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Consequences of BBP's Affordability Initiative

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Panel 5. Quantitative Analyses of Acquisition Outcome Drivers

Wednesday, May 4, 2016	
1:45 p.m. – 3:15 p.m.	**Chair: William Gates,** Dean, Graduate School of Business and Public Policy, NPS ***Consequences of BBP's Affordability Initiative*** Gregory Davis, Research Staff Member, Institute for Defense Analyses Lawrence Goeller, Defense Acquisition Analyst, Institute for Defense Analyses Stanley Horowitz, Assistant Director, Cost Analysis and Research Division, Institute for Defense Analyses ***Further Evidence on the Effect of Acquisition Policy and Process on Cost Growth*** David McNicol, Research Staff Member, Institute for Defense Analyses David Tate, Research Staff Member, Institute for Defense Analyses ***Preparing to Be Wrong*** Prashant Patel, Research Staff Member, Institute for Defense Analyses Michael Fischerkeller, Research Staff Member, Institute for Defense Analyses

Consequences of BBP's Affordability Initiative

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Lawrence N. Goeller—has been a Defense Acquisition Analyst for 30 years. After obtaining his doctorate in physics from Rice University in 1986, he worked as a SETA support contractor for the Air Force acquisition community in the Pentagon, and then ASD/C3I, where he focused mainly on military satellite communications and terrestrial communications systems. From 2004 to 2012, he worked in government for OSD/CAPE/CA, where he produced Independent Cost Estimates for a number of ACAT 1D programs. He joined IDA in 2012. [lgoeller@ida.org]

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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 25 years—and discussing the full plan at Defense Acquisition Board (DAB) meetings. We discuss the management issues involved in carrying out this initiative, along with the results it has had. The most significant outcome is that it has brought Service programmers to the Office of the Secretary of Defense's DAB process. Program managers now need to have their long-term plans approved by the programmers who verify that they fit with the long-term plans of the Service. While an Affordability Analysis is not a cost estimate, it cannot be any more precise than the numerous program cost estimates used to conduct the analysis.

Introduction

The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) 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.

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 in 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 Operations and Support (O&S). Since 2013, the responsibility for this analysis has belonged to the Service staffs. Generally, they present a "sand chart" that piles all spending by portfolios on top of each other, adding up to the expected Service topline, and a second sand chart that shows the expected spending for all of the programs in the portfolio that includes the program under consideration.

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. Carter went on to become Deputy Secretary of Defense in October 2011 and then Secretary of Defense in February 2015. Upon Carter's first promotion, Kendall became acting USD(AT&L) and was confirmed in May 2012, where he is today. These two men were the original proponents of BBP, the first edition (1.0) signed by Carter and the subsequent ones by 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 the DoD began mandating Affordability Analysis. So far, although a few programs have been cancelled, another wave like 2009's has not occurred, although 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 report.

An ongoing tension exists within the 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 is an attempt by the USD to solve this problem with his tools.

Most of the research for this paper was conducted using Acquisition Decision Memoranda, handouts presented at DABs by program managers, and data archived in the Defense Acquisition Management Information Retrieval (DAMIR) System; all are marked "For Official Use Only (FOUO)." Consequently, there are very few actual data in this report. We do have a larger report that includes all of the data and, as of this writing, the distribution rules on it have not yet been set.

The Goals of Affordability (and Their Evolution)

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, was signed by Carter and came to be known as BBP 1.0. This section begins with a discussion of the vision for affordability expressed in the 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).

The 2010 Guidance: BBP 1.0

BBP 1.0 presented a list of 23 principal actions to improve efficiency in the Defense acquisition process. The first five of these actions are associated with the "Target Affordability and Control Cost Growth" area. The motivation is stated in the first paragraph of the 17-page memo itself:

> 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. (USD[AT&L], 2010, p. 1)

We can 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 the Department. How these savings or "redirections" are to be measured is left unstated. 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 23 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.

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; it depends on how the specific goals of affordability (as expressed in BBP 1.0) differ from other policies and oversight mechanisms such as Nunn-McCurdy (N-M) thresholds. 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."

