

Affordable Solutions

Forging the Missing Link: Project to Portfolio



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List of Acronyms and Abbreviations

| | |
|-------|---|
| AMUC | Average Manufacturing Unit Cost |
| AoA | Analysis of Alternatives |
| APUC | Average Procurement Unit Cost |
| BBP | Better Buying Power |
| CAIV | Cost as an Independent Variable |
| CBA | Capabilities-Based Assessment |
| CDD | Capability Development Document |
| CJCS | Chairman of the Joint Chiefs of Staff |
| CJCSI | Chairman of the Joint Chiefs of Staff Instruction |
| CMC | Commandant of the Marine Corps |
| CNO | Chief of Naval Operations |
| CPA | Capability Portfolio Analysis |
| CV | Coefficient of Variation |
| DHS | Department of Homeland Security |

| | |
|----------|---|
| DoD | Department of Defense |
| DOGE | Department of Government Efficiency |
| DTC | Design-To-Cost |
| FOC | Full Operational Capability |
| ICD | Initial Capabilities Document |
| IOC | Initial Operational Capability |
| KPP | Key Performance Parameter |
| JCIDS | Joint Capabilities Integration and Development System |
| MCA | Major Capability Acquisition |
| MDA | Milestone Decision Authority |
| MDD | Materiel Development Decision |
| NATO | North Atlantic Treaty Organization |
| NDAA | National Defense Authorization Act |
| NNSA | National Nuclear Security Administration |
| PAUC | Program Acquisition Unit Cost |
| PPBE | Planning, Programming, Budgeting, and Execution (DoD) |
| PPBE | Planning, Programming, Budgeting, and Evaluation (NNSA) |
| PSPC | Public Services and Procurement Canada |
| OSD | Office of the Secretary of Defense |
| O&S | Operating and Support |
| ROM | Rough Order of Magnitude |
| TAAT | Technomics Affordability Analysis Tool |
| TMRR | Technology Maturation and Risk Reduction |
| TOC | Total Ownership Cost |
| USD(A&S) | Undersecretary of Defense(Acquisition and Sustainment) |
| VAMOSOC | Visibility and Management of Operating and Support Cost |
| WSARA | Weapon System Acquisition Reform Act |

Prelude

The gross federal debt of the United States of America has ballooned to over \$36,000,000,000,000, or thirty-six thousand billion dollars ($\$36 \times 10^{12}$). The liability equates to over a quarter of a million dollars per household. Net interest payments on the debt now exceed defense expenditures for the first time in the nation's history.¹ They've reached a staggering sum of \$3,000,000,000 a day. Absent fiscal change, the debt will inevitably squeeze defense spending. Figure 1 presents notional examples of the impact on naval and ground warfare.

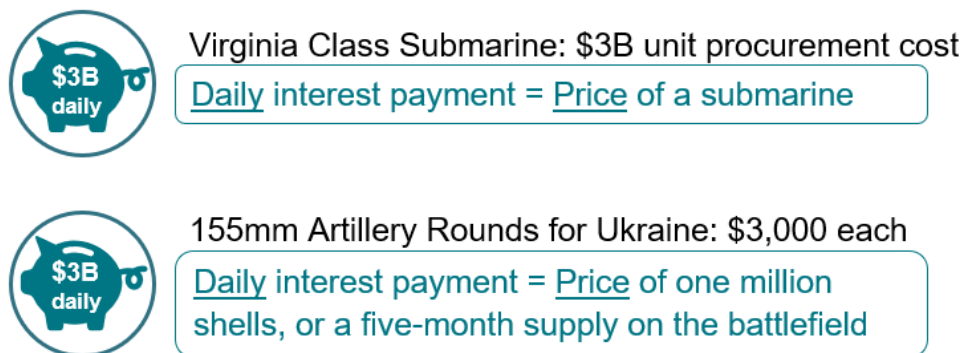


Figure 1: The Opportunity Cost of Daily Interest Payments

The opportunity cost of the daily interest payment equates in the long run to lost defense capability such as force protection and projection, command and control, and logistics. For Ukraine, facing a severe shortage of 155mm rounds, the impact is less abstract – the loss of human life.²

As former Secretaries of State, Defense, Treasury, and Homeland Security have recently signaled, the unsustainable debt represents

“... the single greatest threat to our national security.”³

¹ Roughly \$1T per year for interest payments versus \$0.8T for DoD (the FY2025 President's Budget).

