints) on the Department of Defense (DoD)'s acquisition process. Our assessment is contained in this report. That assessment is constrained because only a few cases exist in which we can point to a specific action and say, "this would not have occurred were it not for the affordability guidance," but we highlight the few we found. We also looked at the effect of affordability analysis in general, because we determined that constraints are only a small part of the picture.

The Goals of Affordability Analysis

Affordability analysis is an initiative supported by successive Under Secretaries of Defense for Acquisition, Technology and Logistics (USD(AT&L)) as part of the Better Buying Power (BBP) program. It was begun by Dr. Ashton Carter and has been continued by Mr. Frank Kendall III, the current USD(AT&L). In theory, the essence of affordability analysis concerns portfolios of acquisition programs. It is meant to assure that all the programs within a portfolio fit within a plausible funding profile for that portfolio over the life of the programs and that all the acquisition portfolios together fit within the Department's overall acquisition budget.

In the first BBP memo, issued in 2010, Dr. Carter wrote:

> We estimate that the efficiencies targeted by this Guidance can make a significant contribution to achieving the $100 billion redirection of defense budget dollars from unproductive to more productive purposes that is sought by Secretary Gates and Deputy Secretary Lynn over the next five years.

Among those "unproductive purposes" he had in mind was surely the Army's Future Combat Systems (FCS) program, which had been cancelled the previous year. FCS never produced hardware the Army could field, but did spend $19 billion (BaseYear 2010); FCS was an expensive failure. While affordability was not FCS's only problem, because of its

[1] *Army Strong: Equipped, Trained and Ready*, Final Report of the 2010 Army Acquisition Review, chartered by the Honorable John M. McHugh, Secretary of the Army, January 2011, 163, accessible at http://www.rdecom.army.mil/EDCG%20Telecoms/Final%20Report_Army%20Acq%20Review.pdf.

high expected cost, an affordability analysis as performed today might have prevented it from receiving Milestone B authority and spending so much money. Thus, affordability analysis is meant to have the greatest impact at the early stages of program development.

Setting and Tracking Affordability Goals

Service programmers conduct affordability analysis—on which affordability constraints are based today—in preparation for Defense Acquisition Board (DAB) meetings. The results are presented in PowerPoint charts at the DAB meeting, but the Services do not release the underlying data used to prepare them, making it difficult to track whether the Services are making consistent assumptions from one DAB to the next. To the extent possible, we have examined affordability submissions across the Services.

Affordability is tracked at the individual program level in the context of portfolios. The primary purpose of affordability constraints is tracking whether programs and portfolios have stayed on target after DABs. Constraints have taken many different forms; today all new acquisition constraints are either in the form of average unit cost or total investment cost.

Affordability constraints are not cost estimates: conceptually, a program could be given a constraint of 100 in arbitrary units even though it only is expected to cost 70. In this case, the Service is saying the value to the nation exceeds the cost. However, the creation of the constraint at 100 is based on the current cost estimates for the other programs in the portfolio and assumptions about the total funding that will be available over the life of the program.

Our conclusions and recommendations are based on our research in the context of the goals of affordability analysis.

Observations

- An analysis of requirements documents did not yield any stories of changes because of affordability analysis. This does not mean that affordability analysis has had no effect on requirements documents, but simply that we could not see it.
- Since affordability analysis is meant to deter the inception of overly ambitious programs, effective affordability analysis will sometimes discourage pursuit of potentially high-payoff technologies. Initially, Affordability was the highest priority in the initial BBP memo. While it is still prominent in the latest iteration, building the most technically capable systems has replaced it at the top. There may be a tension between maximizing technical capability and affordability.

- Affordability has brought Service programmers deeper into the acquisition process, which should mean that programs are less likely to suffer external funding shocks.
- Average cost metrics have a fundamental flaw as affordability targets; they are inconsistent with reducing program buys as a way to achieve affordability since smaller buys increase average cost while reducing total cost. The best form for investment constraints is total cost. Supplemental average cost targets may be useful because they can help identify cases in which the efficacy of a program is degraded because too few systems can be afforded.
- Operation and Support (O&S) estimates are too uncertain and subject to manipulation to play much of a role in long-term affordability analysis. This is a serious shortcoming. We recommend an examination of whether it is possible to make O&S affordability analyses good enough to be useful.
- Affordability analysis is about managing portfolios and assuring that the entire acquisition program fits within the expected funding level in a plausible way. As presently constituted, it does not systematically serve this function. We have studied recent submissions and found that (1) they are not entirely consistent across DABs and (2) sometimes there are even inconsistencies within one set of briefing charts. We recommend that OSD staff be given access to the Service databases that are used to conduct affordability analyses, so they can more effectively perform their oversight functions.
- Current methods of performing affordability analysis do not give enough consideration to the effect of uncertainty. Budget forecasts beyond five years are unlikely to be exact; some programs will fail freeing up funds while others spend more than they had projected, and the capabilities of our rivals and enemies will change. When a program is stopped early, it is easier to estimate the reduction in spending than the reduction in capability.

Contents

1. Introduction

The Institute for Defense Analyses (IDA) was asked by the Director of Performance Assessments and Root Cause Analyses (D,PARCA) in the Office of the Secretary of Defense (OSD) to assess the effect of affordability goals and caps (collectively called constraints) on the Department of Defense (DoD)'s acquisition process. Our assessment is contained in this paper.

The Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L))'s affordability initiative formally began in 2010 as part of Better Buying Power (BBP) and has been in place, with some modifications, ever since. Each Major Defense Acquisition Program (MDAP) and Major Automated Information System (MAIS) program that is reviewed by the Defense Acquisition Board (DAB) is required to conduct an affordability analysis and present the results. The Acquisition Decision Memorandum (ADM) following the DAB reflects the analysis by placing affordability constraints on the program, which will be tracked to verify that the long-term spending plans of the Service remain affordable. Affordability analysis was formally mandated in the latest version of Department of Defense Instruction (DoDI) 5000.02 in January 2015.[1]

Affordability analysis is an exercise in which the entire spending of the Service is projected over the lifetime of the program in question, usually in excess of 25 years. All other projected spending by the Service should leave space for the program in question under the expected top line, and the purpose of the analysis is to measure that space. Once that space is determined, many assumptions are made to generate two simple constraints: one for investment spending and another for Operation and Support (O&S). Since 2013, the responsibility for this analysis has belonged to the Service staffs. Generally, they present one "sand chart" that piles all spending by portfolios on top of each other, adding up to the expected Service top line, and a second sand chart that shows the expected spending for all of the programs in the portfolio, including the program under consideration. Figure 1 and Figure 2 are good examples; they are from the Three Dimensional Expeditionary Long Range Radar (3DELRR) DAB that was held on August 1, 2013.[2]

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[1] Department of Defense Instruction (DoDI) 5000.02, "Operation of the Defense Acquisition System." January 2015.

[2] Defense Acquisition Board (DAB), "Three Dimensional Expeditionary Long Range Radar (3DELRR) Pre-Engineering and Manufacturing Development (EMD) Review," Briefing, August 1, 2013 (FOUO).

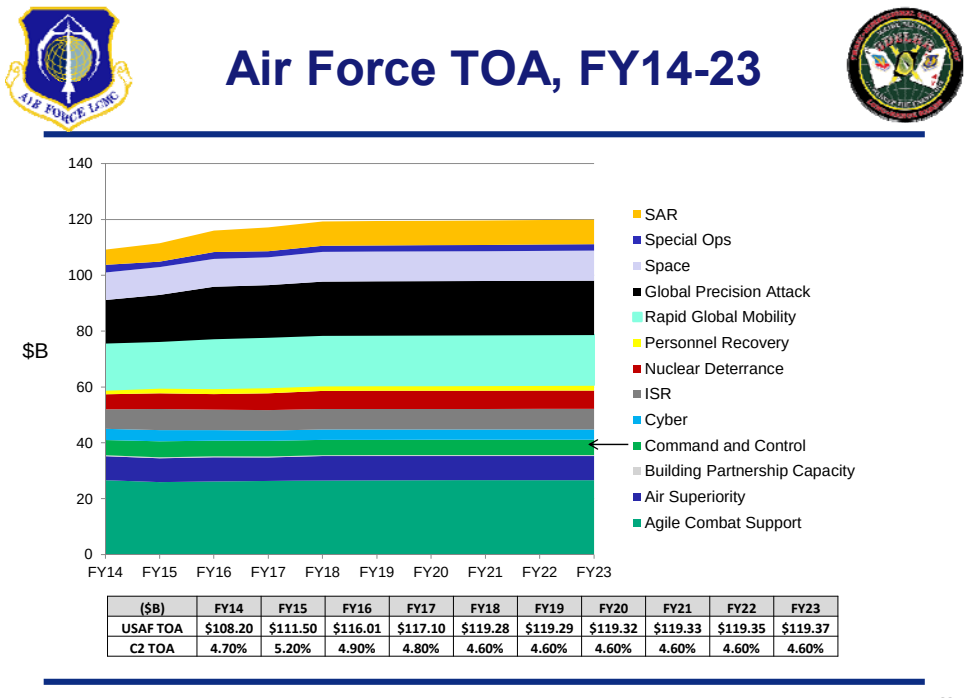

Figure 1. Air Force Total Obligational Authority (TOA), Fiscal Year (FY) 2014–2023

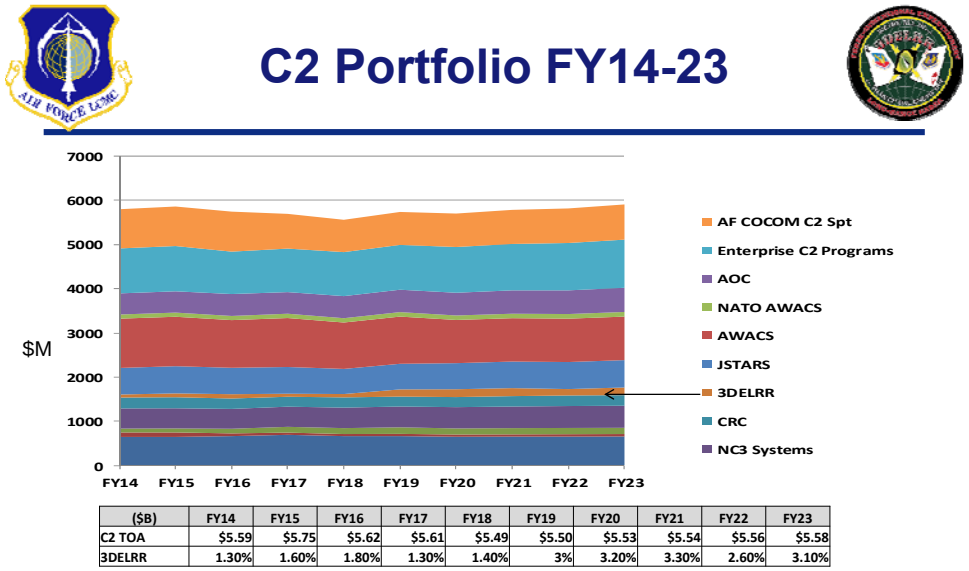

Figure 2. C2 Portfolio FY 2014–2023

Each program has an expected spending profile based on past cost estimates, and these are used to make the sand charts.

In 2009, many programs were ended early, including the Army's Future Combat Systems (FCS), the Marine Corps' new presidential helicopter, and the Air Force's F-22 Raptor—of these, only the F-22 entered service at all. The Honorable Ashton Carter was then the USD(AT&L) and the Honorable Frank Kendall III was his principal deputy. Dr. Carter went on to become Deputy Secretary of Defense in October 2011 and then Secretary of Defense in February 2015. Upon Dr. Carter's first promotion, Mr. Kendall became acting USD(AT&L) and was confirmed in May 2012, where he is today. These two appointees were the original proponents of BBP, the first edition (1.0) signed by Dr. Carter and the subsequent ones by Mr. Kendall. The BBP initiatives have had the backing of the same senior defense team for seven years, providing unusual leadership continuity.

The stated reason for BBP 1.0 was to reduce spending by improving efficiency. An additional reason was the idea that future rounds of cancellations like they had just experienced should not be repeated, and affordability analysis would help prevent it.

In this paper, we look at what has happened in the years since DoD began mandating affordability analysis. So far, although a few programs have been cancelled, another wave like 2009's has not occurred. Another wave so soon would have been quite unexpected, regardless of the policy that was followed. There have been some other ramifications, and they are the subject of this paper.

In Chapter 2 we provide the history of DoD's affordability initiative. Chapter 3 looks at what affordability analysis has accomplished. Chapter 4 considers what DoD should think about to improve affordability analysis, and Chapter 5 shows some of the problems DoD has had and needs to be aware of for the future.

An ongoing tension exists within DoD between programmers and the acquisition community, and affordability analysis is in the center of it. Programmers consider all spending over several years and make all of the pieces fit under the assigned top line in a process repeated annually. The USD(AT&L), as the chief acquirer, makes decisions about programs individually as they come up sporadically throughout the year. The USD wants to prevent having portfolios short on funds, because that leads to stretches and cancellations, but his tools are decisions for individual programs. Affordability analysis with constraints is an attempt by the USD to solve this problem with his tools.

An idealized form of affordability analysis would be for each Service to annually conduct their standard five-year programming process over far more years to verify that everything they plan to acquire is affordable. If this exercise were carried out annually, affordability constraints would not be required because each year the Services would show, as they do now within the Future Years Defense Plan (FYDP), that everything is affordable. Such a requirement has not been placed on the Services and does not seem likely. This

paper discusses the process as it stands today, which replaces the annual analysis of each Service's long-term plans with tracking constraints that are set by the USD at milestone reviews, based on the long-term analysis carried out at that time.

2. Background on Affordability

A. Reducing Spending

The original Memorandum for Acquisition Professionals, "Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending," dated September 14, 2010,[3] was signed by Dr. Carter and came to be known as BBP 1.0. This section begins with a discussion of the vision for affordability expressed in this original memo. It is followed by a more lengthy description of the specific guidance therein, with emphasis on the establishment of affordability targets and requirements (later changed to affordability goals and caps).

1. The 2010 Guidance: BBP 1.0

BBP 1.0 presented a list of twenty-three principal actions to improve efficiency in the Defense acquisition process. The first five of these actions are associated with the major area "Target Affordability and Control Cost Growth." The motivation is stated in the first two paragraphs of the BBP 1.0 memo:

> To put it bluntly: we have a continuing responsibility to procure the critical goods and services our forces need in the years ahead, but we will not have the ever-increasing budgets to pay for them. We must therefore strive to achieve what economists call productivity growth: in simple terms, to DO MORE WITHOUT MORE. . . .
>
> Secretary Gates has directed the Department to pursue a wide-ranging Efficiencies Initiative, of which this Guidance is a central part. This Guidance affects the approximately $400 billion of the $700 billion defense budget that is spent annually on contracts for goods . . . and services. . . . We estimate that the efficiencies targeted by this Guidance can make a significant contribution to achieving the $100 billion redirection of defense budget dollars from unproductive to more productive purposes that is sought . . . over the next five years.[4]

We offer some initial observations based on this guidance. The first is that there is no statement of a formal intention to "revolutionize" defense acquisition; the goal is simply to achieve a specific amount of cost savings over five years that can be used elsewhere within

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[3] Ashton Carter, "Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending," USD(AT&L) Memorandum for Acquisition Professionals, September 14, 2010 (hereafter referred to as BBP 1.0).

[4] Ibid., 1.

the Department. How these savings or "redirections" are to be measured is left unstated and is not mentioned in future versions. A second observation, which is modified elsewhere in this and later memos, is that in the fundamental acquisition tradeoff between cost and requirements, neither is to be favored (or sacrificed); instead, these redirections are to be achieved through improved *efficiency*—presumably through better management and oversight.

The body of the BBP 1.0 memo goes on to direct twenty-three specific actions, broken into five major areas:

- Target Affordability and Control Cost Growth
- Incentivize Productivity and Innovation in Industry
- Promote Real Competition
- Improve Tradecraft in Services Acquisition
- Reduce Non-Productive Processes and Bureaucracy

The first of these five, "Target Affordability and Control Cost Growth," addresses the principal subject of this paper: Affordability. The other major areas will not be discussed in this document.

a. Affordability Vision, circa 2010

We begin with the question, "What problem is the Affordability approach of BBP 1.0 intended to address?" This question is not to be asked in a vacuum; implied is how the specific goals of Affordability (as expressed in BBP 1.0) differ from similar requirements such as cost control and Nunn-McCurdy (N-M) avoidance. The memo offers the following definition: "Affordability means conducting a program at a cost constrained by the maximum resources the Department can allocate for that capability."[5]

One proximate cause that led to BBP 1.0 was the cancellation of a number of programs after years of development and billions of dollars expended; chief among these was the Army's FCS. The perception at the highest levels of OSD, and within the Legislative and Executive branches of the federal government, was that FCS in particular had been "unaffordable from the start" and that this was widely known even at program inception. The cancellation of this program was an embarrassment to the Army and to DoD as a whole. When FCS was a going concern, no affordability analysis was conducted, and it is conceivable that the Army might have made it fit. However, an IDA paper published in 2007[6] documented that the costs of FCS would be far higher than was in the Army's

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5 Ibid., 2.