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 Future Combat Systems (FCS). The perception at the highest levels of the Office of the Secretary of Defense (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 the 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, Tate et al. (2007) documented that the costs of FCS would be far higher than was in the Army's 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 at least in part to "prevent future FCSs." The unaffordability of FCS seems clear in hindsight, but how does one tell which programs that are currently being initiated are likely to become "future FCSs?"

In general terms, two concepts arose as part of the vision. The first was that the five-year planning horizon associated with the Future Years Defense Program (FYDP) was insufficient to prevent initiation of doomed programs: five years does not, in general, even cover the development phase of large programs. Since most of the program costs are incurred during the Procurement and O&S phases, the costs of these phases must be explicitly considered from inception and not pushed off into an out-year "bow wave." Key parts of the guidance, therefore, directed 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 was that programs should not be considered in isolation, that it must be recognized and acknowledged that, in constrained budget environments, cost growth in one program will affect the funding available for other programs. This, it was argued, must be formally recognized and tied to the question that the program manager (PM), the Service, and the OSD should all have in mind: At what point does the cost of a program (including the opportunity cost of other systems) exceed its value to the warfighters and taxpayers? Complicating matters is the well-known but widely disliked 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 each of these programs—this is the purpose of the practice—but generally increases the total costs and delays operational availability.

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.

The principal action mandating affordability gave rise to this paper, and we will look at it in depth. The other four mostly are seen as techniques for increasing productivity. We will also look at "Eliminate Redundancy Within Warfighter Portfolios" because it is the first mention of portfolios and is necessary for understanding how Affordability Analysis is conducted. BBP 1.0 also says,

> 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.* (USD[AT&L], 2010, p. 4) [Emphasis in original, and in all cases that follow]

This is not a focus on making certain that our warfighters have the best stuff possible, but rather trading that away to stay on schedule. Trading away requirements supports the central mission of BBP 1.0: reducing spending.

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 program managers 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 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][1] will be directed to do the same at their level of approval. (USD[AT&L], 2010, p. 2)

The guidance officially states that the PM must incorporate an affordability target as a KPP at the Milestone A DAB. Not stated here, but implied, is that the PM must also incorporate an affordability requirement as a KPP at the Milestone B DAB, and beyond.[2]

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 APUC or PAUC 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

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[1] The Components are the military Services and other agencies.
[2] The terms "target" and "affordability requirement" were later replaced with "goal" and "cap," respectively.

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 and only some of which are under the PM's control.

The requirement to determine and state affordability goals and caps is done to act as a trip-wire for cost growth sufficient to require a re-examination of Service priorities and available resources. It thus overlaps significantly with N-M reporting. We have no objection to this; the target audience is different, and it could prove more useful.

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 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.*

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 (e.g., "tracked vehicles" or "surface ships") became central. The so-called "sand charts" that must be presented in the affordability section of each DAB review are snapshots of these portfolios—often created by extending out indefinitely the spending in the last year of the FYDP.

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 until this time, the Milestone reviews were between one program manager and the appropriate level of acquisition executive, typically USD(AT&L) for Acquisition Category (ACAT) I programs. The requirement to discuss interactions with other programs, even if superficially, forces the PM to engage with the Service prior to Milestone approval. It should not escape notice that a representative of the Service programmer's office 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?* (Enthoven & Smith, 2006) and ought to 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. For a cross-service example, the Army's AH-64 Apache helicopters perform similar missions to the other Services' close air support aircraft.

The 2013 Guidance: BBP 2.0

The Memorandum *Implementation Directive for Better Buying Power 2.0—Achieving Greater Efficiency and Productivity in Defense Spending*, or BBP 2.0, which was signed by Kendall as the Under Secretary on April 24, 2013, incorporates a number of subtle changes

with respect to BBP 1.0, dated two-and-a-half years earlier—some detailed changes and some important "vision implementation" changes. As this is neither the genesis of Affordability Analysis nor current, we treat it with less depth than the other two. There were two important changes from this iteration of BBP.

BBP 2.0 (USD[AT&L], 2013) states, "Constraints stem from long-term affordability planning and analysis, which is a Component leadership responsibility." Explicitly giving the setting of constraints to Component leadership was important. Now the Services would have ownership of the constraints as well as the USD who signed the ADM, guaranteeing that the spending plan brought to the DAB would be approved by Service leadership. Might this have helped prevent the FCS debacle?