² Ukraine fired 10,000 rounds per day during peak availability of the ammunition. Today Ukraine fires only 2,000 rounds daily to conserve ammunition. An objective steady-state rate is roughly 6K to 8K rounds. Taking an average of 7K rounds per day yields a 4.76 months' supply for \$3B.

³ Peter G. Peterson Foundation's "Coalition for Fiscal and National Security," as cited by The Cato Institute, 27 July 2023.

As these distinguished leaders recognize, economic might drives military power.⁴ Admiral Mullen, former Chairman of the Joint Chiefs of Staff, echoes the warning. The debt, if unchecked, will inevitably slow economic growth, reduce income levels, and harm our national security posture. It will "... constrain funding for a strong military and effective diplomacy."⁵

The financial projections are scary. Debt as a percent of Gross Domestic Product (GDP) will soon reach and then surpass the peak value of World War II, as Figure 2 shows, placing our nation even deeper in hock.⁶ Indeed, Congress appears likely to lift the nation's debt ceiling to \$40T from today's \$36T to accommodate the growth.⁷

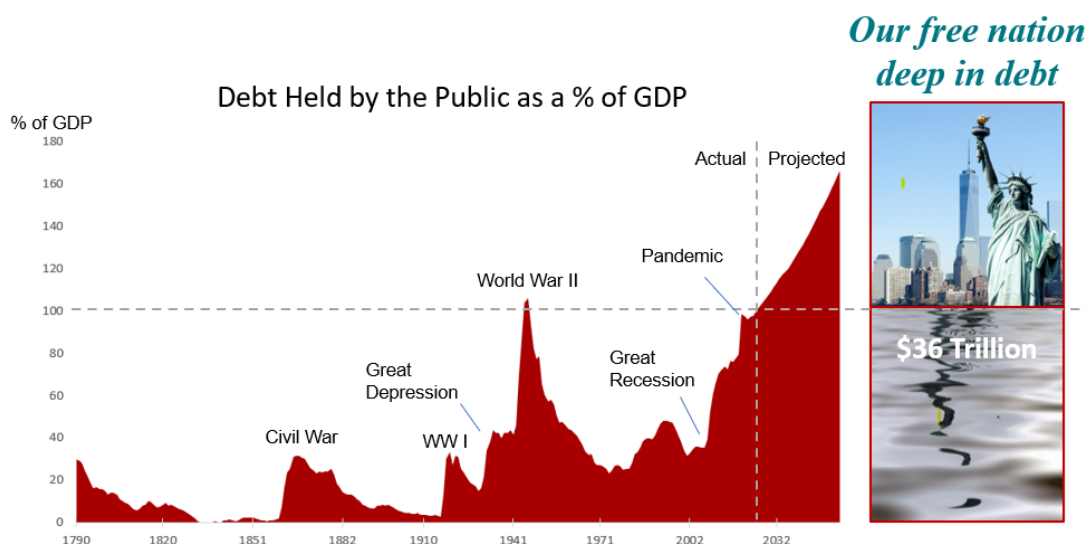


Figure 2: Debt as a Percent of GDP

Given this grim fiscal outlook, coupled with the presidential imperative of DOGE (Department of Government Efficiency), there's a clarion call for *affordable solutions* in the national security domain. Not that the U.S. Congress and the Department of Defense haven't tried before to achieve this elusive goal in defense planning, acquisition, and resourcing. Efforts date back at least to the 1970's with Packard Commission.⁸ They were followed by concepts such as Design-to-Cost (DTC) and Cost-as-an-Independent Variable (CAIV). On the policy side, recent initiatives include

⁴ The might of the U.S. defense industrial base was instrumental in defeating Germany, Japan, and Italy in World War II, delivering production numbers that awe to this day.

⁵ The Peterson Foundation.

⁶ Underlying numerical values on GDP and national debt are from the Congressional Budget Office (CBO).

⁷ The debt ceiling stands at \$36.1T at the time of this writing.