6 David M. Tate et al., "Future Combat Systems (FCS) Cost Review: Summary of Findings," IDA Paper P-4212 (Alexandria, VA: Institute for Defense Analyses, April 2007).

plan. So, even if the official cost estimate might have made it look affordable, the better estimate would have made it more difficult to fit in the plan.

The vision of affordability, then—in the context of BBP 1.0—is in part to "prevent future FCSs." The unaffordability of FCS is clear (or perceived as clear) in hindsight, but how does one tell which programs that are currently being initiated are "future FCSs?"[7]

In general terms, two concepts arose as part of the vision. The first was that the five-year planning period associated with the FYDP was insufficient to prevent initiation of doomed programs: this does not, in general, even cover the costs associated with the Research, Development, Test and Evaluation (RDT&E) phase of a typical program. Since most of the program costs are in Procurement and O&S, these phases must be explicitly considered from inception and not pushed off into an out-year "bow wave." Key parts of the guidance, therefore, direct those responsible for managing the programs to consider the entire life cycle of the program—30 or 40 years—rather than "just" the FYDP.

The second concept is that programs should not be considered in isolation; it must be recognized and acknowledged that, in constrained budget environments, cost growth in one program must result in a decrease in others. This, it was argued, must be formally recognized and tied to the question that the Program Manager (PM), the Service, and OSD should all have in mind: at what point does the cost of a program exceed its value to the warfighters and taxpayers? Complicating matters is the well-known practice of stretching out the schedule of troubled programs—as well as programs that are not troubled, but that must contend with others that are. This lowers the per-year costs of these programs—this is the purpose of the practice—but generally increases the total procurement costs, as well as delaying operational availability.

b. BBP 1.0's Guidance

BBP 1.0 has five "principal actions" related to the "Target Affordability and Control Cost Growth" area:

- Mandate affordability as a requirement.
- Drive productivity growth through Will Cost/Should Cost management.
- Eliminate redundancy within warfighter portfolios.
- Make production rates economical and hold them stable.
- Set shorter program timelines and manage to them.

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[7] While we are not certain that affordability analysis could have prevented FCS, other programs, such as Comanche, also spent significant sums before early termination—affordability analysis might well have ended FCS before Milestone (MS) B or significantly altered it, reducing the subsequent expenditures.

The principal action mandating affordability gave rise to this paper, and we will look at it in depth. The other four mostly are mostly about increasing productivity. We will also look at "Eliminate redundancy within warfighter portfolios" because it is the first mention of portfolios and is necessary for consideration of what the affordability requirement should be—increasing productivity by not buying redundant equipment. Lastly, while shorter program timelines are primarily about improving efficiency, BBP 1.0 also says (italics in the original, in all cases that follow):

> Requirements and technology level for the [program] will have to fit this schedule, not the other way around. *When requirements and proposed schedules are inconsistent, I will work on an expedited basis with the Services and the Joint Staff to modify the requirements as needed before granting authority for the program to proceed.*[8]

This is not a focus on making certain that our warfighters have the best equipment possible; rather, it highlights the central mission of BBP 1.0—reducing spending.

1) Mandate affordability as a requirement

After presenting the definition of Affordability given earlier—"conducting a program at a cost constrained by the maximum resources the Department can allocate for that capability"—this principal action directs PMs to "treat affordability as a requirement before milestone authority [will be granted]." The memo continues:

> *Specifically, at Milestone A, my Acquisition Decision Memorandum (ADM) approving formal commencement of the program will contain an affordability target [later changed to "goal"] to be treated by the program manager (PM) like a Key Performance Parameter (KPP) such as speed, power, or data rate – i.e., a design parameter not to be sacrificed or compromised without my specific authority. At Milestone B, when a system's detailed design is begun, I will require presentation of a systems engineering tradeoff analysis showing how cost varies as the major design parameters and time to complete are varied. . . .* This analysis would then form the basis of the 'Affordability Requirement' that would be part of the ADM decision. . . . this guidance . . . will apply to both elements of a program's life cycle cost – the acquisition cost (typically 30 percent) and the operating and support cost (typically 70 percent). For smaller programs, the CAEs [Component Acquisition Executives] will be directed to do the same at their level of approval.

The guidance officially states that the PM must incorporate an affordability target—later renamed goal—as a KPP at the Milestone (MS) A DAB. Not stated here, but implied, is that the PM must also incorporate an affordability requirement—later renamed cap—as a KPP at the MS B DAB, and beyond. IDA's primary task, with the implied assumption

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[8] BBP 1.0, 5.

that these affordability goals and caps have been implemented, is to explore how programs have responded to stay within these limits.

The guidance does not formally state, nor really even hint at, how these affordability goals and caps are to be calculated. Many different forms for the constraints were used by different programs at DABs, some of which were difficult for OSD to observe, but it has become standard for Average Procurement Unit Cost (APUC) or Program Acquisition Unit Cost (PAUC)[9] to be used to define the constraints when the program is buying many units, and total investment to be used for programs in which that is not the case.

Generally, the stated affordability definition—"conducting a program at a cost constrained by the maximum resources the Department can allocate for that capability"—requires that the Services quantify their allowable level of expenditures by capability area and fit all the programs in that area within that level. Since costs in a capability area cover many programs, tradeoffs must be considered in applying a cap to an individual program. It is difficult to answer the questions: At what point does the cost of (for example) a new helicopter become so high that you would rather cancel the program and either live with the old ones or start over? To what extent would you rather cut back other programs in the portfolio? The idea of asking the PM and the Service to think about this *before* contract award is outstanding—but the answer depends on many factors, some of which change over time or are outside the PM's control.

The requirement to determine and state affordability goals and caps is done to act as a trip-wire for unacceptable cost growth, and thus overlaps significantly with N-M reporting. We have no objection to this; the target audience is different, and it could prove more useful. While affordability analysis may help accomplish the original vision (as we understand it) of preventing FCSs before they start, constraints come too late to accomplish this. Constraints can only have an effect after the program has commenced, so they need to be designed to help the USD fix programs that are having difficulties that were not expected at the milestone where the constraint was created.

2) Eliminate redundancy within warfighter portfolios

This action introduces two concepts that are fundamental to the affordability vision. The memo text begins with the example of a program that the Army decided to cancel (thus

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[9] APUC is the total procurement dollars in a base year divided by the total number of production units. PAUC is the total dollars in the program (RDT&E plus procurement) divided by the total number of units. Both metrics are set in APBs when programs go through milestones. The PAUC and APUC are calculated each year and compared to the APB to determine if there is a Nunn-McCurdy Breach. Using them for affordability targets introduces another use for these numbers. Each year, the PAUC or APUC is compared to the affordability constraint to see if there has been a breach.

freeing up resources for other Army programs) based on the fact that its capabilities could be met by other systems. It reads, in part:

> This was a classic value decision that could not have been made by looking at the . . . program in isolation. The Army had to look at the entire "warfighting portfolio" . . . to see that [the program's] cancellation would not, in fact, result in a major sacrifice of military capability.
>
> *I intend to conduct similar portfolio reviews at the joint and Department-wide level with an eye toward identifying redundancies. . . . I am directing the components to do the same for smaller programs and report the results*.[10]

This is the first mention of the term "portfolio" in the Better Buying Power guidance. As the concept of affordability evolved, portfolios of families of programs (for example, "tracked vehicles" or "surface ships") became central. The so-called "sand charts" that must be presented in the Affordability section of each DAB-level milestone review are snapshots of these portfolios.

The significance of requiring portfolio information to be presented at DAB reviews is not to be underestimated, and it represents something new in the standard OSD Acquisition process. Up to this point, the milestone reviews were between one PM and the appropriate level of acquisition executive, typically USD(AT&L) for Acquisition Category (ACAT) I programs. The requirement to discuss portfolios of other programs, even if superficially, forces PMs to interact with their Service—including, ideally, internal discussions of how the program's cost increases will be offset elsewhere—prior to milestone approval. It should not escape notice that a Service representative now has a seat at ACAT I milestone reviews, which was not formerly the case.

Expecting offsets to come from within a single portfolio is less than ideal, but is a significant step. The ability to trade not just within but between portfolios, and even between Services, is a major theme in the book *How Much Is Enough? Shaping the Defense Program 1961–1969*,[11] and should be. This is especially so because the portfolios used are almost always by platform type. For example, trucks and utility helicopters are in different Army portfolios (transportation and aviation), and while there are many missions where neither could replace the other, on the margins, trades between them might be the best choice. As a cross-Service example, the Army's AH-64 Apache helicopters perform similar missions to the other Services' close air support aircraft.

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[10] BBP 1.0, 4.

[11] K. Wayne Smith and Alain C. Enthoven, *How Much is Enough? Shaping the Defense Program 1961–1969* (Santa Monica, CA: The RAND Corporation, October 2006).

2. The F-35

By almost any metric, the largest program in DoD is the joint Air Force and Navy F-35 Lightning II, also known as the Joint Strike Fighter or JSF. The F-35 received its only affordability constraint in an ADM signed by Mr. Kendall as the Acting Under Secretary on March 28, 2012.[12] All previous milestones occurred before BBP 1.0 was signed. The investment target for affordability reads as follows:

> I establish the following affordability targets for Unit Recurring Flyaway (URF) cost. The URF targets are based on the Joint POE. By the next program milestone, the Full-Rate Production Decision, planned for FY 2019, the FY 2019 URF for each variant should be at or below the amounts reflected in the following table. These targets are based upon planning assumptions reflected in the FY 2013 President's Budget and the 2011 projection for international partner procurement. If there are subsequent changes to either the U.S. or international partner procurement quantities, the Joint Program Office (JPO) shall isolate the effect that this has on the below URF targets as a factor that is not within their management control.

	FY 2019 URF TY$M	FY 2019 URF BY12$M
USAF (CTOL)	83.4	71.5
USMC (STOVL)	108.1	92.7
USN (CV)	93.3	80.0

These constraints only relate to costs in FY 2019. According to the December 2012 Selected Acquisition Report (SAR), FY 2019 was expected to be the year of the full-rate production decision, and it still is. It seems to tempt the program to play games with costs in that year to fit the metrics both by shifting costs to other years and by how they define what is and is not recurring flyaway. Note that there is not a standard percentage of procurement dollars that always fall into this category.

The O&S target is stated here.[13]

> I establish the following affordability targets for sustainment cost, that I direct be reviewed annually against the estimate. At steady state operations, defined as operations at peak Primary Aircraft Authorized (PAA), the cost per flying hour should be at or below the amounts reflected in the following table. The targets are based upon assumptions reflected in FY 2013 beddown planning for aircraft delivery and operations. Detailed ground

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[12] Frank Kendall, "F-35 Lightning II Joint Strike Fighter Acquisition Decision Memorandum," Memorandum for the Secretary of the Navy and Secretary of the Air Force," March 28, 2012 (FOUO). Abbreviations in cited table: TY – Then Year; CTOL – Conventional Takeoff and Landing; STOVL – Short Takeoff/Vertical Landing; CV – Carrier Variant.

[13] Ibid.

rules and assumptions are contained in the Business Case Analysis supporting 2366b certification.

	Cost per Flight Hour BY12$K
USAF (CTOL)	35.2
USMC (STOVL/CV)	38.4
USN (CV)	36.3

For the O&S numbers, the cost per flight hour can generally be reduced by increasing flight hours—and total cost.

Neither metric captures full costs, so they do not relate to how many dollars are available for other programs.

The December 2012 SAR shows the total obligations for RDT&E and Procurement for this program were expected to be $10.5 billion in 2019, of which only $7.7 billion were for recurring flyaway costs. The rest was for other categories. Our analysis, based on the December 2014 SAR, shows how many procurement dollars this program is expecting to spend that are not in recurring flyaway costs.

The funds in Figure 3 are sufficient to have significant affordability repercussions for other acquisition programs.

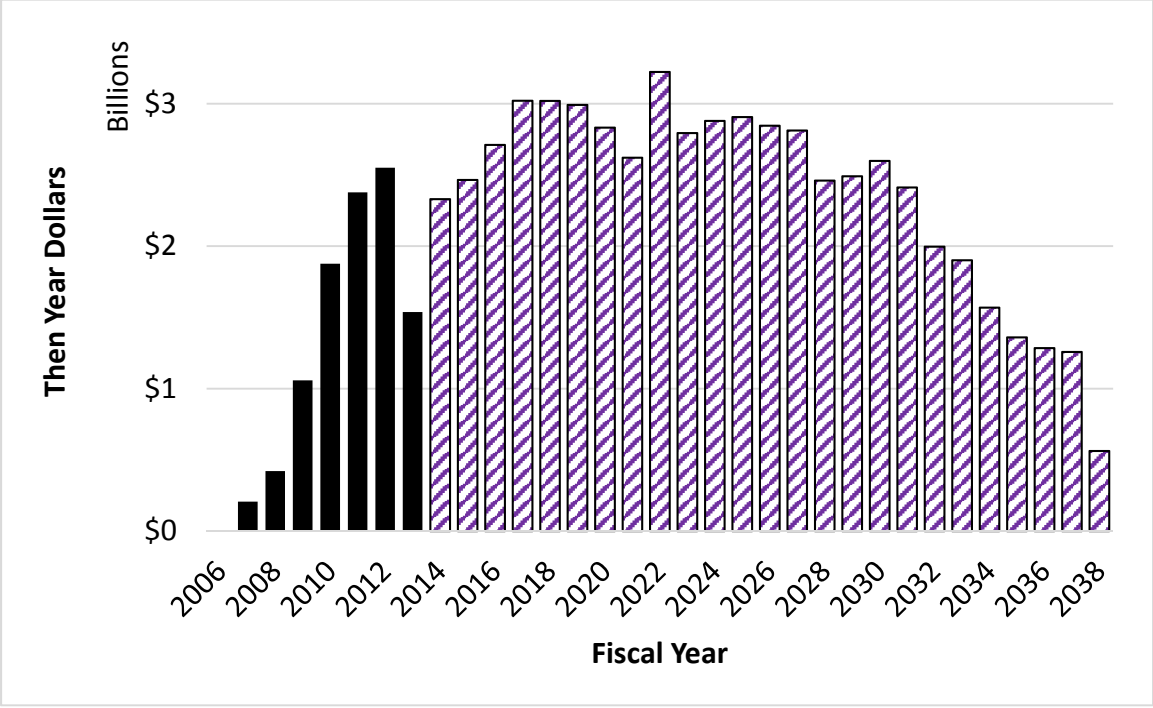

Figure 3. F-35 Procurement Spending Outside of Recurring Flyaway Costs (December 2014 SAR)

What the affordability requirement from the ADM does look like is a requirement to live within the 2012 cost estimate. This is why if quantities, either for the United States or our allies, change, the constraint can be modified "as a factor that is not within their management control."[14] Affordability has evolved since then, and Mr. Joseph Beauregard, of USD(AT&L)/(ARA), has told us that there are some in OSD who would like to see this program's constraint redefined.

3. The 2013 Guidance: BBP 2.0

The memo "Implementation Directive for Better Buying Power 2.0 – Achieving Greater Efficiency and Productivity in Defense Spending," (hereafter referred to as BBP 2.0),[15] was signed by Mr. Kendall as the USD(AT&L) on April 24, 2013. It incorporates a number of subtle changes with respect to BBP 1.0. In addition to these subtle changes, some important "vision implementation" changes are made as well.

The format has changed: rather than a single, eighteen-page document, it has been separated into a two-page memo and two attachments. The first attachment is a one-page Reference Guide, and the second is a twenty-six-page list of implementing guidance and actions. The overall tone has also changed, as will be discussed below. Since this memo is significantly newer, there has been less time for BBP 2.0 to influence the acquisition process than BBP 1.0. Affordability Goals and Caps remain, but as we will see, organizational responsibilities for implementing them have evolved. We will discuss three parts of the BBP 2.0 memo. As before, we consider the non-affordability efforts in BBP to be outside the scope of our task.

In the September–October 2013 issue of *Defense AT&L* magazine, Chad Ohlandt, a researcher at RAND then serving on a detail at the Acquisition Policy Analysis Center in AT&L, published an article called "Dispelling the Myths of DoD's Affordability Policy."[16] The five-page article lays out in very broad terms what the Services are supposed to do and why. He wrote that "Affordability is all about using that knowledge to avoid starting or continuing programs that we cannot reasonably expect to pay for in the future." The timing of this article suggests that there were still questions within the acquisition community about the purpose of affordability analysis and how to do it.

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[14] We presume that "their" refers to the program office and its contractors.