Perhaps the most stunning quote in BBP 2.0 (USD[AT&L], 2013) is this: "If affordability caps are breached, costs must be reduced or else program cancelation can be expected." This may have been implied before, but in BBP 2.0, this threat became explicit. Kendall doubled down on the importance of this initiative. With the costs of breaching so clearly high, there might now be pressure not only on the program office to not breach the constraints, but also on the OSD, which might also feel compelled to not report a breach to prevent having to conduct such a severe action, which might not be warranted.[3]

In the September–October 2013 issue of *Defense AT&L,* 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." 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.

New Priority: Technological Superiority

By 2015, Kendall's focus had shifted somewhat. Using funds efficiently was still important, but he was also concerned about technological dominance, and said so in BBP 3.0.

The 2015 Guidance: BBP 3.0

The memo *Implementation Directive for Better Buying Power 3.0—Achieving Dominant Capabilities Through Technical Excellence and Innovation*, henceforth referred to as BBP 3.0, was signed by Kendall on April 9, 2015. While the commitment to affordability remained, the tone changed significantly.

As was the case with BBP 2.0, BBP 3.0 (USD[AT&L], 2015) is brief—this time only a single page. It is accompanied by two attachments: a one-page Summary Page, and a 33-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," and the half-page section of the Implementation Guidance that specifically refers to affordability.

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[3] We expect most parents recall making a threat that had to 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.

BBP 3.0 Memo Body

In this memorandum, Kendall writes, "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 one hand, all of the guidance about the importance of maintaining long-term affordability, via requirements reduction if necessary, still remains in place: "New in Better Buying Power 3.0 is a stronger emphasis on innovation, technical excellence, and the quality of our products." Here we see the emphasis on innovation, which is likely to discourage trading capability for affordability. With less trading, there might be more cost growth. Furthermore, an emphasis on innovation will lead to more ambitious programs that are more likely to yield cost growth. Cost growth from either source would squeeze other programs and can lead to unaffordable portfolios. On the other hand, ambitious programs sometimes fail, and if they are canceled they can open up affordability space as well.

BBP 3.0 Implementation Guidance: Overview

The Overview, page 1 of the Implementation Guidance, states,

> 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.

Previously, the emphasis had been on reducing spending. This guidance is new.

BBP 3.0 Implementation Guidance: Achieve Affordable Programs

While there is a new focus in BBP 3.0, 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" (Implementation Guidance, p. 2).The USD has not given up the possibility of cancelling programs that exceed their affordability constraints, but the apparent stakes have been lowered considerably.

Formal Guidance: DoDI 5000.02

In January 2015, Kendall signed DoD Instruction (DoDI) 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. The new instruction has a five-page enclosure entitled "Affordability Analysis and Investment Constraints," which explains in some detail how Affordability Analysis should be conducted. It also contains a simple example of calculating a constraint for a fleet of trucks when it is assumed that the budget, inventory, capability, and unit cost all will be constant for the foreseeable future.

The Accomplishments of Affordability

Currently, a little more than a third of active acquisition programs have an affordability constraint, which implies that a complete Affordability Analysis was conducted. Those that do not have one are older programs and therefore have not been through a DAB recently. Most are post Milestone C and have been in production for a while.

The most common form of affordability constraint is a limit on Average Procurement Unit Cost (APUC). The next most common form limits Program Acquisition Unit Cost (PAUC). When BBP 2.0 was signed in April 2013 (discussed previously), responsibility for

conducting the Affordability Analysis and creating constraints was explicitly given to the Services (BBP 1.0 did not indicate who was to be responsible for this). In the early days, affordability metrics were sometimes based on many other metrics, such as "unit recurring flyaway cost" in one specified year and "Average Ship Acquisition Cost." Most programs now have metrics—discussed later in the Affordability Metrics section—that can be easily checked against a value reported in the annual Selected Acquisition Report (SAR), usually APUC, PAUC, or total investment.

This brings us, finally, to the fundamental question: To what degree have actual ACAT I programs adjusted their plans as a result of the affordability initiatives? 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. We did look, and found no evidence that they were influenced by affordability constraints. We were unable to find any requirements documents written over the last five years in which a requirement was relaxed and was clearly done to make a program affordable. We also did not hear such stories from our interviews with members of the acquisition community; what we did hear were accounts of programs that changed how they met requirements or bought hardware. The biggest change we noted was the role of the Service programmers, often called "the 8s"[4] in the acquisition process.