⁸ The Packard Commission (named after its chairman, David Packard, co-founder of Hewlett-Packard), was established by President Ronald Reagan in 1985 to improve the efficiency of the DoD.

the Weapon System Acquisition Reform Act (WSARA) of 2009; Better Buying Power (BBP 1.0, 2.0, and 3.0); the adaptive acquisition framework; and Planning, Programming, Budgeting, and Execution (PPBE) Reform of 2024.⁹

None of the initiatives so far has achieved the success hoped for. Too often the concept of affordability postulated in the initiatives has morphed into a simplistic assessment of the availability of current and near-term appropriated funds.

But there's a better way.

Technomics' ground-breaking Affordability Analysis Tool fills the gap between aspiration and reality. It provides an analytical paradigm that emphasizes project risk and opportunity costs in the portfolio – to better illuminate issues of affordability. It's the right innovation at the right time as the nation's debt piles higher, placing in jeopardy our national security and that of our allies.

⁹ Final report of the PPBE Reform Commission, chaired by Mr. Robert Hale, was issued in March 2024. It's available at <https://ppbereform.senate.gov/finalreport/>.

Abstract

Nobody but nobody wants unaffordable solutions. Yet all too often projects are initiated that can't be paid for. This leads to cost and schedule growth, program cancellations, or fielding a capability without the resources to sustain it.

Affordability analysis, holistically executed, ensures that the cost of a project syncs with long-range modernization, force structure, and manpower plans, given resource constraints.

In common practice, however, affordability analysis frequently devolves into an assessment of funding needs over a five-year horizon. This myopic perspective short-changes decision makers by failing to deliver pricing options and portfolio impacts.

This research presents an innovative alternative, the Technomics Affordability Analysis Tool (TAAT). Integrating life-cycle cost estimates, assessments of risk, and evaluation of resource availability, it offers leadership a menu of options for pricing the current program of record and for adjusting all other projects in the portfolio. TAAT presents a 360-degree view of decision space – dollars, risk, and “*project punch*,” with the latter a newly minted metric of capability and capacity (a geometric mean of scaled values) that supports the imperative to get technology into production at scale. As Dr. Bill LaPlante (former USD(Acquisition and Sustainment)) stresses, “production is deterrence.”

Additionally, the framework supports the establishment of cost constraints (goals and caps) on projects, in accordance with regulation and law. S-Curves are generated based on user inputs of CVs (coefficients of variation) or on Technomics' extensive library of benchmark values derived from actual acquisition results. Leadership then chooses where on the risk curve to price the program, and where to establish unit cost as a threshold value (a minimum for affordability) or as an objective value (a should-cost target).

Importantly, Technomics' CV benchmarks support cost realism. Too often optimism bias prevails early on. The CVs can be used as primary inputs or as invaluable cross checks.

Finally, Technomics' innovative research provides a governance framework for implementing and executing affordability analysis, or the *who*, *what*, *when*, and *how*, to include timelines of activities, deliverables, providers of information, and stakeholder involvement. While built for the U.S. DoD, the framework has been successfully mapped to acquisition processes in several other federal departments and agencies, and to defense departments in Australia and Canada.

The bottom line? Sharpened illumination of trade space, improved program pricing, better understanding of risk, and stronger alignment of projects with strategy.

Introduction

Definition

Affordability analysis addresses the degree to which the life-cycle cost of a program or project accords with long-range modernization, force structure, and manpower plans of a component or departmental-level organization,¹⁰ given resource constraints. A life-cycle perspective is essential since operating and sustainment costs can exceed acquisition costs three to one.¹¹

Differentiation

Affordability analysis differs from an Analysis of Alternatives (AoA) and Capability Portfolio Analysis (CPA). An AoA compares the operational effectiveness, suitability, and lifecycle costs of a set of alternatives (materiel solutions) to satisfy a gap in capability.¹² The AoA should include an assessment of the affordability of each of the options.

Portfolio analysis, on the other hand, is much broader in scope. It seeks to balance the risk, capacity (procurement quantities), life-cycle cost, interoperability, sustainability, and affordability of a set of programs in a warfighting domain for delivery as an *integrated suite* of mission-effective *capability*.