[15] Frank Kendall, "Implementation Directive for Better Buying Power 2.0 – Achieving Greater Efficiency and Productivity in Defense Spending," Memorandum for Secretaries of the Military Departments, Deputy Chief Management Officer, Department of Defense Chief Information Officer, Directors of the Defense Agencies, and AT&L Direct Reports, April 24, 2013.

[16] Chad J. R. Ohlandt, "Dispelling the Myths of DoD's Affordability Policy," *Defense AT&L* (September–October 2013): 4–8.

a. BBP 2.0 Memo Body

The memo states:

> [W]e are continuing our efforts in the following seven areas to achieve greater efficiency and productivity in defense spending:
>
> 1. Achieve affordable programs;
> 2. . . . .

Affordability still owns the top spot, while the remaining six are about efficiency. The format and structure have changed; there are no longer five major areas; there are now seven major groups (although this term is not used), the first of which has been reduced from "Target Affordability and Control Cost Growth" to "Achieve affordable programs." In BBP 1.0, there were twenty-three principal actions in total, five of which were in the "Affordability" major area; now there is a single principal action (although again this term is no longer used), associated with an unnumbered list of specific actions.

In place of the BBP 1.0 guidance structure, BBP 2.0 presents a much more general list of overarching principles that are inherently qualitative and more "big picture" than BBP 1.0. Mr. Kendall appeared to be stepping back from the "hands on" approach that his predecessor took in the first memo.

b. BBP 2.0 Guidance and Actions: Achieve Affordable Programs, General Guidance

Much of the general guidance on affordability is a continuation of BBP 1.0, but there are a few highlights to mention.

> Constraints stem from long-term affordability planning and analysis, which is a Component leadership responsibility.[17]

Explicitly giving the setting of constraints to Component leadership was important. Now, in addition to the USD who signed the ADM, the Services would have ownership of them. This guaranteed that the spending plan brought to the DAB would be approved by Service leadership. Might this have helped prevent FCS?

Perhaps the most important quote in this section is this:

> If affordability caps are breached, costs must be reduced or else program cancelation can be expected.[18]

This may have been implied previously, but in BBP 2.0 this threat became explicit. Mr. Kendall doubled down on the importance of this initiative. With the costs of breaching so

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[17] BBP 2.0, Attachment 2, 1.

[18] Ibid.

clearly high, there might now be pressure not only on the program office to not breach the constraints, but OSD might also feel compelled to not report a breach to prevent having to conduct such a severe action, which might not be warranted.[19]

> Affordability analysis will examine competing Component fiscal demands for production and sustainment within a relevant portfolio of products over enough years to reveal the life-cycle cost and inventory implications of the proposed new products within the portfolio – nominally 30 to 40 years.[20]

This paragraph revisits the portfolio idea. It also makes clear that affordability is not only about the FYDP, but also about the years far beyond it.

c. BBP 2.0 Guidance and Actions: Achieve Affordable Programs, Specific Guidance

> ASD(A) [Assistant Secretary of Defense for Acquisition] will provide additional details on requirements, formats, and supporting data submissions in the revised DoDI 5000.02 . . . as well as updates to the Defense Acquisition Guidebook (DAG) and the Defense Acquisition Board (DAB) templates . . .
>
> ASD(A), with support from the Service Acquisition Executives (SAEs), will define a standard list of portfolios for my approval . . .
>
> Director, Acquisition Resource and Analysis (ARA), will update its program data repository, the Defense Acquisition Management Information Retrieval system, to track affordability constraints.[21]

The first and third of these directives have been accomplished, or largely so, and should be very helpful going forward. However, the second of the above tasks—the establishment of a standard list of portfolios—has made strides but is not yet complete. We have analyzed the Army's DAB slides over the last few years to look at portfolio stability, and that analysis is in Section 5.A. It is not clear that these portfolios are the right ones or that they are stable enough for long-range planning. Nonetheless, the very act of establishing a channel of communication between ASD(A) and the Services regarding their portfolios has led to a much greater degree of standardization and stabilization than in the past. This is good, since it facilitates the Services getting a better handle on portfolio consistency over time.

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[19] We expect most parents recall making a threat to their children that would undoubtedly yield compliance… only to find themselves holding the pieces of a broken antique dish and now having to decide if they really are going to cancel the family vacation.

[20] BBP 2.0, Attachment 2, 1.

[21] Ibid., Attachment 2, 2.

B. New Priority: Technological Superiority

By 2015, Mr. Kendall's focus had shifted somewhat. Using funds efficiently was still important, but he was also concerned about American technological dominance and said so in the latest edition, BBP 3.0.[22]

1. The 2015 Guidance: BBP 3.0

The memo "Implementation Directive for Better Buying Power 3.0 – Achieving Dominant Capabilities through Technical Excellence and Innovation," hereafter referred to as BBP 3.0, was signed by Mr. Kendall on April 9, 2015. While the commitment to affordability remains unchanged, the tone has changed significantly.

As was the case with BBP 2.0, the BBP 3.0 memo itself is very brief—this time only a single page. It is accompanied by two attachments: a one-page Summary Page, and a thirty-three-page attachment called "Better Buying Power 3.0 Implementation Guidance." We will again discuss three parts of this memo, although it will be a slightly different aggregation: the one-page memo itself, the one-page Implementation Guidance "Overview," [the first page of the Implementation Guidance] and the half-page section of the Implementation Guidance that specifically refers to Affordability [on the second page of the Implementation Guidance].

a. BBP 3.0 Memo Body

The second paragraph of the memo states:

> There is more continuity than change in Better Buying Power 3.0. Core initiatives focus on: ensuring that the programs we pursue are affordable. . . . We will continue all of these efforts.

On the one hand, all of the guidance about the importance of maintaining long-term affordability, via requirements reduction if necessary, still remains in place. However, it continues:

> New in Better Buying Power 3.0 is a stronger emphasis on innovation, technical excellence, and the quality of our products.

Here we see that the emphasis on innovation, in particular, will likely discourage trading capability for affordability and lead to the start of more programs that later turn out to be "unaffordable," like FCS.

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[22] Frank Kendall, "Implementation Directive for Better Buying Power 3.0—Achieving Dominant Capabilities through Technical Excellence and Innovation," Memorandum for Secretaries of the Military Departments, Deputy Chief Management Officer, Department of Defense Chief Information Officer, Directors of the Defense Agencies, and AT&L Direct Reports, April 9, 2015 (hereafter referred to as BBP 3.0).

b. BBP 3.0 Implementation Guidance: Overview

In contrast to BBP 1.0 and 2.0, which were about reducing spending, the second paragraph of the BBP 3.0 Implementation Guidance states a new idea:

> The theme that ties the content of BBP 3.0 together is an overriding concern that our technological superiority is at risk. Potential adversaries are challenging the U.S. lead in conventional military capability in ways not seen since the Cold War. Our technological superiority is based on the effectiveness of our research and development efforts.[23]

c. BBP 3.0 Implementation Guidance: Achieve Affordable Programs

While there is a new focus in this edition of BBP, much of the guidance on affordability remains the same. Perhaps the most important change is, again, in tone.

> ACAT I programs projected to exceed approved caps will undergo a Defense Acquisition Executive (DAE) review to determine appropriate corrective action.

The USD has not given up the possibility of cancelling programs that exceed their affordability constraints, but the apparent stakes have been lowered considerably.

2. Formal Guidance: DoDI 5000.02

In January 2015, Mr. Kendall signed Department of Defense Instruction 5000.02, "Operation of the Defense Acquisition System." It is consistent with BBP 3.0 and codifies that all of the affordability work that had been done before is now required along with many other changes to the process.

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[23] Ibid., Attachment 2, 1.

3. The Accomplishments of Affordability

How have the five principal actions associated with BBP 1.0's major area of "Target Affordability and Control Cost Growth" fared since they were first stated in September 2010? And, more specifically, what effect have the mandated Affordability goals and caps had on the performance of defense acquisition?

According to OUSD(AT&L)/(ARA), a total of forty-three programs (forty-two currently active) have been assigned affordability constraints in ADMs as of January 2016. These are shown in Table 1. Note that thirteen of these program have been assigned constraints twice, and four have been assigned constraints three times. According to the Defense Acquisition Management Information Retrieval (DAMIR) system on February 24, 2016, there are currently 105 active programs: 83 MDAPs and 22 MAIS programs, so 63 have no affordability constraints. Spell-outs for all programs are provided in the Abbreviations list.

Table 1. All Affordability Constraints Assigned as of January 2016

#	Program	MDD	MS A	Pre-EMD/ Development RFP DAB	MS B	MS C	Other
1	Gator Landmine Replacement	17-Jul-2015					
2	GBSD	11-Oct-2013					
3	LTAMDS	2-Feb-2015					
4	PSCS	27-Sep-2013					
5	JSTARS Recap	7-May-2015	10-Dec-2015				
6	F-15 EPAWSS	18-Jun-2014	14-Aug-2015				
7	IFPC Inc 2 - I	24-Mar-2014					
8	MGUE Inc 1	9-Apr-2012					
9	Ohio Replacement	10-Jan-2011					
10	ACV 1.1			26-Mar-2015	19-Dec-2015		
11	B-2 DMS			21-Jun-2013			
12	JAGM			17-Oct-2014			
13	JPALS Inc 1A			5-Nov-2015			
14	NGJ		3-Jul-2013	21-Apr-2015			
15	T-AO(X)			5-Apr-2013 18-Jun-2016			
16	3DELRR			8-Nov-2013	30-Sep-2014		
17	AMDR			21-May-2012	4-Oct-2013		
18	AMPV	16-Mar-2012		26-Nov-2013	22-Dec-2014		
19	AOC-WS Inc 10.2				11-Oct-2013		
20	B61 Mod 12 LEP TKA			30-Apr-2012	19-Nov-2012		
21	CIRCM	29-Dec-2011			25-Aug-2015		
22	CRH			2-Mar-2012 9-Oct-2012	18-Jun-2014		
23	EPS		2-Mar-2012		30-Apr-2014 4-Nov-2015		
24	F-22 Inc 3.2B				26-Jun-2013		
25	F-35				28-Mar-2012		
26	GPS OCX				19-Nov-2012 4-Nov-2015		
27	IAMD				1-Feb-2012		
28	JLTV			25-Jan-2012	20-Aug-2012		
29	JMS Inc 2				18-Jun-2013 4-Nov-2015		
30	LCS				7-Apr-2011		
31	Space Fence Inc 1			4-Oct-2012	30-May-2014 4-Nov-2015		
32	SSC				5-Jul-2012		
33	VH-92A (VXX)			5-Apr-2013	17-Apr-2014		
34	FAB-T CPT					26-Oct-2015	
35	LMP Inc 2					6-Jul-2015	
36	PAC-3 MSE					27-Mar-2014	
37	PIM					21-Oct-2013	
38	RQ-4A/B Global Hawk (Inactive)					23-Feb-2015	
39	SDB II					4-Jun-2015	
40	WIN-T Inc 2					3-Jun-2015	
41	RMS						25-Aug-2014
42	CANES						13-Oct-2015
43	MQ-8 Fire Scout						11-Dec-2015

Notes: MDD - Materiel Development Decision; EMD – Engineering and Manufacturing Development; RFP – Request for Proposal.

The DAMIR system, maintained by OUSD(AT&L)/(ARA), now contains a spreadsheet that tracks all active affordability constraints, allowing all parties in OSD to monitor the status of the affordability metrics easily. Part of IDA's tasking was to "[d]evelop options for how OSD staff specialists can effectively track these changes as part of future DAES [Defense Acquisition Executive Summary] reviews if the MDA is interested." Most targets are now expressed in terms of APUC or PAUC, and this makes tracking them much easier than it was when the constraints took many different forms, some of which OSD could not track at all with their data.

The Affordability segment in the milestone documentation is typically composed of two parts. The first of these is some sort of Affordability metric—a goal or a cap—that the PM, the Service, and USD(AT&L) can refer to as time goes by. The second is the inclusion of a "sand chart" that illustrates the magnitude of the program under review relative to the portfolio of programs into which the Service has bundled it, and the size of that portfolio relative to the expected entire Service top line. We will discuss each of these in turn.

The most common affordability constraint is in the form of an APUC, followed by PAUC. After BBP 2.0 was signed in April 2013 (discussed in Chapter 3), responsibility for creating the Affordability APUC or other metric was given to the Services. BBP 1.0 did not indicate who is to be responsible for its synthesis.

Both the Affordability and SAR APUC and PAUC have shortcomings as affordability metrics (discussed in Section 4.C.1). However, they offer the advantages that they are calculated and reported annually for all programs, so they add little additional work to the PM and are readily tracked in DAMIR.

These directives lead finally to the fundamental question: To what degree have actual ACAT I programs adjusted their requirements, costs, or schedules as a result of Affordability goals and caps? The answer is: probably a bit, but it is difficult to tell.

The obvious place to look for the effect of affordability analysis is in requirements documents, so we did. We found no evidence that they were influenced by affordability constraints. Over the last five years, we were unable to find any requirements documents in which a requirement was relaxed and was clearly done to make a program affordable. We also did not hear such stories from our interviewees. We heard about programs that changed how they met requirements or bought hardware. The biggest change we noted is the role of the Service programmers, often called "the 8s"[24] in the acquisition process.

While changing constraints were fairly easy to find, changes to programs were much harder, for two reasons. First, the barrier between the Services and OSD precludes insight

[24] "The 8s" refers to the Army's G8, the Air Force's A8, and the Navy's N8. Each of those is an office on the Service staff that programs funds over multiple years. The Navy's N8 has delegated their role at DABs to N2/N6 or N9 for most programs; these offices also take a long view of their portfolios.

into how the Services and the program offices have actually reacted to the Affordability guidance presented in BBP 1.0. Second, there are many factors that separate programs that stay on track from those that do not. These include contractor competence, PM talent, number and magnitude of technical challenges, stability of funding, stability of requirements, and a variety of unknown unknowns—all in addition to Affordability guidance. It is difficult for OSD to sort out these effects.

A. Changing Constraints

If constraints change too easily, they are not constraining anything. Mr. Kendall has said that he will modify affordability constraints if there is a change in quantity, so we wanted to see how often affordability constraints changed. While there is an official list of affordability constraints posted on DAMIR, that file does not include changes, only those that are currently in force. OUSD(AT&L)/(ARA) gave us a spreadsheet that tracks all constraints ever levied. That file showed seventeen programs that have had multiple affordability constraints, and we were able to find the relevant ADMs for all but three of them. We present these fourteen programs in Table 2. Spell-outs of all acronyms are provided in the Abbreviations list.

Table 2. Affordability Constraints for Fourteen Programs with Multiple Assignments

Program Name	Affordability Constraint		
Constraint Type	First	Second	Third
3DELRR			
APUC	$36,600,000	$35,000,000	
ACV 1.1			
APUC	$6,500,000	$6,500,000	
AMDR			
PAUC	$495,000,000	$495,000,000	
AMPV			
APUC	$2,400,000	$3,200,000	$3,620,000
B61 Mod 12 LEP TKA			
APUC	$259,000	$386,000	
CIRCM			
Maximum Unit Cost	$3,750,000		
APUC		$3,030,000	
CRH			
APUC	$66,900,000	$66,900,000	$65,000,000
JLTV			
APUC	$370,000	$399,000	
NGJ			
APUC	$36,840,000	$38,280,000	
T-AO(X)			
Average Ship Acquisition Cost	$560,000,000		
APUC		$560,000,000	
OCX			
Investment	$3,495,000,000	$4,112,000,000	
EPS			
Investment	$1,530,000,000	$1,380,000,000	
JMS Inc 2			
Investment	$345,000,000	$319,000,000	
Space Fence Inc 1			
Investment	$1,603,700,000	$1,306,800,000	$1,185,000,000

Only B61 Mod 12 LEP TKA, AMPV, and OCX showed changes of more than 15 percent in their constraints. The OCX had major cost growth and is discussed in Section 3.C. In the other two cases, the final constraint was assigned at MS B, so the early one was a goal and only the last one was a binding cap. Most of the constraints that changed also had a change in either constraint type or the base year of the dollars used to define

them. The early constraint for 3DELRR was APUC in then-year dollars,[25] which was changed at MS B to 2014 dollars.

It seems that most constraints have stayed in force because there have been few changes and those have been relatively small.

B. Bringing in the Service Programmers

The new affordability mandates have brought representatives of the Service programming offices to the table for milestone reviews. It will likely have to be the Services that enforce the Affordability reforms and prevent future FCSs. As strange as it sounds, the PMs have often bypassed their own Services at milestones; making the Services responsible for "owning" Affordability forces the PMs and the Services to interact on these issues far more than they have done in the past.