While changes to 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 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, program manager 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 the OSD to sort out these effects.

Changing Constraints

If constraints change too easily, then they are not constraining. 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 in DAMIR, that file does not include changes, only those that are currently in force. The Office of the Secretary of Defense (Acquisition Resources and Analysis) kindly gave us a spreadsheet that tracks all constraints ever levied. That file showed that there are 17 programs that have had their affordability constraints changed.

Of these 17, only four had one binding cap changed for another, as opposed to a non-binding goal replaced by either a new goal or cap. The four caps all changed on the same day in 2015. One of these four programs had suffered significant cost growth but was also deemed to be important enough to warrant a higher cap. One ADM raised the cap for that program and lowered the caps for three others in the same Service portfolio.

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[4] "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.

We do not know what underlying analysis went into these new caps. The ADMs that we read (all marked FOUO and therefore not publicly available) only show what the new and old caps were; we could not see if meeting the new constraints yielded a portfolio that was just as affordable as meeting the old constraints, because the constraints were in different base years and each constraint was associated with a different spending profile. Our experience suggests that these calculations were done by a staff member at the Service and were accepted by the OSD after some scrutiny. Still, this clearly shows that the OSD and the Service were thinking about affordability in terms of a portfolio of programs and not one program at a time.

Bringing in the Service Programmers

The new affordability mandates have brought representatives of the Service programming offices to the table for Milestone reviews. This has improved the communication between the programmers and the acquisition communities inside the Services. The long-term spending plans presented at a DAB in the past may not have been seen by the Service's programmer. Making the Services responsible for "owning" affordability forces the PMs and the programmers to interact on these issues far more than they have in the past.

Every year the DoD sends the SARs (prepared by program offices) and the President's Budget (PB; prepared by the Service programmers) to the Congress. Within the FYDP, these must agree. However, for years beyond the FYDP, there can be significant disagreement between what the two documents say. For example, both the F-35 and Joint Light Tactical Vehicle (JLTV) programs show discrepancies between the December 2014 SAR submission and the January 2015 PB submission. In the 2016 budget submission, the Navy reported total costs for the F-35C carrier variant of $55.66 billion and for the F-35B short take off and vertical landing variant of $47.66 billion, for a total of $103.32 billion over the life of the program. 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 N8 that wrote the budget submission and the program office that wrote the SAR were not on the same page. Affordability Analysis will not fix that annual problem, but it does require agreement at DABs when both groups are in the room.

Affordability Analysis also demands longer term planning from the programmers. Before Affordability Analysis, only the five years in the FYDP received significant focus. Now they are required to plan over longer durations. The Army has a new tool called the Long Range Investment Requirements Analysis (LIRA), which they use for this purpose. LIRA tracks planned Army expenditures over many years, which is exactly what Kendall has required. Unfortunately for the OSD, the G8 has stated that the Army does not intend to grant access to LIRA to any other organization—this system is for Army internal use only, which means that while the OSD can look at the results of the Army's long-term studies, unlike with the FYDP, they will not be able to verify or validate the models or their inputs. We believe the other Services have similar systems and similar concerns about sharing data.

Ground Combat Vehicle

In 2011, the Army's Ground Combat Vehicle received Milestone A authority but no affordability constraint, and it appeared in PB 2014. But 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. However, 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.

Management Considerations

To make Affordability Analysis as useful as possible, there are several factors that need to be thought through. While it has already yielded some wins for the DoD, as discussed previously, we think some improvements could be made. We also want to highlight what is working well.

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 ought not to proceed. However, what cost data should be used 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 which will be in 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.

Affordability Metrics

Affordability 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 does not threaten the portfolio's affordability—allows it to continue without his involvement.

Investment Metrics

One 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 ought not to be adopted. First, such a requirement would take away much discretion in future years. There may be good reasons 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 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. 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 a table with as many as 40 numbers in it, which might be unwieldy.

One simplification would be maximum annual obligations. The ADM would say, "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 program funding generally is not flat, in some years the cap would 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 when there are cost problems. While this does relate to affordability, it is likely to be counterproductive.