Affordability, then, is an essential consideration in both the AoA and CPA.

Operational Tenets

A focus on affordability drives performance and cost trades, constraints gold-plating, and helps ensure that unaffordable programs do not enter the acquisition process.

An affordable program

- Syncs with strategy
- Addresses opportunity cost
- Reduces risk in the portfolio

¹⁰ An enterprise perspective is crucial. Examples of component organizations are NA-10 (Defense Programs) within the National Nuclear Security Administration (NNSA) and the Department of the Navy (DON) within the DoD. Programs should be affordable at both the component and ultimately the departmental levels.

¹¹ The ratio depends upon the type of platform, its mission, service life, and operational tempo. "O&S costs can reach as high as 60 to 80 percent of the life cycle costs of a weapon system," [Defense AT&L: Product Support Issue](#), March–April 2012.

¹² As Dr. Todd Calhoun notes, "The real purpose of an AoA is to validate requirements." Technomics' conversation with Dr. Calhoun, then Director, Program Analysis and Evaluation, HQ USMC.

- Fits within the topline.

Projects should be on-strategy, or in alignment with the long-term goals of an organization. Not all are, such as the Navy's Littoral Combat Ship.¹³ Further, they need to address the opportunity cost of the investment within a portfolio. An all-too-common tendency is the pursuit of "exquisite requirements"¹⁴ for a weapon system acquisition program which then leads to budget shortfalls elsewhere in a warfighting domain, jeopardizing delivery of needed capability. *Zumwalt Class* destroyers are a good example (\$8B unit cost with "crazy"¹⁵ requirements). Finally, an affordable project needs to fit within a portfolio's funding topline over the long term, not just within a five-year window.¹⁶

Collectively, the tenets of affordability support enhanced resource optimization and risk management.

Requirement

Law and regulation jointly establish the requirement for affordability analysis.

Policy emanates from the Office of the Secretary of Defense (OSD), the Chairman of the Joint Chiefs of Staff (CJCS),¹⁷ and from the Services. Department of Defense (DoD) instruction requires that acquisition programs "Prioritize product support and affordability."¹⁸ The requirement holds for all acquisition pathways, with phases and decision points within the Major Capability Acquisition (MCA) pathway depicted in Figure 3.

¹³ LCS lacked self-defense in the littoral and the concept of mission modules proved problematic. "Those requirements for that ASW [Anti-Submarine Warfare] package for LCS were developed back in 2008 against a diesel [submarine] threat in the littorals. And then our minds shifted to we'll be using these things in the deep blue ocean. LCS is as noisy as an aircraft carrier and so there are some big challenges there that we should have pick up on way earlier." [Admiral Gilday, then Chief of Naval Operations, 2022].

¹⁴ "We will pursue greater quantities of systems that represent the '75 percent' solution instead of smaller quantities of '99 percent,' exquisite systems." [Then Secretary of Defense Robert Gates. Remarks to the Senate Armed Services Committee, 2009].

¹⁵ *Journal of Cost Analysis and Parametrics*: Volume 12 | Issue 1 | February 2025, "Innovative Risk-Driven Contract Pricing Strategy," Technomics, page 19. Additionally, ICEAA 2023, p. 24 of slide deck.

¹⁶ Examples of the five-year window are DoD's Future Years Defense Program (FYDP) and the Future-Years Nuclear Security Program (FYNSP) of the National Nuclear Security Administration (NNSA).

¹⁷ CJCSI 5123.011, "Charter of the JROC and Implementation of JCIDS," 30 Oct 2021.

¹⁸ DOD INSTRUCTION 5000.02, "Operation of the Adaptive Acquisition Framework," Office of the Under Secretary of Defense for Acquisition and Sustainment, 2022, page 11.