Every year, DoD sends the SARs and the President's Budget (PB) to the Congress. Within the FYDP, these two documents must agree. However, after that there can be significant disagreement between what the two documents say. For example, in the 2016 budget submission in FY 2015, the Navy reported total costs for the F-35 CV at $55.66 billion and for the STOVL variant of $47.66 billion, for a total of $103.32 billion. The December 2014 SAR lists the combined total at $86.8 billion. These numbers clearly show that even in the era of affordability analysis, the Navy programmers that wrote the budget submission and the program office that wrote the SAR were not coordinated. Affordability analysis cannot make the annual budget and SAR submissions match, but it does make certain that at DABs, the numbers will line up, as both groups are in the room.

Affordability analysis also demands longer term planning from the programmers. Before affordability analysis, five years of planning for the FYDP was generally considered sufficient. Now they are required to plan over longer durations. The Army has a new tool, the Long-Range Investment Requirements Analysis (LIRA), that they use for this purpose. LIRA tracks planned Army expenditures over many years, which is exactly what Mr. Kendall has required. Unfortunately for OSD, access to LIRA is not permitted for anyone outside the Army. This system is for Army internal use only, which means that while OSD can look at the results of the long-term studies performed by the Army, unlike with the FYDP, they will not be able to duplicate them or do their own. We believe the other Services have similar systems but also similar concerns about their data.

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[25] APUC is a well-defined term in defense acquisition and is invariably calculated with some year's constant dollars. A TY APUC is an unusual concept that could lead to some strange results. We never saw this idea used anywhere else.

C. Constraining Portfolios

Despite the difficulties with maintaining the definitions of portfolios, a recent success of affordability analysis, involving trades across programs, should be highlighted. This story is about the Air Force's Next Generation Operational Control System, or OCX, which is a replacement for the ground control system for the global positioning system (GPS) satellite constellation. When this program received its MS B in November 2012, its threshold to begin operations was October 2017, and its total acquisition cost was supposed to be under $3.7 billion (BY 2012). In October of 2015, a new Acquisition Program Baseline (APB) showed a total cost of $4.1 billion (BY 2012) and operations beginning in July 2020. On November 4, 2015, Mr. Kendall signed a remarkable ADM. As required, the affordability cap for OCX rose, but the constraints for three other programs changed as well, as outlined in Table 3.

Table 3. Affordability Constraint Changes from the November 4, 2015 ADM

Program	Original Constraint	New Constraint
OCX (Original Constraint November 19, 2012)		
Total Investment (BY 2012)	$3.495 billion	$4.112 billion
Total Sustainment (BY 2012)	$1.469 billion	$1.321 billion
Enhanced Polar System (EPS) (Original Constraint April 30, 2014)		
Acquisition Cost (BY 2014)	$1.530 billion	$1.380 billion
Average Annual O&S (BY 2014)	$17.5 million	$16.6 million
Joint Space Operations Center Mission System (JMS) Inc 2 (Original Constraint June 18, 2013)		
Acquisition Cost (BY 2012)	$345 million	$319 million
O&S Cost through FY 2035 (BY 2012)	$868 million	$613 million
Space Fence Inc 1 (Original Constraint May 30, 2014)		
Acquisition Cost (BY 2014)	$1.3068 billion	$1.185 billion
O&S Cost through FY 2039 (BY 2014)	$1.3295 billion	$1.197 billion

We do not know what underlying analysis went into these new constraints. The data in Table 3, which include information spread across five ADMs, cannot tell us if meeting the new constraints yields a portfolio that is just as affordable as the original constraints, because the constraints are in different base years and each constraint is associated with a different spending profile. Our experience suggests that these calculations were done by Air Force personnel and OSD accepted them after some scrutiny. Still, this clearly shows that OSD and the Air Force were thinking about affordability in terms of a portfolio of programs and not one program at a time.

As of the December 2015 SARs, only OCX, EPS, and Space Fence[26] reported cost estimates at or under these new constraints. The JMS Inc 2 program reports in DAMIR that it is $31 million over its new cap. The JMS Inc 2 PM made the following entry in DAMIR: "Per 10 U.S.C. Chapter 144A, the Program Manager estimates there is a Critical Change due to extending the program's schedule and increasing total acquisition cost." Therefore, changes to JMS can be expected.

D. Effects on Individual Programs

A few programs have been significantly changed by affordability analysis. We highlight two stories here: one from the Navy and one from the Army.

1. The E-2D Advanced Hawkeye

We have heard that in response to affordability analysis, some programs have hunted for and found ways to reduce costs. A representative of N2/N6 in the Navy told us that the E-2D program has a higher annual buy rate than it would have because their affordability analysis showed that they could reduce cost and buy more of other systems, all while delivering aircraft to the fleet sooner. We note that the E-2D program has no affordability constraint because it achieved MS C in 2009, before BBP 1.0 was signed, but it is part of N2/N6's portfolio of programs and so is part of their affordability analyses for other programs.

2. New Armored Ground Vehicles for the Army

In 2011, the Army's Ground Combat Vehicle (GCV) program received MS A authority but no affordability constraint, and it appeared in PB 2014. However, the program went no further in the acquisition process. The vehicle they planned to buy was longer and heavier than had been anticipated, which likely would have presented significant operational difficulties. Additionally, affordability was also a problem, as it would have needed more than half of the expected funds in the combat vehicles portfolio. That this program went no further is a success for which affordability analysis can claim at least partial credit.

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[26] Frank Kendall, "Space Fence Increment 1 Milestone B Acquisition Decision Memorandum," Memorandum for the Secretary of the Air Force, May 30, 2014 (FOUO). The Space Fence Inc 1 affordability cap is actually stated in its MS B ADM as "$1,353.4 million (then-year dollars) for acquisition costs from FY 2013 to completion ($1,306.8 million in base-year 2014 dollars)." It is presented this way even though the official program reports that spending began in FY 2005. While the new cap in the 2015 OCX ADM does not say that the pre-FY 2013 dollars should not be included, that assumption has been made in future calculations and therefore Space Fence's cost estimate and cap are equal. This unusual phrasing and calculation has no effect on when the cap will be exceeded, but it does make the situation harder for outsiders to understand.

The Armored Multi-Purpose Vehicle (AMPV) program received MS B authority in December 2014. This vehicle replaces GCV as the largest program in the combat vehicles portfolio at present. Although AMPV has a different mission than GCV and is in all regards less capable, it is less expensive, and the combat vehicles portfolio with it included is affordable.

4. Management Considerations

To make affordability analysis as useful as possible, there are several factors that need to be thought through. While affordability analysis has already yielded some wins for DoD, as discussed above, we think that some improvements could be made. We also want to highlight where we feel that it is working well.

A. Technical Definition of Affordability

Different people have different definitions of "affordability," and many of them are vague. However, the Army Staff has adopted a formal set of definitions, presented here in full, that we think is useful. While the definitions use the word "Army" in several places, other Services or OSD could adopt them with only the smallest changes. It was sent to us informally by COL Farrell of the Army G8 and is dated February 23, 2016.

- **Affordable**
  - A determination that the Life Cycle Cost (LCC) of an acquisition program is in consonance with the long-range investment priorities and force structure plans of the Army. This determination is made by comparing the approved cost estimate to the Affordability Constraint during the life-cycle of the acquisition program.
- **Affordability**
  - The degree (within caps and goals) to which a program remains affordable in consonance with the Army's long-range investment priorities and force structure plans.
- **Affordability Constraints (goals and caps)**
  - Life-cycle cost goals and caps dictated by affordability analysis. Constraints are determined in a top-down manner based on the resources the Army can allocate for an acquisition program given the priority of the capability provided, inventory objectives and required deployment schedule—not by program cost estimates. When approved affordability constraints cannot be met, then technical requirements, schedule, and required quantities must be revisited.

- **Affordability Analysis (process)**
  - Continual [l]ong-range planning that determines the resources the Army can and is willing to allocate to fund a new capability based on relative priority within the investment portfolio. The analysis is supported by a quantitative assessment of all programs in the prospective program's portfolio that demonstrates the ability to fund the new program over its planned life cycle within annual budget projections for each appropriation.

We would like to see the definition of "Affordable" expanded so it can also apply to a portfolio—including of a full Service—but even as they stand, these definitions are quite useful. However, they do not provide all of the information required to conduct an affordability analysis.

In an important sense, affordability means that the cost of a program is worth its value to the warfighter, given the other things that could be bought with the money spent on the program. Quantifying the point at which a program is no longer worth the cost is a key part of acquisition management. This is one of the central arguments of the book *How Much Is Enough?*[27]—but very difficult to do and always susceptible to intense criticism. Nonetheless, phrases like "Affordability means conducting a program at a cost constrained by the maximum resources the Department can allocate for that capability," which appears in the BBP 1.0 memo, does not provide a detailed recipe for those who must produce quantitative affordability constraints. Enclosure 8 of the January 7, 2015 version of DoDI 5000.02, "Affordability Analysis and Investment Constraints,"[28] discusses the importance of affordability analysis and offers an example of how to calculate a cap on unit cost once the affordability constraint for the overall program has been determined, but nowhere in this document is the term actually defined. An article entitled "Dispelling the Myths of DoD's Affordability Policy" presents a list of five things that affordability is *not*, but only sentences such as the following on what it *is*: "Affordability analysis simply determines how much the Component leadership wants to allocate to a particular need."[29] If future administrations, and future USD(AT&L)s, are expected to continue the current affordability policy, a more rigorous quantitative definition and explanation may be necessary.

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27 Smith and Enthoven, *How Much is Enough?*

28 DoDI 5000.02.

29 Chad J. R. Ohlandt, "Dispelling the Myths of DoD's Affordability Policy," *Defense AT&L* (September–October 2013): 4–8.

B. Affordability and Cost Estimates

The relationship between the affordability of a program and the cost estimates of the programs in its portfolio should be considered. Affordability constraints are not cost estimates, and for any program that is going forward, the constraint must be greater than or equal to the cost estimate—otherwise it should not proceed. However, what cost should be laid in for the other programs in the affordability analysis? A program can become unaffordable because cost estimates have risen for other programs in its portfolio.

Consider new program A is part of a portfolio with incumbent programs Z, Y, and X. Each incumbent program has a cost estimate that should be in their SARs and budget submissions, but also an affordability constraint that is higher. Should A's target assume that Z, Y, and X each stay within their cost estimates or that they float up closer to their affordability targets? If only cost estimates are used, programs could see cost rises that make the portfolio unaffordable without any one exceeding its constraint. However, if the affordability targets are assumed, the space for program A is smaller, and the difference between the cost estimates and the affordability constraints might be seen as a "slush fund" to be taken away from the portfolio. So far, it seems, the Services are assuming that all programs in the portfolio will stick to the cost estimates when doing their affordability analyses, making it possible that all programs could remain under their constraints and still yield an unaffordable portfolio.

C. Affordability Metrics

We will now discuss whether the affordability metrics being used are appropriate for tracking the affordability of programs. The metrics should be designed so that the USD can be notified when something is happening that requires his attention but—as long as the program is performing well—allows it to continue without his involvement.

1. Investment Metrics

The natural way to make an affordability constraint would be to say that the Service may spend no more than X_j on the program in each year j from the present to the expected end of the program. This sequence of numbers is what a detailed affordability analysis yields. However, this has never been used and there are at least two reasons this should not be adopted. First, such a requirement would take away much discretion in future years. There are good reasons Services sometimes choose to increase the spending in one year and decrease it in another, perhaps to get the capability in the field sooner or simply as a trade to increase efficiency by buying at a higher rate. Historically, this discretion has belonged to the Services, and Mr. Kendall has not suggested that he wants to take it away. Another reason not to adopt this requirement is that it is complicated to state. Mr. Kendall wants to describe the affordability constraint simply in an ADM, and while he has used

tables with three numbers for the F-35, this approach would require an unwieldy table comprising as many as forty numbers.

One simplification would be maximum annual obligations. The ADM could state, "This program may not exceed *X* dollars in any given year." This relates to affordability; as long as the annual obligations stay low, other programs will also be affordable. Because it is an approximation, it is likely that in some years the cap would actually be higher than the available dollars, but that would be sorted out by the Service programmers. Unfortunately, this metric not only allows stretches and increases to total cost, it practically demands them because the only action this metric restricts is putting more money into one year. While this does relate to affordability, it is likely to be counterproductive.

As discussed earlier, the OUSD(AT&L) and the Services have largely settled on the use of APUC or PAUC as the metric of choice for most programs, because they can track it annually when the SARs are written. However, APUC and PAUC do not actually relate to affordability. If a Service has a problem with affordability, it can reduce the number of units it plans to buy or stretch the buy over more years. Either choice will decrease the costs in each year, making the portfolios more affordable. At the same time, these actions increase PAUC and APUC. While the fact that PAUC and APUC are only loosely related to affordability appears to be a "bug," it is actually a "feature." It means that the USD will be alerted and forced to act when the Service makes a decision that decreases annual cost, but increases unit cost, to make a program fit in the budget.

Also in use are metrics based on total investment or total procurement dollars. Typically, metrics based on totals are used for programs such as OCX or Space Fence, in which the program is buying a single capability, not some number of identical (or more often similar) items such as ships, missiles, or ground vehicles. Total expenditure metrics are also easily tracked by the SARs.

A weakness of unit cost is that, even for programs that are buying many units, the definition of *one* is not always clear. For example, the Army's ATIRCM/CMWS program bought two different systems[30] for the protection of helicopters. Some *units* were only CMWS systems and others included both ATIRCM and CMWS. They also had some other accounting choices that affected unit cost.[31] The Navy's Integrated Defensive Electronic Countermeasures (IDECM) program is similar, with different *blocks* all included together. Some of the units include avionics systems and others include only replaceable decoys. In the Air Force's Global Hawk program, each unit was a single remotely piloted aircraft, so counting units was fairly straightforward, but the prices varied significantly from one

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[30] The name ATIRCM/CMWS is a combination of two systems: the Advanced Threat Infrared Countermeasures (ATIRCM) and the Common Missile Warning System (CMWS).

[31] Harold S. Balaban et al., "Root Cause Analysis for the ATIRCM/CMWS Program," IDA Paper P-4601 (Alexandria, VA: Institute for Defense Analyses, June 2010).

variant to another because the payloads were very different, and some payloads were included in the program and others were not. It is not uncommon for the program office to be able to change the mix of what it plans to buy, which may make the unit cost look favorable even as costs rise.

Total expenditure metrics are similar to average unit costs, but without the units in the denominator. This is commonly used for systems like OCX or Space Fence; rather than buying some number of units, the Service is developing and buying one system. However, stretching the program has the same effect here as it does in PAUC and APUC—it becomes more affordable, but as total cost increases, this measure increases. While very few programs that buy integer systems have used total expenditures, we think more should consider it. This metric has the benefits of average unit costs in that a stretch can trigger an affordability breach, but it is also more closely related to affordability. A drawback to total expenditure is that programs that are successful and have their quantities increased then look unaffordable. Of course, if a Service wants to buy more, it should be an easy matter to go to the USD and ask for a higher cap for that reason.

Another interesting consideration when choosing between total investment and average unit cost is in long-term plans. If the metric used is average unit cost, program offices are incentivized to show more units going out into the future because these units can show increased learning, thereby reducing costs, and the program office has more units over which development costs can be spread. Total investment encourages programs to report fewer units into the future. Because the N-M rules already use PAUC and APUC, the combination of the N-M rules and affordability rules would provide counter-balancing incentives. It is also possible that both a total and a unit cost could be specified.

a. Include RDT&E?

Whether a total or a unit cost is adopted for a metric, there is still a question of whether or not RDT&E should be included. Some programs, like OCX, only have RDT&E funds, so in these cases, the answer is clearly yes. For others, in general, including RDT&E makes sense because it relates to the funds that are available for other programs. Therefore, total investment is better than total procurement, and PAUC is preferable to APUC.

The best argument for excluding RDT&E funds is that PMs should not skimp on development costs in order to make their program affordable. However, by not including RDT&E in the metric, PMs are then incentivized to call more of their costs RDT&E; while most expenditures in a program are clearly RDT&E or procurement, there is significant gray area in the middle, and excluding one and not the other would encourage the Service to play games with how they categorize that gray area funding. Affordability is about funds available for other programs; their "color" is not relevant.

b. Sunk Costs

All of the metrics include sunk costs, and these costs should not affect decision making on a program going forward. The question should be whether the expected costs in the future are worth what we expect to get for them. The expected future expenditures in year *N* of a program should be less than they were in year *N-1*. Creating something to track that takes that into account would require specifying every year, and we dismissed that above. This is not a major problem, because the costs sunk before the metric was established are already included. If, *N* years after the metric was established, projected spending is too high, that should trigger a breach of the cap and cause investigation by OSD. Therefore, sunk costs will not be what causes a program to breach—only cost projections in the future.

c. Exotic Metrics

Some of the earliest metrics selected included *average end unit cost*, *average ship end cost*, and the F-35's *unit recurring flyaway cost in 2019*. We have dubbed these metrics "exotics" and they should not be used, for two reasons. First, they are not easily tracked, so program offices could hide what is going on from outsiders by using them. Outsiders would include OSD, but might also be the Congress or their own Service. Second, many of these metrics do not include all costs and consequently do not relate to how much funding is available for other programs.