As discussed earlier, AT&L and the Services have largely settled on the use of the APUC or PAUC[5] as the metric of choice for most programs because they can track it annually when the SARs are written. Also in use are metrics based on total investment or total procurement dollars. Typically, metrics based on totals are used for programs such as the GPS Operational Control System (OCX) or Space Fence, where the program is buying a single capability—not some integer number of identical (or more often similar) items like ships, missiles, or ground vehicles. Total expenditure metrics are also easily tracked by the SARs.

The primary problem with APUC and PAUC is that they are not closely related to affordability. If a Service has a problem with affordability, they can reduce the number of units they plan 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 unit cost. While this 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 increases unit costs in order to make a program fit in the budget.

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/CMWS5F[6] program bought two different systems for the protection of helicopters. Some "units" were only CMWS systems and others included both. They also had some other accounting choices that affected unit cost (Balaban et al., 2010). 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 variant to another because the payloads were very different, and some payloads were included in the Global Hawk 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 unit cost, but without the units in the denominator. Stretching the program has the same effect here as it does in unit costs. While very few programs that buy integer systems have used these, we think more should consider it. This metric has the benefits of average unit cost in that a stretch can trigger an affordability breach, but it is also more closely related to affordability. A drawback to total

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[5] 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 Acquisition Program Baselines (APBs) when programs go through milestones. The PAUC and APUC are calculated each year and compared to the APB to determine if there is an N-M 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 the affordability constraint has been breached.

[6] The name ATIRCM/CMWS is a combination of two systems. One system is the Common Missile Warning System (CMWS) and the other is the Advanced Threat Infrared Countermeasure (ATIRCM).

expenditure is that programs that are successful and have their quantities increased then look unaffordable.

Another interesting consideration regarding choosing between total investments and average unit cost is in long-term plans. If the metric used is average unit cost, program offices are incentivized to show more and more units going out into the future because these units can show increased learning, thereby lowering costs, and they provide more units over which to spread development costs. 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.

O&S Metrics

As the dominant life-cycle cost of most programs, O&S costs are 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 (DoD, 2015). The problem of developing a practical methodology for estimating O&S costs for a modern, high-tech program at inception—that is, Milestone A—is larger than affordability, but the portfolio's affordability cannot be accurately estimated without estimating the O&S costs.

To accurately model future O&S costs, one must first be able to accurately determine these costs for current programs. Goeller et al. (2014), along with researchers in many other organizations, discovered that allocating O&S costs to programs is vastly more difficult than assigning 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, 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 wing.
- The actual logs of expenditures are not all centrally located, despite large efforts to implement programs such as Visibility & Management of Operation & Support Cost (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 Operation & Maintenance 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 the funds or it may fly fewer hours than is considered optimal because there were insufficient funds to support more. Actual O&S costs are, in fact, a combination of what is required and what is provided.

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

Placing a requirement on O&S costs for 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 O&S costs.

It is not clear what the O&S constraints that have been set will do, and the way they are phrased makes them quite different. Some are totals over many years, which would provide different incentives than others that are on a per-year basis, so a program could meet the constraint in some years and not in others. In any event, once the O&S costs are the dominant cost in a program, the USD(AT&L) usually has very little say over the program's future. 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. Designing systems with an eye toward lower O&S down the road is wise, but it is not at all clear what an affordability constraint can accomplish.

Limits of Affordability Analysis

Current Bow Wave

The "bow wave" has been a concern in the Pentagon since at least the Kennedy Administration, when Secretary of Defense Robert McNamara's team created the FYDP to extend planning horizons. The FYDP's "out years" are not a perfect prediction of the future, but they do enforce a level of discipline to Service programmers and ensure 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 intended 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; Gertler, 2015; Hale, 2016). In an ideal world, Affordability Analysis would make this bow wave impossible. 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 Affordability Analysis has failed, but were Affordability Analysis not in use, the bow wave might 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 deal with over time.

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 one case.

In Figure 1, 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 $835,000. 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 Milestone 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 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 25 years.