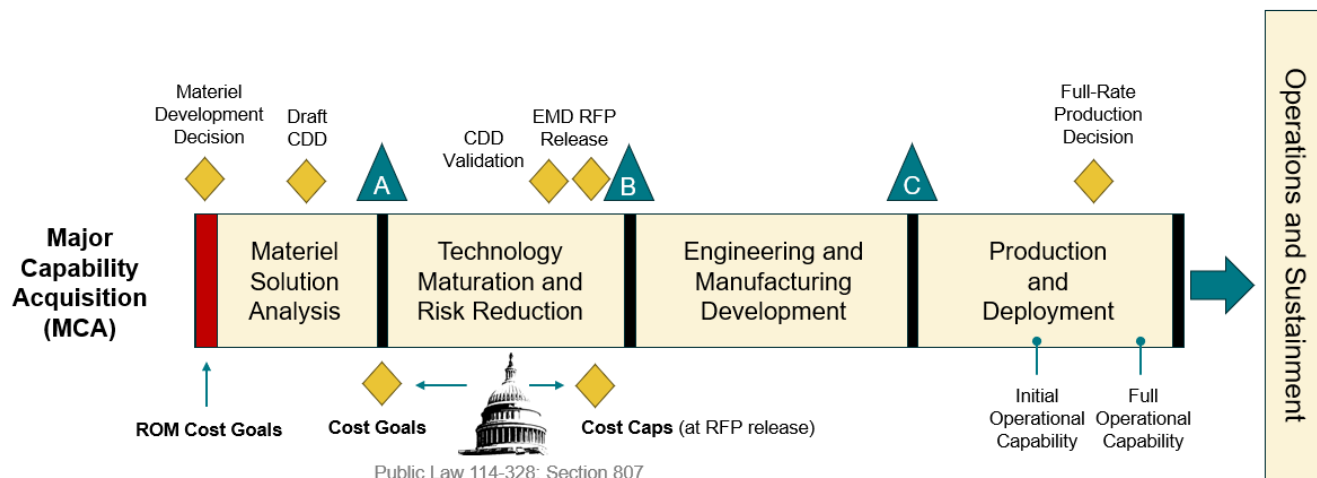


Figure 3: Cost Goals and Caps within the MCA Pathway

Preceding the Materiel Development Decision (MDD), the Chairman of the Joint Chiefs of Staff (CJCS) recommends the execution of a ROM affordability analysis as part of a Capability-Based Assessment (CBA) of prospective materiel solutions to fill gaps in warfighter need.¹⁹ The CBA leads to the establishment of ROM cost goals at the MDD.²⁰

Continuing into Materiel Solution Analysis, the requirements community owns the Capability Development Document, with a draft CDD a byproduct of the Analysis of Alternatives (AoA). The ROM cost goals established earlier become formal cost goals at Milestone A.

CJCS sets stringent requirements for affordability analysis in the CDD for application throughout acquisition and sustainment. As Figure 4 shows, the guidance encompasses a holistic view of affordability to include: an assessment of the availability of outyear funding; the potential need for portfolio tradeoffs; the importance of life-cycle cost estimates; and the application of cost risk and uncertainty analysis.²¹

¹⁹ Manual for the Operation of the Joint Capabilities Integration and Development System; 31 August 2018, pages BC-16 to BC-18.

²⁰ The goals are expressed as ranges or bands to support early affordability assessments. AF/A5/7 CAPABILITY DEVELOPMENT GUIDEBOOK, Volume 2C, September 2023.

²¹ Ibid. DoDI 5000.73, referenced by the Joint Staff, requires the Services to generate a Component Cost Position, informed by an independent cost-analysis organization. In many cases, such as for ACAT ID programs, the OSD CAPE (Cost Assessment and Program Evaluation) generates an ICE.