2. O&S Metrics

Controlling O&S costs—the dominant life-cycle cost of most programs—is critical to maintaining affordability in the broadest sense.

Maintenance practices have changed significantly in the age of digital electronics, composite materials, parts obsolescence, and technology refreshes. We note that the lone example of O&S costs in the January 7, 2015 version of DoDI 5000.02 involves a low-tech example of a truck program. The problem of developing a practical methodology for estimating O&S costs of a modern, high-tech program at inception—that is, before MS B—is larger than simply affordability.

To realistically model future O&S costs, one must first be able to accurately determine these costs for current programs. IDA (along with many other organizations)[32] discovered that simply tracking O&S costs of ongoing programs is vastly more difficult than tracking

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[32] Lawrence N. Goeller et al., "Munitions O&S Roadmap Approach for Air Force Total Ownership Cost (AFTOC) Model," IDA Paper P-5193 (Alexandria, VA: Institute for Defense Analyses, September 2014). (Draft) (FOUO)

RDT&E and Procurement costs, although it is improving. There are a number of reasons for this:

- Commonly, the O&S resources of several programs are combined into a single Program Element (PE), making isolation difficult.
- Often O&S costs of one system—for example, a cruise missile—are actually funded out of another program—for example, a B-52 squadron.
- The actual logs of expenditures are not all centrally located, despite considerable efforts to implement programs such as Visibility and Management of Operating and Support Costs (VAMOSC) and Air Force Total Ownership Cost (AFTOC).
- In some cases, maintenance is covered by a warrantee contract with the vendor that supplied the system—meaning that the cost to maintain that system is not only unknown to the government, it is contractor proprietary. This maintenance is funded with procurement dollars rather than Operations and Maintenance (O&M) dollars and can be years away from when the maintenance is performed.
- Even where O&S costs can be isolated by program, the funding often represents what the maintenance organization was given—and not what they actually needed to satisfy all of their requirements. This problem can go in both directions—a plane might fly more hours than required because they have available funds or it may fly fewer hours than is considered optimal because of insufficient funds to support more hours. Actual O&S costs are, in fact, a combination of what is required and what is provided.

All of these problems are being addressed, and even a casual look at the SARs today shows that the work here is more sophisticated and careful than it was five years ago. However, there are other issues besides difficulty.

Placing a requirement for O&S costs on a program in development could provide poor incentives to the program office. Because actual costs are likely to be analyzed even on prototype hardware, suboptimal decisions about how to operate and test it might be made. Perhaps a truck must be tested in sandy conditions, where it is particularly difficult to maintain. Because of the high costs associated with this, a PM might feel compelled to run another meaningless long test in more benign conditions to lower the measured mean time between failures and the associated O&S costs.

The impact of the O&S constraints that have been set is not clear, and the way they are phrased makes them quite different from one another. Some are totals over many years, which would provide different incentives from others that are on a per year basis, so a program could meet the constraint in some years and not in others. Even though the O&S costs are the dominant cost in many programs, the USD(AT&L) usually has very little say over the future of the program. Would the Under Secretary want a new program started to

replace a fielded system because the O&S costs are too high? This is unclear. This does not mean that trying to design a system to reduce the O&S costs down the road is a bad idea, but it is not clear what an affordability constraint can accomplish.

5. Limits of Affordability Analysis

A. Definitions of Portfolios

At DABs, the Services present sand charts and stacked bar charts similar to Figure 4 and Figure 5 to demonstrate that they have conducted affordability analysis.

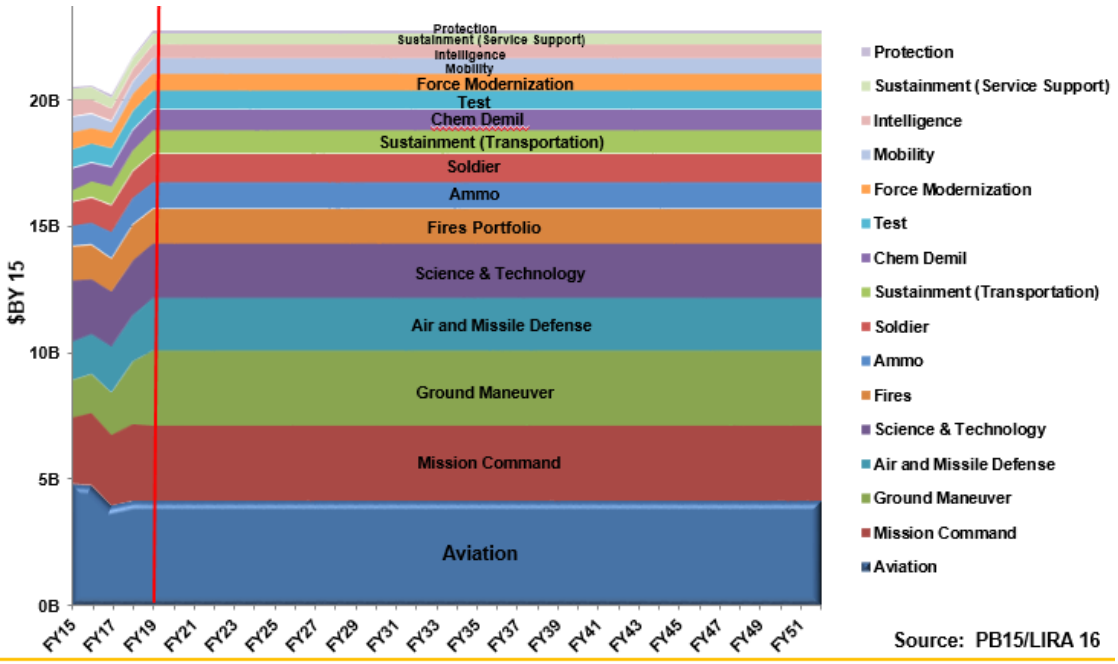

Figure 4. Sand Chart from the Joint Air-to-Ground Missile Program DAB, dated September 9, 2014

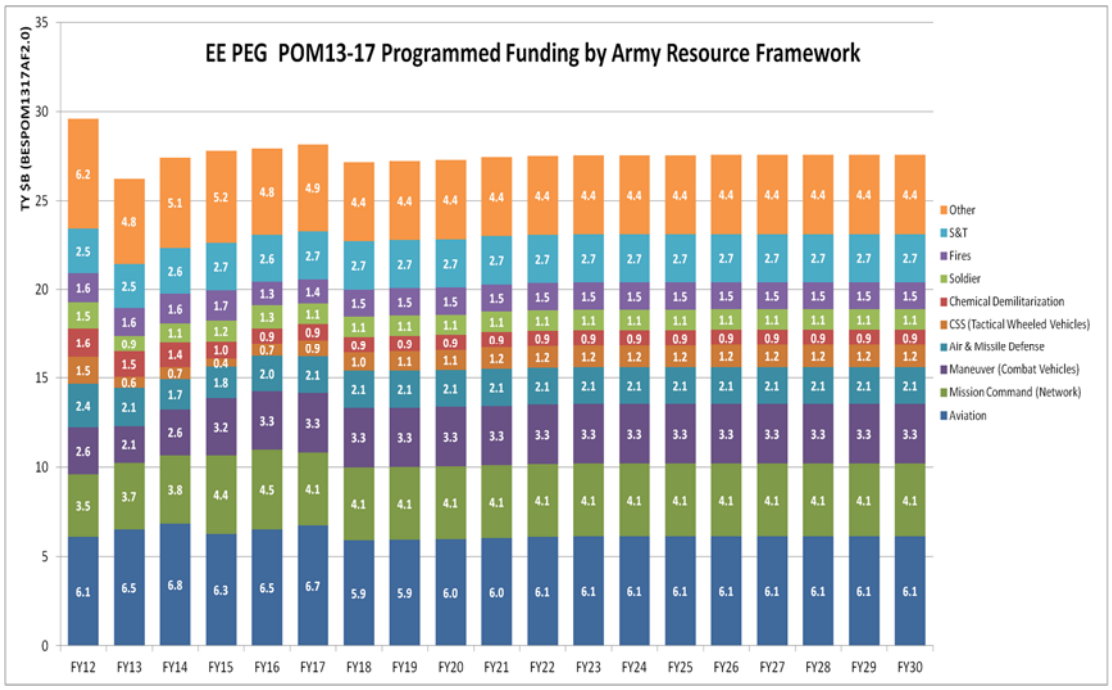

Figure 5. Stacked Bar Chart from the AMPV DAB, dated February 8, 2012

None of these charts was delivered with spreadsheets, and only some of them had numerical labels on the bars as seen in Figure 5. Analyzing them required recalculating chart measurements, which involved mining eleven Army DAB charts. Although time limitation was a significant issue, we specifically chose the Army because it had the greatest number of charts with labeled values. These charts were a good baseline measure to verify whether our recalculation methodology was accurate.

Furthermore, cost measurements differed from one chart to another. Some graphs only showed then-year dollars; others stated them in different base-year dollars; and a few, such as Figure 6, depicted them in then-year and base-year dollars. For several charts like Figure 7, they did not specify which types of dollars they were reporting. We saw similar scenarios from the other Services as well.

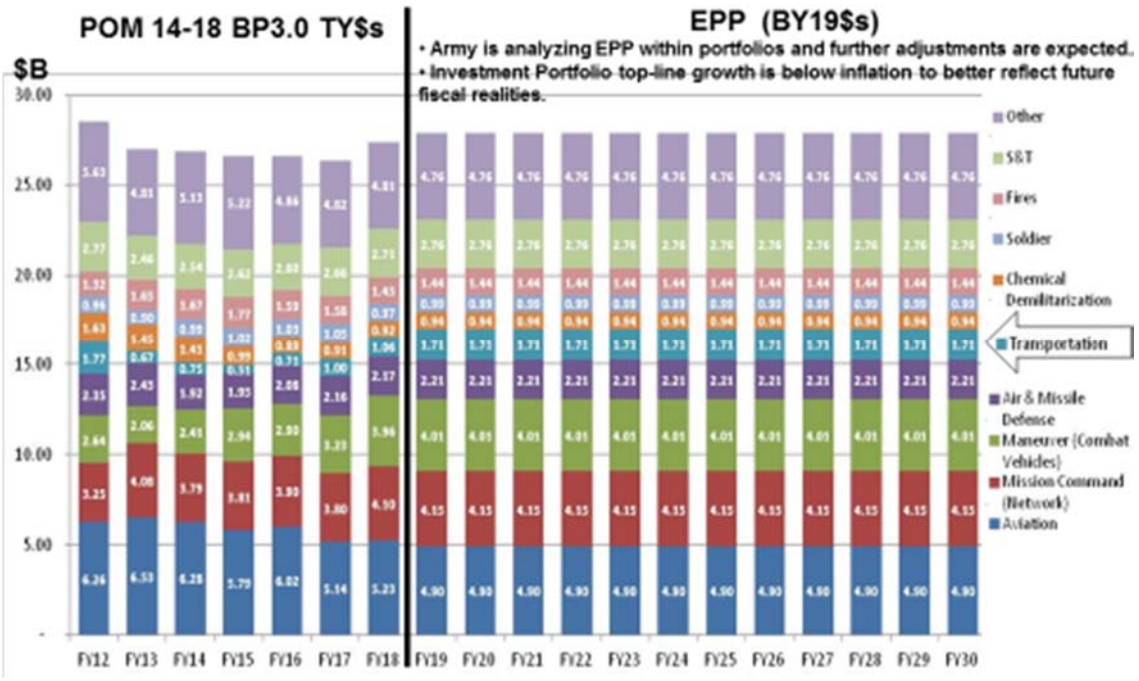

Figure 6. From the JLTV DAB, dated August 9, 2012

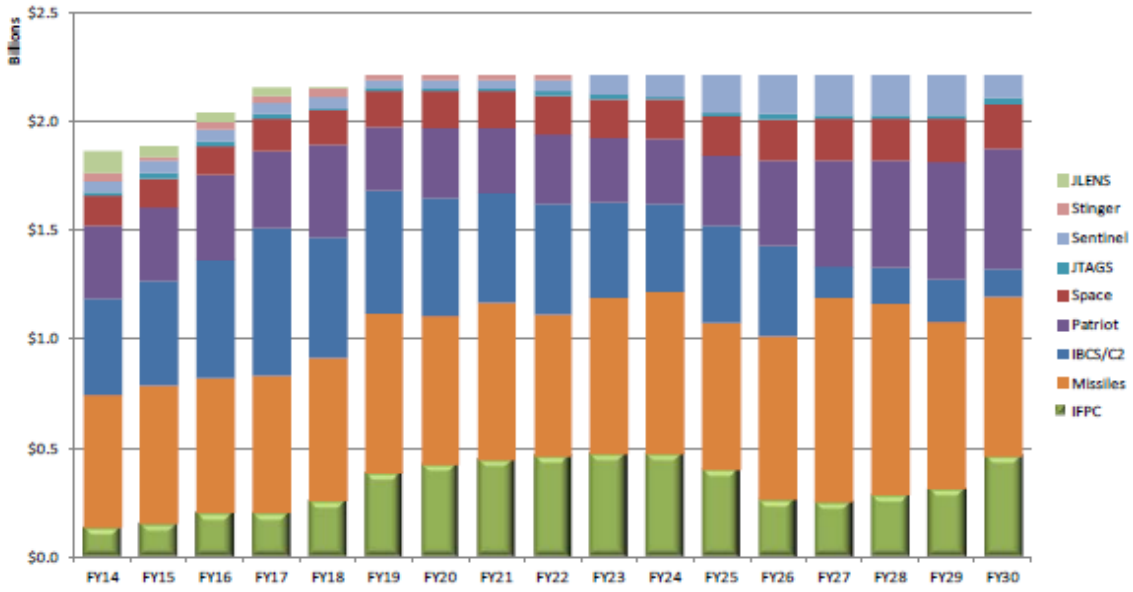

Figure 7. From the Indirect Fire Protection Capability (IFPC) Increment II DAB, dated October 22, 2013

Besides the lack of transparency in data and a uniform baseline measure, the Army also appeared to have moved programs from one portfolio to another. In some sets of DAB charts, the Army included two affordability charts for the same DAB review. The first chart looked at the Army's total investment plan and the second studied the specific portfolio for the program under review. Despite transforming cost calculations to a standard dollar

figure, there were a few instances where costs of the specific portfolio did not match those stated in the first chart. These situations will be discussed later as a metric used to measure precision.

1. Measures of Accuracy

To address these issues, a few inferences were made based on the bar graphs and sand charts that the Army provided. Assuming that the incremental values measuring the costs were accurate, we reverse-engineered spreadsheets from those graphs. Using the Adobe Acrobat measuring tool, we were able to not only control for errors by fixing all measurements to be perpendicular to the x-axis, but also determine a scale ratio between the incremental costs and the measured distance corresponding to those incremental costs. We used that method to estimate the numbers for charts without specified values. Although similar results could have been measured for quantified programs, we kept the Army's numbers. The re-engineered spreadsheets gathered other data that accomplished the following: recording the types of portfolio; itemizing the programs or families of programs; noting if the portfolio used then-year, base-year, or a combination of both; reporting the base-year date; and listing the DAB programs from which the data were obtained.

Additionally, we deduced that some portfolios had different names in different sets of charts. The category of "combat service support (tactical wheeled vehicles)," for example, was determined to measure the same costs as that of transportation. We used several sources to strengthen this conclusion. On the Combined Arms Support Command (CASCOM) website, the US Army specifically listed the Tactical Wheeled Vehicle Requirements Management Office under the Transportation Division of the Force Development Directorate.[33] Furthermore, as depicted in the Joint Light Tactical Vehicle (JLTV) MS B DAB's transportation portfolio, $1.6 billion of the $1.7 billion calculated as the average was composed of light, medium, and heavy tactical wheeled vehicles. Similar arguments regarding nomenclature could be applied elsewhere. These cases included categorizing "ground maneuver" as "maneuvers (combat vehicles);" and classifying test, force modernization, mobility, intelligence, service support, and protection portfolios as "others".

We also found portfolio measurements to be more consistent than individual program measurements. With the exception of Common Infrared Countermeasures (CIRCM)'s June 2014 DAB, which only looked within the aviation portfolio,[34] every set of charts included at least one of all Army portfolios. Since affordability analysis is intended for investment planning beyond the FYDP, this assumption meant that averaging a family of programs'

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[33] See the Force Development Directorate Transportation Division page on the CASCOM website, http://www.cascom.army.mil/g_staff/cdi/fdd/TC/.

[34] CIRCM's subfamily is Aircraft Survivability Equipment, which is under the main portfolio, Aviation.

post-FYDP costs should produce the most robust affordability measure across DAB files based on the data we had. For charts within a portfolio, calculations entailed summing to the top line divided by the number of years. For those measuring total investment dollars, we totaled the costs for each portfolio (aviation, combat vehicles, and chemical demilitarization) divided by the number of years.