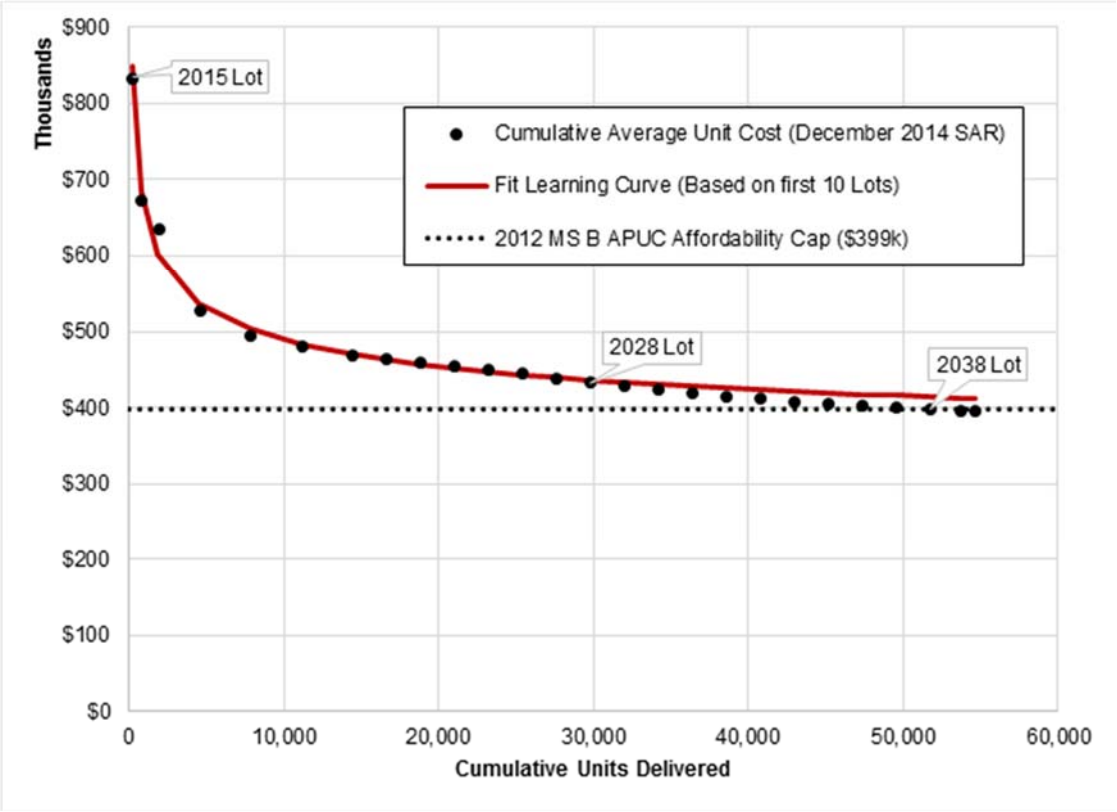

Figure 1. JLTV Costs in BY 2012 Dollars Based on the December 2014 SAR Estimate

The most recent PB submissions for JLTV show a significant decrease in cost with a new APUC of $333,000. This is probably good news for the Army and taxpayers. 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, for a while, the JLTV program office was showing some strange numbers, apparently to keep their program's costs below the cap assigned at Milestone B.

Innovation and Predictability

The first two BBP memos were about reducing spending. This is a laudable goal, but it cannot be the DoD's only one. BBP 3.0's full title includes the words *Achieving Dominant Capabilities Through Technical Excellence and Innovation*—which suggests another focus is coming back to the fore: The 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. Those estimates are 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 available. If any 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 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*, tells 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, and then there were huge cost growth and schedule slips besides.

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 they then changed their minds again. Pork barrel spending (before the term was invented)—the six ships were built in six cities, a decision Mr. Washington made, knowing that he was trading away efficiency. The ultimate result, however, was similarly awesome: warships, including the USS *Constitution*, that were the most capable the world had ever seen.

We can and will build cutting-edge equipment in the future, and, 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 40-year models.

Conclusion

Affordability Analysis is a useful but limited tool for the OSD to try to make sure the Services are planning their acquisitions far into the future. Constraints are a part of that process, and allow the USD 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 unexpected success is that this initiative has brought the Service programmers into the DABs. Several times in the life of each program, the program manager and his "eight" 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.

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[7] Also referred to as BBP 1.0
[8] Also referred to as BBP 2.0

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