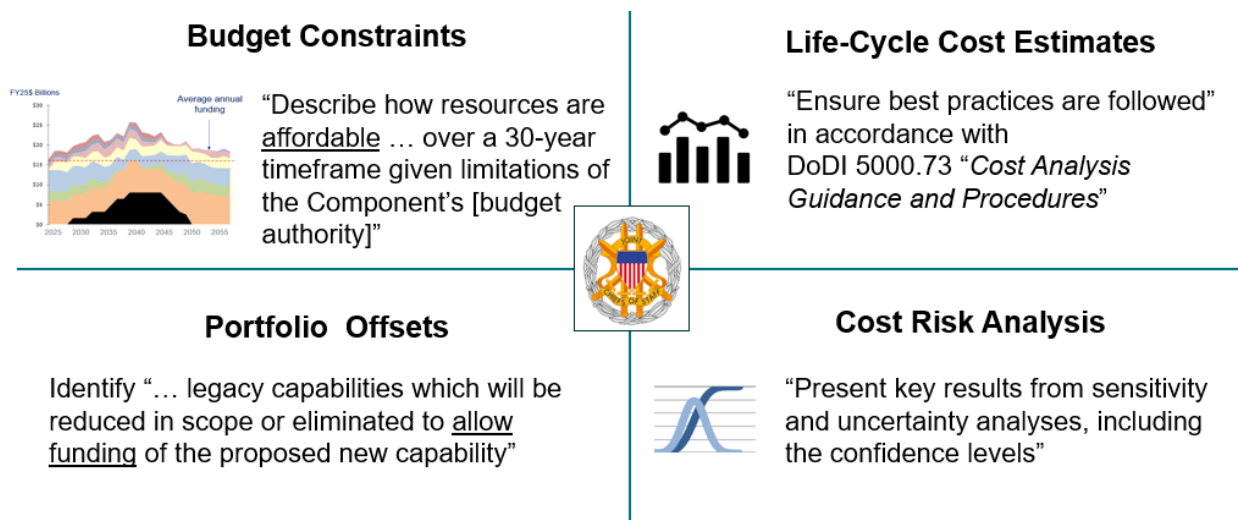


Figure 4: Requirements from JCIDS

Cost Constraints

Public law establishes the bedrock requirement for the affordability cost constraints, or the goals and caps. Programs must “be affordable” and they shall set affordable targets in terms

“... the procurement [average] unit cost [PAUC] & sustainment cost.”²²

Coverage, then, extends over the life-cycle – not just acquisition. Not wanting to play second-fiddle to the DoD, the Congress not only *specifies* which metrics to use, but *defines* them, too!²³

That said, the law and DoD allow some flexibility in practical implementations of the requirement. Unit cost might be defined in terms of acquisition program unit cost (APUC), lead-ship or follow-ship end cost, unit-recurring flyaway for procurement, or average manufacturing unit cost (AMUC). Sustainment might be defined in terms of average yearly O&S cost or the cost per operating hour.

²² Public Law 114-328 Section 807, as implemented in 10 USC 4271. The law applies to Major Defense Acquisition Programs. The Services have expanded the requirement to cover additional ACAT (Acquisition Category) levels.

²³ Ibid. Section 2432(a)(2). To wit: “The term “procurement unit cost,” with respect to a major defense acquisition program, means the amount equal to (A) the total of all funds programmed to be available for obligation for procurement for the program, divided by (B) the number of fully-configured end items to be procured.”

The goals can be set as a threshold and objective values.²⁴ A threshold unit cost is considered an *acceptable* affordability target, achievable at low-to-moderate risk. Ideally, the threshold value is a ceiling, above which cost should not rise. An objective unit cost, lower than the threshold, is potentially *achievable* as a should-cost target, but with additional risk and investment, with the program manager working in tandem with the contractor.

Moving beyond goals, a cap is an affordability cost typically set at a point beyond which the decision calculus regarding the materiel or capability solution needs to be revisited. Tradeoffs must be considered in applying a cap to an individual program. Setting the cap entails an analysis of this key issue:

At what point does the cost of a new or enhanced capability become so high that portfolio leadership would rather cancel the program, significantly reduce quantity or operational capability, or cut back other programs in the portfolio rather than continue?

The cost caps are treated as Key Performance Parameters (KPPs) in terms of importance.²⁵ In theory they are binding.²⁶

Tailored Guidance

The Services provide additional guidance. The DON, for example, requires affordability analysis at *each* of eleven gate reviews, depicted in Figure 5.²⁷ The reviews require the resource sponsor, program manager, and Program Executive Officer (PEO) to “report on a program’s progress towards achieving applicable KPPs,” including the affordability cost targets.

²⁴ The Chief of Naval Operations (CNO) requires Navy acquisition programs for “platforms , payloads , and systems” to establish KKP threshold and objective values for both cost and schedule. These acquisitions shall “Establish an objective value for unit cost at least 5% below a threshold value.” CNO Memo of 2013, “Mandatory Navy Key Performance Parameters for Cost, Schedule, and Space , Weight , Power, and Cooling Margins.”