2. Measures of Precision: Program Repositioning

Two other metrics were used to increase precision. First, we repositioned programs to their original portfolios. There were a few instances in which the Army moved programs from one portfolio to another, even in the same DAB. As a result, portfolios' funding projections did not match those stated in the total investment chart. The clearest example is the Paladin Integrated Management (PIM) program. As stated in the *2014 Army Equipment Modernization Plan*, one of the Indirect Fires Materiel Strategy's main programs was PIM.[35] Consequently, we decided that shifting the PIM program from the combat vehicle portfolio to its original indirect fires portfolio would allow for more precise cost comparisons across DABs. In doing so, we determined combat vehicle costs under total Army investments and those of the combat vehicle portfolio to be nearly equivalent in the AMPV MDD DAB of February 2012.[36]

However, despite using the same methodology, the PIM MS C DAB suggested otherwise. Whereas the total investment dollars stated an average value of $4.5 billion post-FYDP, the combined fires and combat vehicles portfolios were estimated to cost $4.14 billion. More specifically, the Army approximated fires portfolio values of $1.5 billion in the totals chart and $1.3 billion in the second chart; the combat vehicle portfolio value changed from $3.0 billion to $2.8 billion. Considering that a $360 million differential exists between these two DABs, it is possible that the Army might have only included some programs when combining the fires and combat vehicles portfolios together. The Army addressed neither precision munitions—besides Guided Multiple Launch Rocket System (GMLRS) (such as Army Tactical Missile System (ATACMS) and Excalibur/Precision Guidance Kit (PGK))—nor other delivery platforms besides PIM (such as M119, M777, M270A1, and High Mobility Artillery Rocket System (HIMARS)), even though they constituted important capability strategies in the indirect fires portfolio.[37] Therefore, the PIM program's portfolio designation for these DABs is unclear.

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[35] Headquarters, Department of the Army, Office of the Deputy Chief of Staff, G-8 Plans, Strategy and Policy Division, *2014 Army Equipment Modernization Plan* (Washington, DC: May 13, 2013), accessible at http://www.g8.army.mil/pdf /AEMP2014_lq.pdf.

[36] The comparison excluded PIM. It also estimated the Combat Vehicles portfolio to originally be in BY$13 before base-year was readjusted. See explanation that accompanies Table 1.

[37] HQ, Department of the Army, *2014 Army Equipment Modernization Plan*, 43.

Further disparity exists in graphs that placed investments in the correct portfolio, but showed costs that significantly differed from the same portfolio's costs in the total investment chart. Although avionics was one of the core investment categories under the aviation portfolio,[38] the total investment chart did not appear to have categorized avionics under aviation in the Joint Air-to-Ground Missile (JAGM) EMD DAB in September 2014.[39] We calculated aviation cost in the total investment chart to be $4.13 billion and that in the aviation portfolio to be $4.58 billion.

3. Measures of Precision: Post-FYDP Fixed Inflation Assumption

Second, for portfolios without base-year specifications post-FYDP, we assumed that the Army used constant dollars set in the first year after the FYDP. In the majority of portfolios observed, the Army did not expect inflation post-FYDP. As it noted in a few DABs, "investment portfolio top-line growth is below inflation to better reflect future fiscal realities."[40] This practice is a gross approximation. The Army further reported in the JLTV MS B DAB transportation portfolio that no inflation was included in the extended planning period (EPP), which referred to the nine-year period after the FDYP. Since the JLTV transportation portfolio's graphical trend is consistent with all other portfolios after program readjustments, we estimated long-range base-year dollars for the following portfolios: CIRCM's aviation portfolio in 2011 at BY$18, AMPV's total investment dollars in 2012 at BY$18, JLTV's transportation portfolio in 2012 at BY$19, and Indirect Fires Protection Capability (IFPC) II-A's air and missile defense portfolio in 2013 at BY$19.

The only exception to this rule for unreported EPP base-year dollars was AMPV's 2012 combat vehicles portfolio, which we determined to be in BY$13. After removing PIM costs from the combat vehicles portfolio, all of its investment estimates were lower than those of the total Army chart. Consequently, we determined that cost measurements for the combat vehicles portfolio differed from total Army cost measurements. In turn, assuming that AMPV's total investment dollars in 2012 measured in BY$18 is correct, the combat vehicles portfolio had to be reported in a smaller base year. We initially chose BY$13 because FY 2013 is the first FYDP year in the combat vehicles portfolio. Both charts then showed similar cost measurements (+/- $0.2 billion) once the PIM program and chart transformations to BY$13 were accounted for.

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38 Ibid., 37.

39 DAB, "Joint Air-to-Ground Missile (JAGM) RFP Release," Briefing, September 9, 2014. (FOUO)

40 Army Program Analysis and Evaluation (PA&E), "Army Transportation: Sample JLTV Affordability Slides, Briefing, October 25, 2012, Slide 2.

4. Conclusion

Presuming that the above conclusions are accurate, we successfully standardized the dollar figure by using Army inflation rates for each portfolio's procurement appropriations as a proxy. The Naval Center for Cost Analysis gathered these data as an Excel workbook called the *NCCA Inflation Indices and Joint Inflation Calculator*,[41] which contains macros that allow for swift conversions from one base year to another. While its query separated Army procurement from RDT&E appropriations, the inflation factor between RDT&E and all procurement appropriations for base year-to-base year conversions were equal to one part in 10,000, so differences between the indexes were irrelevant. Using these metrics and reported/estimated EPP base-year, we determined BY$19 to be the standard measure for cost comparison. Table 4 captures all of the assumptions and corrections mentioned previously.

The results reported in Table 4 demonstrate that the Army measured affordability inconsistently from December 2011 to September 2014. As noted before, JAGM reported two aviation portfolios in the same DAB that had a $600 million cost differential. Aviation also suffered a $1 billion loss between February 2012 and October 2012. This observation is troublesome because short-term economic problems should not decrease projected funding significantly for average long-term costs, especially if they truly are measured across DABs. Furthermore, even though the Army stated that each portfolio's costs will remain relatively fixed after the FYDP, both the transportation and combat vehicles portfolios from February 2012 to October 2013 had long-run costs that fluctuated—rising significantly then declining. The portfolio categorizing "other" costs also exhibited the same fluctuation tendency from October 2012 to September 2014. Moreover, these observations did not match the cost relationship shown at the total investment level.

The most remarkable findings in the data are in DABs such as PIM and JAGM, where, in the same set of briefing charts, the cost of the portfolio changed. In the JAGM case, the aviation portfolio went from $4.4 billion to $5.0 billion in one page.

Consequently, we determined that the portfolios are not consistent. Their trends appeared to match short-run rather than long-run projections. They do not mesh with affordability's goal of setting realistic program baselines, establishing fiscal feasibility of the program, or showing constant long-run costs in portfolios. As such, we do not believe these bar graphs, sand charts, or other similar displays have served OSD well in tracking Army affordability. More consistent data in the future will allow OSD to conduct subsequent affordability analysis in a more thorough, granular manner. The data collection for this report should be a good starting point for tracking these portfolios in the future.

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[41] Naval Center for Cost Analysis, *NCCA Inflation Indices and Joint Inflation Calculator*, accessible at https://www.ncca.navy.mil/tools/inflation.cfm.

Table 4. Affordability Cost Measurements per Portfolio in Steady State Reported at DABs between December 2011 and September 2014—All Costs were Transformed into BY$19

	Program/ DAB Date										
Portfolio	**CIRCM 11-Dec**	**AMPV 12-Feb**	**AMPV 12-Feb**	**JLTV 12-Oct**	**JLTV 12-Oct**	**AMPV 13-Aug**	**PIM 13-Oct**	**PIM 13-Oct**	**IFPC 13-Oct**	**JAGM 14-Sep**	**JAGM 14-Sep**
Aviation	6	6		4.9			5			4.4	5
Mission Command		4.2		4.2			3.9			3.3	
Combat Vehicles		3.4	3.3	4		3.2	3.2			3.1	
Air & Missile Defense		2.1		2.2			2.2		2.2	2.3	
Transportation		1.2		1.7	1.7		1.5			1.1	
Chem Demil		0.9		0.9			1			0.8	
Soldier		1.1		1			1.3			1.1	
Fires		1.5		1.4			1.6	1.4		1.4	
S&T		2.8		2.8			2.6			2.3	
Other		4.5		4.8			5.2			4.6	
Investment Total		**27.7**		**27.9**			**27.5**			**24.3**	

B. Current Bow Wave

The "bow wave" has been a concern in DoD since at least the Kennedy Administration, when Secretary of Defense Robert McNamara's team created the FYDP to extend planning horizons in the Services. The FYDP's "out years" are not a perfect prediction of the future, but they do enforce a level of discipline on Service programmers and assure that there is some possible way to continue five years out with the spending plans of today—there cannot really be a bow wave within five years, anymore. However, there can be a bow wave beyond the FYDP that will cause headaches for programmers when those bills come due; affordability analysis is supposed to reduce that.

Today, some analysts perceive a large bow wave beyond the FYDP in large part because of big programs like the Navy's new ballistic missile submarines and the Air Force's long-range strike bomber (LRSB).[42] In an ideal world, affordability analysis would make this bow wave impossible—or at least push it off forty years. These programs are both in the early stages, meaning there is significant uncertainty, but they are likely to be expensive. We will not assert that this proves that affordability analysis has failed. Were affordability analysis not in use, the bow wave might well be worse. More than half of all acquisition programs still have no affordability constraints. Affordability analysis is a tool that may make the bow wave easier to handle.

C. Affordability Games

In some ways, the acquisition system is a game and the laws, regulations, and policy are the rules. Affordability analysis and constraints are new rules, and they have led to some gaming by the Services and program offices. The JLTV is an obvious case.

In Figure 8, the horizontal axis shows cumulative units delivered. Each black circle represents an annual lot delivery, and three of them are called out by year to orient the reader. The dots and the solid red line show what we call the "Cumulative Average Unit Cost." This is what the program's APUC would be if the program were executed until that point and then terminated. If the 2015 lot were purchased and nothing else, the program's APUC would be $835 thousand. This is normal; it is expected that the longer the program runs, the lower the APUC should be. Two things about this chart are particularly noteworthy. First, according to the black dots, the program will not meet the affordability goal set at MS B unless it continues producing according to plan until at least 2038. Second, starting in 2028, for no known reason, the cost estimate starts to fall below the fitted

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[42] Jeremiah Gertler, Specialist in Military Aviation, "The Air Force Aviation Investment Challenge," Congressional Research Service Report R44305 (Washington, DC: CRS, December 11, 2015); Robert Hale, "How DoD Can Manage The Great Bow Wave," *Breaking Defense*, http://breakingdefense.com /2016/03/how-dod-can-manage-the-great-bow-wave/.

learning curve. Without this unexplained decrease, the JLTV would never meet its affordability target. The chart may make the differences look small, but in 2040, if the costs each year match the learning curve instead of the prediction, the total extra cost would be $300 million over twenty-five years.

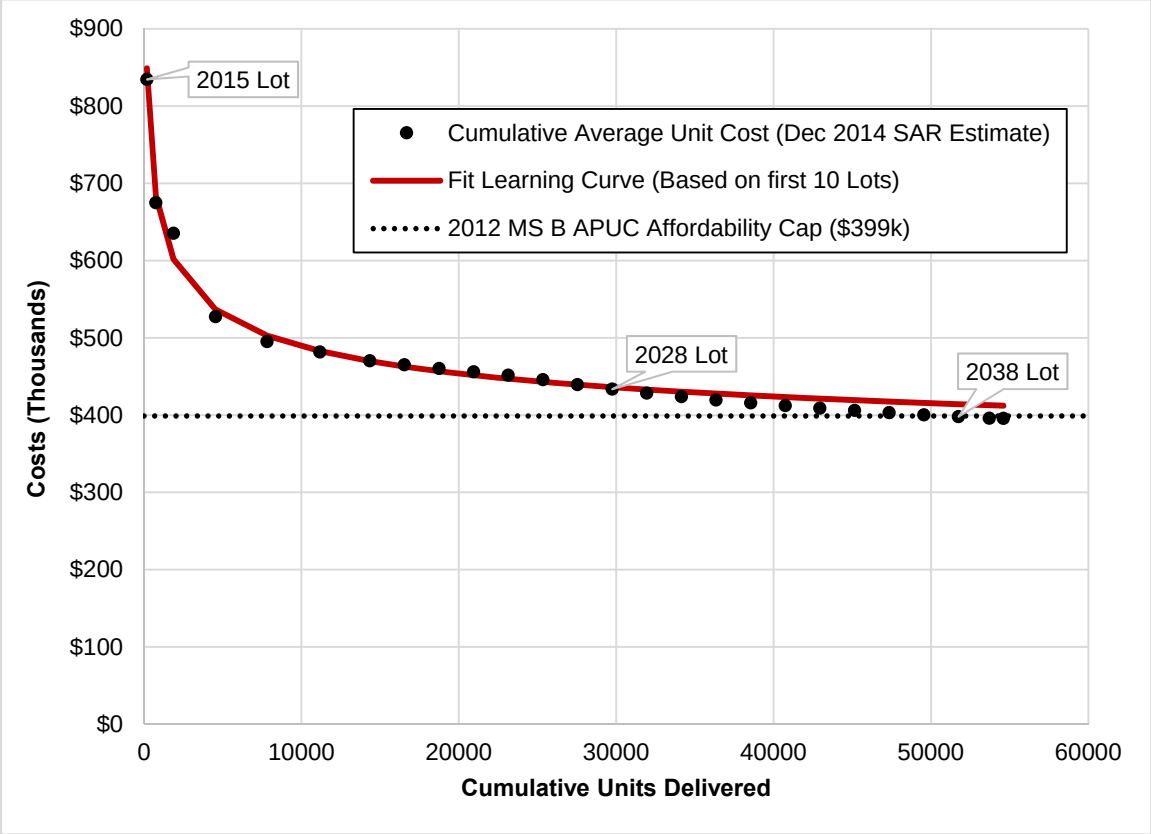

Figure 8. JLTV Costs in BY 2012 Dollars based on the December 2014 SAR Estimate

The most recent PB submissions for JLTV show significant decrease in cost, with a new APUC of $333 thousand. This is probably good news for the Army and taxpayers in general. We do not know if the program has achieved this by finding efficiencies, reducing capability, or merely quantifying optimism. This change was not made to satisfy the existing affordability cap, as they met that the year before and it did not require a change. It is possible that the Army conducted its own internal affordability analysis and decided they needed to reduce the cost of this program. Whatever the case, it is clear that until the latest submission, the JLTV program office was reporting strange numbers to keep their program under the affordability cap assigned at MS B. They were playing a game.

D. Innovation and Predictability

The first two BBP memos were about saving money. This is a laudable goal, but it cannot be DoD's only goal. BBP 3.0's full title includes "Achieving Dominant Capabilities

through Technical Excellence and Innovation"—which suggests another focus is coming back to the fore. This title suggests that DoD should be acquiring state-of-the-art systems. Designing such systems is inherently difficult and unpredictable; it is also a long-standing American tradition.

Unfortunately, affordability analysis is predicated on knowing costs. Every program in the portfolio has a cost estimate and that is combined with the expected budgets to determine how much funding is available for the system under evaluation. If those cost estimates are highly uncertain, it is impossible to know how much extra funding is really available. If several of those programs are pushing the state of the art, it is difficult to know what they will cost. FCS may have gone too far, but long reaches in the past have yielded excellent results, and we need those from time to time. We present a historic system that shows how long this problem has been around.

Ian Toll's 2008 book *Six Frigates: The Epic History of the Founding of the U.S. Navy*[43] tells us, in the story of the Washington Administration's program to build six heavy frigates as the backbone of a new navy: "The estimated cost of construction, victualling, and three months' pay for officers and crew was $600,000. It was an estimate that would seem preposterous in retrospect." This was a huge sum at the time, dwarfing all federal expenditures other than the interest on the enormous national debt that had been accumulated during the War of Independence, in addition to huge cost growth and schedule slips.

The program was plagued with many of the issues we see today. Dramatic requirements changes—is their purpose to defeat the Barbary Pirates or fight the Navies of France and Britain? Uneven funding—at one point, the Congress required that the program be reduced from six to three ships, but then reversed their decision. Pork barrel spending (before the term was invented)—the six ships were built in six cities, a decision that President Washington made, knowing that he was trading away efficiency. The ultimate result, however, was awesome: warships, including the U.S.S. Constitution, that were the most capable the world had ever seen.

We can and will build cutting-edge equipment in the future; in contrast to the recent past, the current environment is starting to encourage such development again. Even if we are always smart, such programs are difficult to predict: some will cost more than expected, some will fail, and some will be tremendous successes. These programs are difficult to fit into forty-year models.

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[43] Ian W. Toll, *Six Frigates: The Epic History of the Founding of the U.S. Navy* (New York: W. W. Norton & Company, Reprint edition March 17, 2008).

6. Conclusion

Affordability analysis is a useful but limited process that OSD can use to try to ensure that the Services are planning their acquisitions far into the future. Constraints, which are a part of that process, allow the USD(AT&L) a rough monitor of the affordability of each Service's programs when they are not undergoing DABs. The direct effects are likely positive but have been modest.

The spirit of affordability analysis has taken hold in DoD. The case of OCX shows that clearly. The decision made to put more funding into one program and take from others is likely what would have happened in the past, but affordability analysis forced the Air Force to make the decision and put it in front of the USD. In the past, he might never have been told where the funds had come from.

The best forms for affordability constraints are total investment cost and PAUC. These metrics are easy to track and cover all of the costs of the program. The two metrics are breached under somewhat different situations, so using both may be useful.

The current practice for conducting affordability analysis does not account well for uncertainty. The long-term sand charts generated by the analysis assume that the costs of all programs outside of the one under consideration are well known, although we know that changes are possible in both directions—some programs will experience cost growth and others may see their total expenditures decrease. While cost growth is more common than its reverse, program cancellations or reductions in quantity are quite common, so there is a real possibility of funds freeing up. Also, the DoD top line is not predictable over the time scales of the analysis and can change materially in either direction.

Affordability analysis kills some programs before starting and may reduce requirements in others from where they might otherwise be at a very early stage. The GCV is a perfect example of this. While the GCV would have made the Army combat vehicle portfolio unaffordable with the reasonable assumptions made at the time, it is also likely that many of those assumptions would prove incorrect. Had GCV received MS B authority, there were only two possibilities: (a) it would have fit, or (b) something would have had to be curtailed down the road. The first possibility would have played out if the top line went up, perhaps for a war, or if other programs that were taking up space went away—cancellations do happen. However, even if the GCV had not fit, the USD would have pushed into the future the decision of what to cut. Five or ten years in the future, when the Army would be squeezed, it is quite possible that they would have decided to keep GCV and cut something else to make room. By not starting the program, the decision was made

earlier. Keeping the option on GCV would have had costs associated with it, but might have been appreciated if it were available. In one sense, GCV was not an FCS—because it was not nearly as technologically ambitious, its costs were not likely to grow as much as FCS's did. However, in another sense, it might have been like FCS in terms of forcing cancellations in the future, but the cancellation might not have been GCV itself.

The unexpected success is that this initiative has brought the Service programmers into the DABs. Several times in the life of each program, the PM and his Service's programmer sit in the same room and look at the same long-term spending plan. We believe that this is unprecedented and a significant benefit for the Department of Defense.

Appendix A.
Our Meetings

We conducted several meetings to learn what different parts of the acquisition community were working on. Our primary meetings were as follows:

- 19 August 2015 – Army G8, LTC David Richkowski
- 20 October 2015 – RAND Irv Blickstein, John Yurchak, and Bradley Martin
- 3 November 2015 – OSD-PARCA-APAC, Dr. Philip Antón
- 16 November 2015 – Navy N2/N6, Stephen Sadler
- 29 December 2015 – Army G8, COL Christopher Farrell, Billie Watts, and Alfred Wilson
- 14 January 2016 – AT&L(ARA), Joseph Beauregard and David Bawel

We would like to thank Mr. Michael Titone at OSD-PARCA for his efforts to help set up meetings in the early stages of this project.

Appendix B.
Some Affordability Theory

As a topic, affordability is nuanced, and its definition is broad enough to introduce interpretation. That said, if we characterize it as a form of *demand-side* analysis, then affordability has the major benefit of being consistent with economic theory. The ability to leverage an extensive economic toolkit is helpful for two reasons.

First, demand has clear ownership. Simply put, the owner is whoever demands a particular good. In the defense community, this translates to senior leaders with mission requirements and obligation authority—those who are ready, willing, and able to purchase. Identifying demand's owner allows us to be clear about non-owners, for example, end users or demand enablers, like the acquisition community.

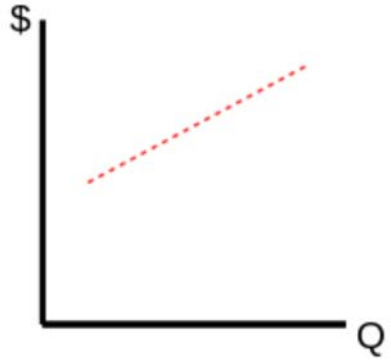
Because the acquisition process has different *types* of players, it is composed of divergent incentives. Incentives for each type are altered not only by the form of a particular affordability constraint but also by the ownership structure. This includes enforcement, access to information, and the degree to which decisions are deferred. We discuss incentives elsewhere in this paper.

A second benefit of affordability's toolkit is the ability to identify helpful second-order relationships. We will make this clear via an extended example. Consider the workhorse supply and demand framework. In Figure B-1, the horizontal axis is the quantity supplied, while the vertical axis is the per-unit sale price. An individual firm's supply of good Q at various unit prices is given by the red, dashed curve.[1]

Analysts give a number of reasons for its upward slope; however, an intuitive one is that total profit increases as the price goes up. Thus, a firm prefers to sell more units in order to cash in on higher prices. A second reason for the upsloped curve is that for fixed levels of factories and equipment, worker productivity first increases and then decreases as

[1] Technically, since supply is defined as a function of price, this is actually an inverse supply curve. In competitive markets, the inverse supply curve is the firm's marginal cost curve. When firms have a degree of market power, the curves diverge somewhat. However, this does not detract from the central analysis.

a firm adds additional labor.[2] Decreasing productivity drives up the cost of producing more units, which forces the supply curve up.



Note: The horizontal axis is the quantity supplied, while the vertical axis is the unit sale price.

Figure B-1. A Firm's Supply Curve for a Particular Good

This is to be distinguished from the process of "learning-by-doing," in which it is more costly to produce initial units than subsequent ones. When firms learn, the supply curve shifts outwards. In other words, as the firm realizes process improvements, certain cost components decline and the firm can offer more units at a particular price than it could earlier in the production process. In Figure B-1, one could imagine a rightward shift of the red curve as learning occurs.

Hidden Demand Model

Several methods exist for determining whether goods are affordable. Amongst the most basic approaches is to look at how much something costs, look at how much funding is available, prioritize your wants, and then buy what you can afford. In other words, the defense Component merely satisfies its budget constraint without recourse to any second-layer demand analysis. As such, call this the *method of hidden demand*.

Each good has its own supply curve, so consider three major defense programs a Component wants to buy. With a pronounced flare for the anti-climactic, call these programs 1, 2, and 3. In Figure B-2, the horizontal axis reflects the quantity supplied Q_1, Q_2, and Q_3 for each program, inclusive of support features and functions. The vertical axis represents the unit sale price, inclusive of all life-cycle or total ownership costs as appropriate. The dashed, red supply curves are the quantity-cost pairs derived from each vendor's estimates.

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[2] Labor is not the only example; this applies to any variable production input. That said, upward sloping supply is not strictly necessary. Our analysis in this extended example is not substantively altered by other reasonable shapes for the supply curves.

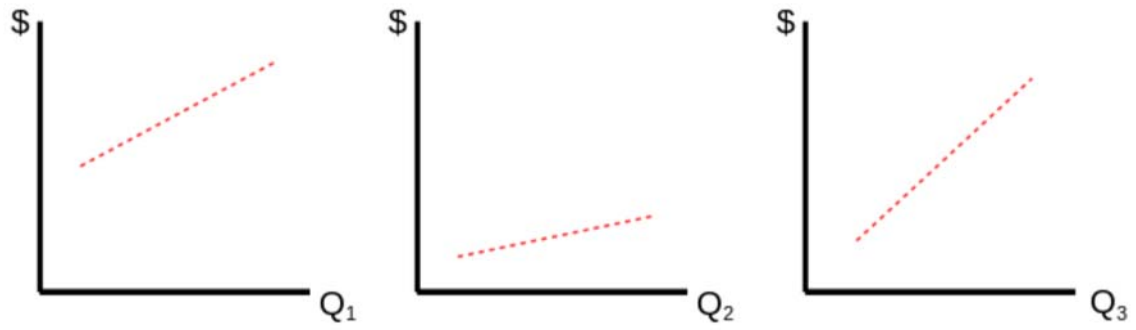


Figure B-2. Supply Curves for Defense Programs 1, 2, and 3

For purposes of the example, assume the Component does some demand analysis every year and decides Program 1 is the highest priority program, Program 2 is second, and Program 3 is third. The Component also knows its future total budget projection (FTBP) over the life of the three programs. Based on operational analysis—and conditional on its FTBP—the Component knows it needs q_1 and q_2, which are expected to cost E(C_1) and E(C_2) per unit. Additionally, enough budget still remains to fund quantity q_3 at E(C_3). Call (q_1, q_2, q_3) the selected course of action.[3] The three graphs of Figure B-3 depict this situation.

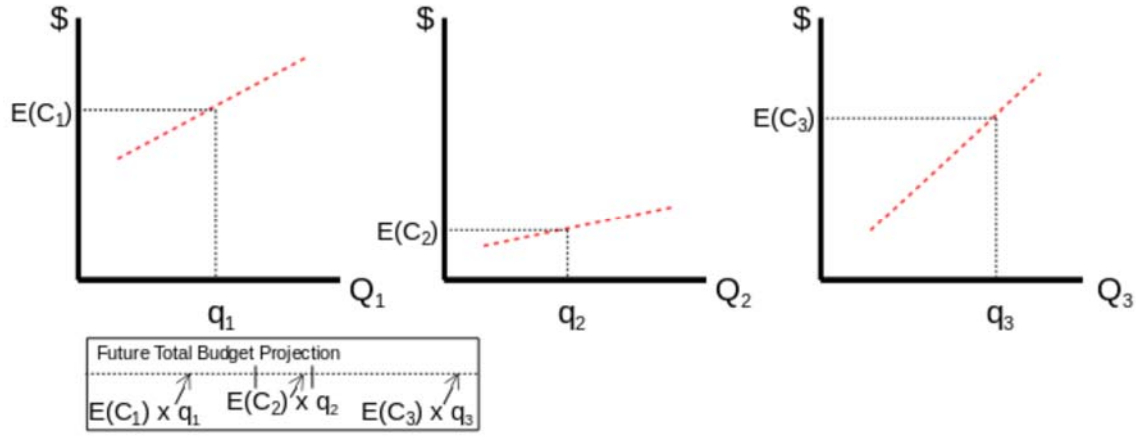


Figure B-3. A Component has Enough Funding to Purchase Quantities q_1, q_2, and q_3 of Three Defense Programs

[3] We can easily extend the example to incorporate cost-plus payment schemes.

Since the Component has the ability to allocate resources out of its FTBP, the programs are affordable, by the Defense Acquisition Guide (DAG)'s definition. There are two additional ways to see this. First, mathematically,

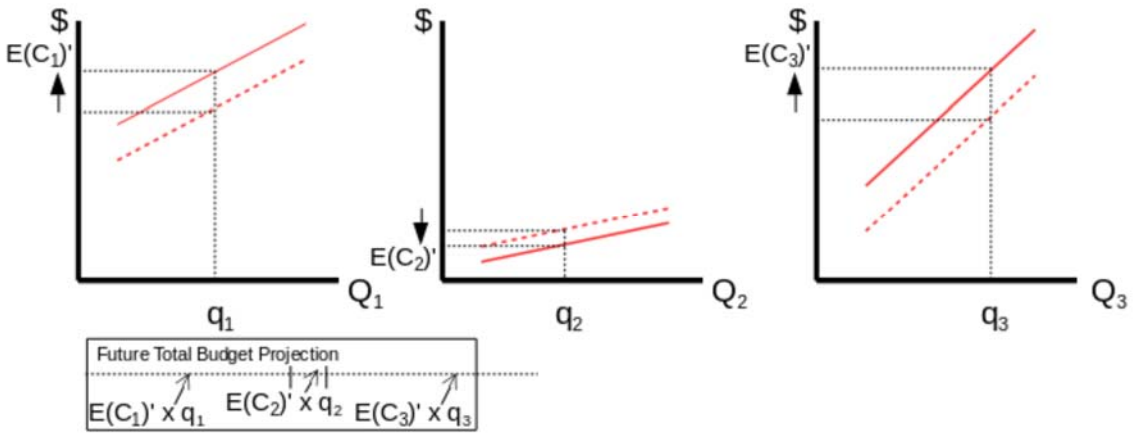
$$\mathrm{E}(C_1)q_1 + \mathrm{E}(C_2)q_2 + \mathrm{E}(C_3)q_3 \leq FTBP.$$

In other words, we multiply quantities by costs and sum them up as on a hardware store receipt.

Second, graphically, let the future total budget projection over the life of the three programs be the *length* of the FTBP box at the bottom of Figure B-3. For $i = 1, 2, 3$, the expected unit cost $\mathrm{E}(C_i)$ is the length of the vertical line from the supply curve to the horizontal axis at the desired quantity q_i. Graphically, the DAG definition holds when the expected costs $\mathrm{E}(C_i)$ scaled by their respective quantities q_i fit into the FTBP box end-to-end.

Since the Component prioritized needs and conducted course of action analysis in keeping with the projected operating environment, *the hidden demand method is a form of demand analysis*. Affordability targets could then be built using a number of different methods, including benchmarking them off the expected costs at the selected course of action based on priority. For example, one could set the top priority's target 10 percent above $\mathrm{E}(C_1)$ and adjust the other targets from there.

However, cost estimates tend to vary over time. Fast forward a year to the point when the Component revises its plan. In Figure B-4, each program's updated costs are given by the solid red lines. Programs 1 and 3 now have increased costs, while Program 2 realized lower costs. Figure B-4 also shows that the Component's course of action last year (q_1, q_2, q_3) now has updated unit costs ($\mathrm{E}(C_1)', \mathrm{E}(C_2)', \mathrm{E}(C_3)'$), where the *prime* mark distinguishes this year's costs.



Note: The dashed red curves represent last year's costs for each of the three suppliers, while the solid red curves represent this year's costs.

Figure B-4. Supplier Costs Change Over Time

Depending on the particular quantities chosen, the Component may now find $E(C1)'q_1+E(C2)'q_2+ E(C3)'q_3 > FTBP$; unit costs increase and exceed the FTBP box.[4] As long as the Component was at its FTBP last year, this *always* occurs when at least one cost increases and the others stay the same or increase.

The appeal of the hidden demand method is its simplicity: check the prices, prioritize your wants, buy what you can afford. However, when $E(C_1)'q_1+E(C_2)'q_2+E(C_3)'q_3 > FTBP$, (q_1, q_2, q_3) is no longer affordable. The Component needs to adjust its course of action—potentially by modifying quantities, timelines, and capabilities; seeking increased authorizations; or even canceling a program it had previously begun.

Explicit Demand Method

In this second method, Component leadership explicitly considers its demand based on projected operational requirements. This is more extensive than prioritizing programs: it involves tracing out rough demand curves.[5] In the first pass, dollar signs may or may not be involved. The Component prioritizes individual programs as fractions of its mission set and considers intensity of demand for program quantities, capabilities, timelines, and so forth. For example, the current threat environment might dictate that air-to-air munitions occupy 5 percent of the cost of a particular portfolio.

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4 The graphs visually normalize each of the qi to 1 so the three segments $E(C_1)q_1$, $E(C_2)q_2$, and $E(C_3)q_3$ are visually equivalent to the lengths $E(C_1)$, $E(C_2)$, and $E(C_3)$. This makes it easier to visualize the impact of changing costs graphically. Of course, the visual normalization is not at all necessary; the method holds for a longer FTBP box with the actual quantities.

5 While these are drawn as straight lines, discrete purchasing habits have a stair-step shape. For example, if a Component would consider 120, 140, or 160 aircraft—but never 133 or 146—we would see the demand curves drop vertically at 120, 140, and 160.

Second, the Component reconciles its priorities and demand intensities with its FTBP. When run across a number of courses of action, the result is the sequence of program demand curves shown in Figure B-5.

Note: The horizontal axis represents the quantity demanded, while the vertical axis is unit sale price.

Figure B-5. Demand Curves for Programs 1, 2, and 3

Whether the vertical axis is dollar signs or a "slice-of-the-pie" measure, one can say a considerable deal about demand. For example, if Program 1 is an important tactical platform with no other comparable-role platforms available, demand may be inelastic around the operationally required quantity. This means the need is pronounced, and the Component may be less sensitive to changes in the program's cost.

On the other hand, if Program 3 is less pressing, or it has a number of viable existing alternatives, demand may be elastic around the operationally forecast quantity. That is, the Component may be much less willing to accommodate increases in the program's cost.

Reconciling priorities and intensities with the FTBP is essentially a question of willingness-to-pay (WTP). For any given quantity q_i, where $i = 1, 2, 3$, WTP is the vertical distance from the demand curve to the horizontal axis at that quantity q_i. At quantities q_1, q_2 and q_3—the same course of action as in the hidden demand method—Figure B-6 graphically represents WTP per unit as the length of the green lines.