²⁵ “Implementation Directive for Better Buying Power - Obtaining Greater Efficiency and Productivity in Defense Spending,” The Undersecretary of Defense for Acquisition, Technology and Logistics (USD AT&L), 3 November 2010.

²⁶ Congress set an affordable cost cap for CVN-79, *USS Kennedy*, at \$11.4B then-year dollars. The ship was delivered incomplete at the cap in accordance with the congressional mandate. But costs didn’t end at that point. Work continued *after* delivery. The current cost estimate for CVN-79 is \$13.9B, or \$2.5B over the so-called “binding” cap.

²⁷ Either the Chief of Naval Operations (CNO) or the Commandant of the Marine Corps(CMC) chairs the requirements gates (blue), depending upon which Service is the lead. The Assistant Secretary of the Navy(Research, Development, and Acquisition) chairs the acquisition gates (yellow).

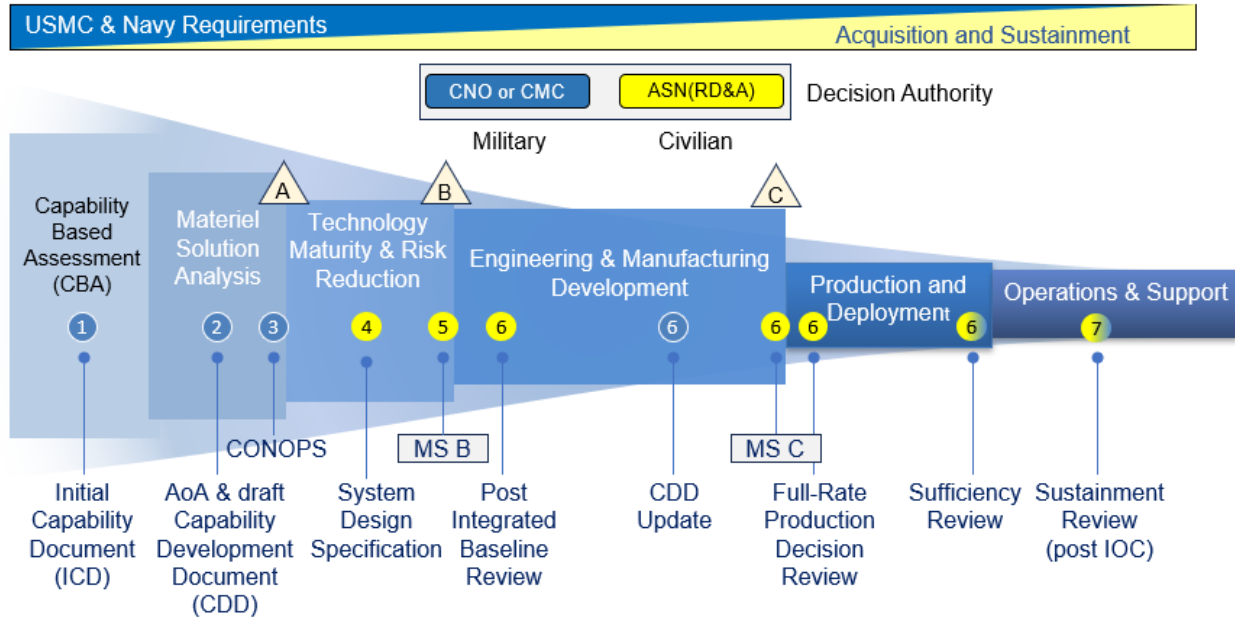


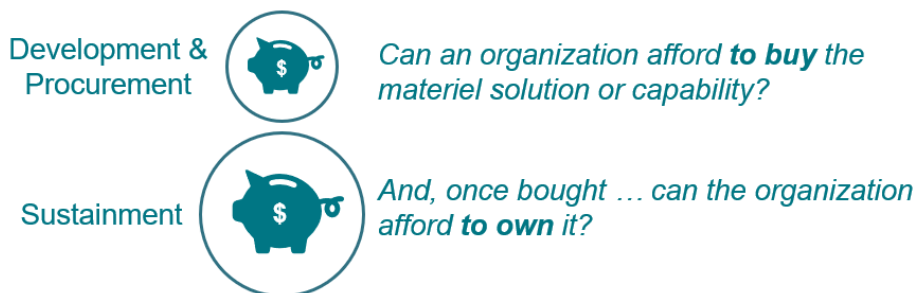
Figure 5: DON Requirement for Affordability Analysis

Gap

Challenge

The pattern repeats itself all too often in defense acquisition – marginally affordable development followed by costly production followed by even more costly sustainment – with a bow wave of outyear funding shortfalls.