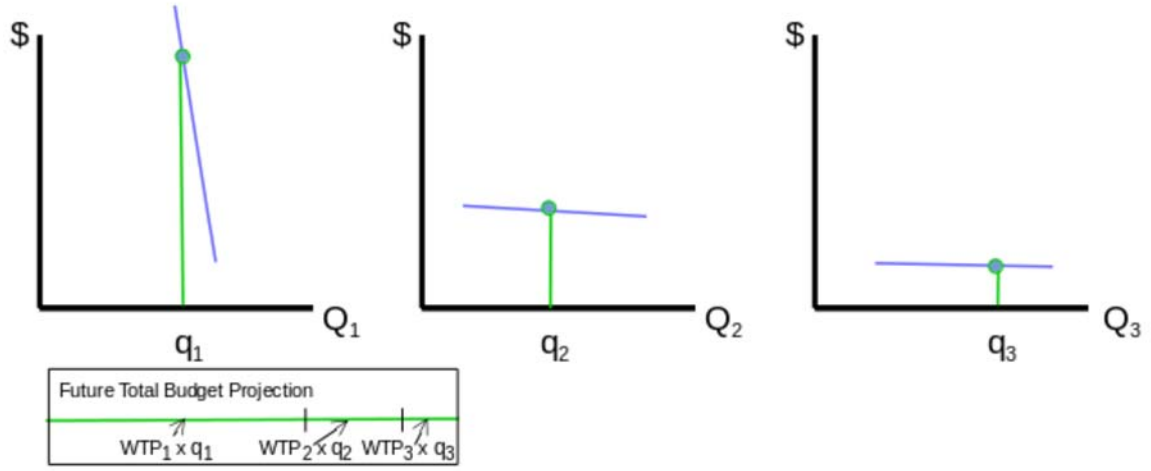


Figure B-6. Unit Willingness to Pay at Quantities q_1, q_2, and q_3

In the mathematical sense, a particular course of action (COA) (q_1, q_2, q_3) should satisfy $WTP_1q_1 + WTP_2q_2 + WTP_3q_3 \leq FTBP$. Graphically, the unit willingnesses to pay WTP_i scaled by their respective quantities q_i should fit into the FTB box end-to-end, where we continue the visual normalization of footnote 4.

Now consider the same supply curves as in the hidden demand method. Figure B-7 shows that Programs 1 and 2 have WTP above cost at q_1 and q_2. However, Program 3 has cost above WTP at q_3. Practically, while Program 3 may be the third priority, the Component's demand analysis indicates it may not be as significantly involved in the operational mission as the other two programs.

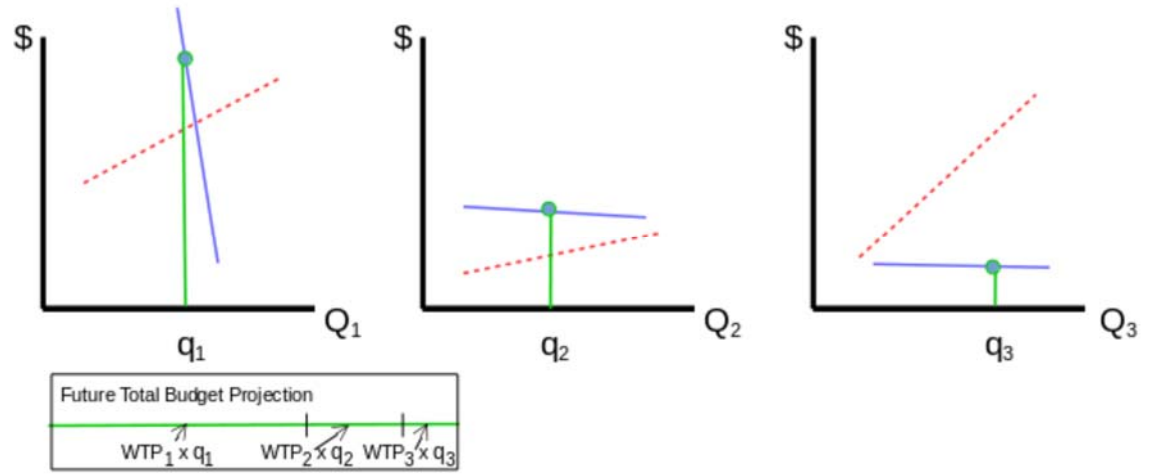
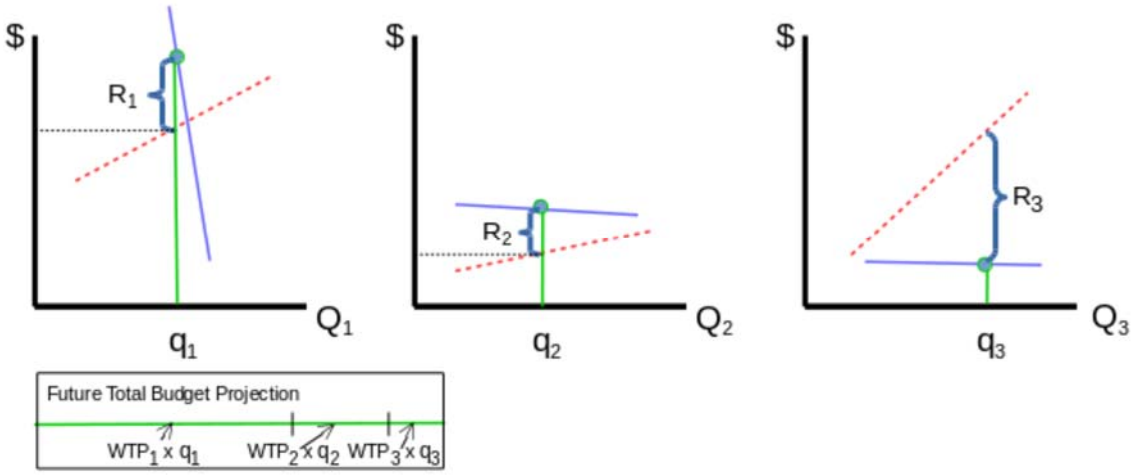


Figure B-7. The Component May Not be Willing to Pay for q_3 in Program 3

Few are likely interested in an equilibrium analysis of the defense industry.[6] However, supply and demand curves are germane for a more practical reason: they allow us to undertake helpful second-order analysis. In this case, we can propose a measure of program risk R.

Define R_i for each program $i = 1, 2, 3$ as the distance between demand and cost at a particular quantity. Mathematically, $R_i = WTP_i - \mathrm{E}(C_i)$. This is a point measure of buyer surplus or "wiggle room," since the Component is willing to pay more than the units actually cost. In Figure B-8, note that the blue curves are above the red curves at q_1 and q_2, which means $R_1 > 0$ and $R_2 > 0$.



Note: Each distance R_i, $i = 1, 2, 3$ is a measure of buyer surplus or "wiggle room." Program risk decreases as R_i increases.

Figure B-8. Program Risk

We can think of risk as being inversely proportional to buyer surplus and thus to R_i. In other words, more wiggle room implies lower risk. In Figure B-8, R_1 is longer than R_2. This means Program 1 has *lower* risk (more wiggle room) than Program 2. Thus, if costs shift up by the same amount for both Programs 1 and 2, the larger buyer surplus for Program 1 translates into less risk of program modification.

However, unit cost is above the Component's willingness to pay at q_3, which means $R_3 < 0$. This is one method of determining that Program 3 is not affordable in its own right. While the Component may still have the funds available to purchase COA (q_1, q_2, q_3), as

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[6] In the presence of competition, economic theory suggests the market clearing quantities lie at the intersection of supply and demand. One might not expect this to be the case in the defense industry, however, since (1) both buyers and firms have some degree of market power, (2) costs require frequent updating, and (3) buyers have distinct preferences over quantity structures. In the presence of market power, "supply" requires a somewhat more technical interpretation than what we outline above. However, since a technical analysis of markets with both monopsony and monopoly components is not indicated, we will continue forward with the stylized, but practical, view outlined above.

represented by the visual normalization in the FTBP box, explicit demand reveals q_3 is not *individually* affordable ($R_3 < 0$).

The ability to create risk measures is a second-order feature enabled by explicit demand analysis. Since the risk measures are WTP-based in the explicit method (rather than, say, benchmark-based as in the hidden demand method), the Component now has an *additional* tool to diagnose program proposals. Under explicit demand, the Component should either (a) not start Program 3, or (b) dramatically reduce the quantity demanded. This stands in contrast to hidden demand where, under present cost estimates, the Component was able to afford COA (q_1, q_2, q_3).

For purposes of the example, fast-forward a year and imagine we see precisely the same cost revisions (solid red curves) that we did in the hidden demand example. Programs 1 and 3 experience cost increases, while Program 2 realizes a cost reduction. Figure B-9 shows updated risk measures for each program. Label these R'_1, R'_2, and R'_3. R'_1 is now shorter than R'_2, meaning Program 2 has more wiggle room than Program 1. This reflects an important design feature: program risk evolves—appropriately—with costs and priorities.

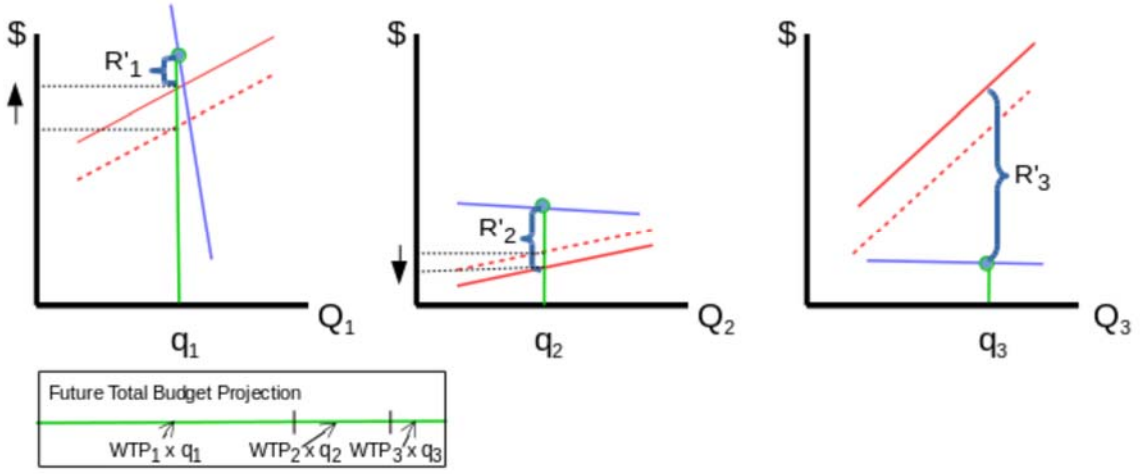

Figure B-9. Adjusted Program Costs Imply Updated Risk Measures R'_1, R'_2, and R'_3

COA (q_1, q_2, q_3) is still not affordable, because q_3 is not individually affordable. However, this is old news; the Component was able to diagnose the lack of affordability last year. Likewise, note that the visually normalized WTP segments did not overrun the FTBP box. This transformation away from "cost-space" and towards "WTP-space" is stabilizing, which is a second advantage.

Illustrations

Figures

Tables

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Abbreviations

3DELRR	Three Dimensional Expeditionary Long Range Radar
ACAT	Acquisition Category
ACV	Amphibious Combat Vehicle
ADM	Acquisition Decision Memorandum
AFTOC	Air Force Total Ownership Cost
AMDR	Air and Missile Defense Radar
AMPV	Armored Multi-Purpose Vehicle
AOC-WS	Air Operations Center – Weapon System
APAC	Acquisition Policy Analysis Center
APB	Acquisition Program Baseline
APUC	Average Procurement Unit Cost
ARA	Acquisition Resources and Analysis
ASD(A)	Assistant Secretary of Defense for Acquisition
AT&L	Acquisition, Technology and Logistics
ATACMS	Army Tactical Missile System
ATIRCM	Advanced Threat Infrared Countermeasures
BBP	Better Buying Power
BY	Base Year
CAE	Component Acquisition Executive
CANES	Consolidated Afloat Networks and Enterprise Services
CASCOM	Combined Arms Support Command
CIRCM	Common Infrared Countermeasures
CMWS	Common Missile Warning System
COA	Course of Action
CRH	Combat Rescue Helicopter
CTOL	Conventional Takeoff and Landing
CV	Carrier Variant
D,PARCA	Director of Performance Assessments and Root Cause Analyses
DAB	Defense Acquisition Board

DAE	Defense Acquisition Executive
DAES	Defense Acquisition Executive Summary
DAG	Defense Acquisition Guidebook
DAMIR	Defense Acquisition Management Information Retrieval
DMS	Defensive Management System
DoD	Department of Defense
DoDI	DoD Instruction
EMD	Engineering and Manufacturing Development
EPAWSS	Eagle Passive/Active Warning and Survivability System
EPP	Extended Planning Period
EPS	Enhanced Polar System
FAB-T CPT	Family of Advanced Beyond Line of Sight Terminals Command Post Terminal
FCS	Future Combat Systems
FTBP	Future Total Budget Projection
FY	Fiscal Year
FYDP	Future Years Defense Program
GBSD	Ground Based Strategic Deterrent
GCV	Ground Combat Vehicle
GMLRS	Guided Multiple Launch Rocket System
GPS	Global Positioning System
GPS OCX	Global Positioning System Next Generation Operational Control System
HIMARS	High Mobility Artillery Rocket System
IAMD	Integrated Air and Missile Defense
IDA	Institute for Defense Analyses
IDECM	Integrated Defensive Electronic Countermeasures
IFPC	Indirect Fires Protection Capability
JAGM	Joint Air-to-Ground Missile
JLTV	Joint Light Tactical Vehicle
JMS	Joint Space Operations Center Mission System
JPALS	Joint Precision Approach Landing System
JPO	Joint Program Office
JSF	Joint Strike Fighter
JSTARS	Joint Surveillance and Target Attack Radar System
KPP	Key Performance Parameter

LCC	Life Cycle Cost
LCS	Littoral Combat Ship
LEP TKA	B61 Mod 12 Life Extension Program Tailkit Assembly
LIRA	Long-Range Investment Requirements Analysis
LMP	Logistics Modernization Program
LRSB	Long-Range Strike Bomber
LTAMDS	Lower Tier Air and Missile Defense Sensor
MAIS	Major Automated Information System
MDAP	Major Defense Acquisition Program
MDD	Materiel Development Decision
MGUE	Military GPS User Equipment
Mod	Modification
MS	Milestone
NGJ	Next Generation Jammer
N-M	Nunn-McCurdy
O&M	Operations and Maintenance
O&S	Operation and Support
OCX	Operational Control System
OSD	Office of the Secretary of Defense
PAA	Primary Aircraft Authorized
PAC-3 MSE	Patriot Advanced Capability Missile Segment Enhancement
PARCA	Performance Assessments and Root Cause Analyses
PAUC	Program Acquisition Unit Cost
PB	President's Budget
PGK	Precision Guidance Kit
PIM	Paladin Integrated Management
PM	Program Manager
PSCS	Protected Satellite Communication Services
RDT&E	Research, Development, Test and Evaluation
RFP	Request for Proposal
RMS	Remote Minehunting System
S&T	Science and Technology
SAE	Service Acquisition Executive
SAR	Selected Acquisition Report
SDB	Small Diameter Bomb
SSC	Ship to Shore Connector

STOVL	Short Takeoff/Vertical Landing
TOA	Total Obligational Authority
TY	Then-Year
U.S.C.	U.S. Code
U.S.S.	United States Ship
URF	Unit Recurring Flyaway
US	United States
USD	Under Secretary of Defense
VAMOSC	Visibility and Management of Operating and Support Costs
WIN-T	Warfighter Information Network-Tactical
WTP	Willingness-to-Pay

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14. ABSTRACT

We studied the Affordability constraints placed on acquisition programs since Better Buying Power was introduced by the Under Secretary of Defense for Acquisition, Technology and Logistics in 2010. This initiative can be thought of as extending programming from five years in the future to the full life of each acquisition program, typically in excess of twenty-five years. We discuss the management issues involved in carrying out this initiative, along with its results. The most significant outcome is that it has brought Service programmers to the Office of the Secretary of Defense's Defense Acquisition Board process. Program managers now need to have their long-term plans approved by the programmers, who verify that it fits with the long-term plans of the Service. While an affordability analysis is not a cost estimate, it cannot possibly be any more precise than the numerous program cost estimates used to conduct the analysis, meaning there will always be some uncertainty in planning, and the uncertainty gets larger the further into the future one looks.

15. SUBJECT TERMS

Affordability, Analysis, Defense, Acquisition, MDAP, MAIS, Constraints, Goal, Target, Programmers, Planning, BBP, Better Buying Power

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