To get effective and sustainable capability into the hands of the user, a Total Ownership Cost (TOC) perspective is fundamental:²⁸



But analytical challenges arise from the get-go. During the AoA and into Technology Maturation and Risk Reduction (TMRR) and then into Engineering and Manufacturing Development (EMD), requirements remain opaque with program baselines only roughly defined. Cost risk and uncertainty are at a peak. But early-on is *exactly* when affordability analysis matters *most*. 70% of TOC is determined by Milestone A while only 5% of the money is expended.²⁹ By Milestone B, the figures are 80% and 10%.

The challenge, then, is to execute better affordability assessments (especially early-on) to avoid issues downrange. Incorporating TOC into the picture sharpens the odds of successful outcomes.³⁰

²⁸ According to the Defense Acquisition Guidebook (DAG), “total ownership cost includes the elements of a program’s life-cycle cost as well as other related infrastructure or business processes costs not necessarily attributed to the program in the context of the defense acquisition system.” That said, the Department of Navy treats TOC as equivalent to life-cycle cost.

²⁹ Department of the Navy [Total Ownership Cost \(TOC\) Guidebook](#), OPNAV N4.

³⁰ Beyond the basics, a mega affordability challenge emerges: cross-portfolio and cross-component analysis. Here’s an example. Arguably the most important acquisition program in the United States today is Columbia Class submarines, the hardest-to-kill leg of the nation’s strategic triad. As former DoD acquisition czar and recent Secretary of the Air Force Frank Kendall asks, “Can DoD and DOE *together* afford Columbia Class?” DoD funds submarine design, build, and sustainment. This includes funding the Trident II D5 Intercontinental Ballistic Missile (ICBM) Life Extension Program (LEP), an ACAT IC effort in and of itself. The National Nuclear Security Administration (NNSA), a component of the Department of Energy (DOE), funds the design, build, and maintenance of the W93 nuclear warhead for missile. To date, the authors are unaware of any holistic affordability analysis of the joint capability.

Track Record

As Mr. Frank Kendall, former Secretary of the Air Force, notes:

“We have a tendency ... to have started too many projects we can’t afford. We need to be more focused and more disciplined about starting things that we really do intend to take into production.”³¹

Cost growth compounds the problem. Too often acquisition programs cost far more than anticipated – undermining the foundations of any previous assessments of affordability. Joint Strike Fighter (JSF) is a classical example, with 70% cost growth (\$170B in TY\$) from the original program baseline.³²

Program cancellations punctuate the failures. They yield negative ROIs and jeopardize the affordability of other projects in a portfolio. Future Combat System (FCS), to take an egregious example, was the largest and most ambitious acquisition program in the Army’s history. The program imploded at the cost of \$18B.³³

Dr. Mark Husband of the Defense Acquisition University (DAU) summarizes the acquisition scorecard

“... the DoD has rightly been criticized for spending as much as 40 percent of its acquisition funding on programs that were terminated before delivering capability.”³⁴

That’s 40% in lost dollars that could have supported the affordability of other projects.

The sustainment challenge is arguably stiffer. O&S costs for acquisition programs are more difficult to estimate with accuracy than investment costs, and the process for effective implementation of affordability caps for O&S costs are immature.

DoD’s O&S bow wave is unsupportable given projected resources. For example, the U.S. Navy struggles to maintain its fleet of attack submarines and strategic boomers. The estimated sustainment cost of F-35 has recently increased from roughly one trillion then-year dollars to over \$1.5 trillion.³⁵ And, at the tactical level, ammunition for the Advanced Gun System (AGS) on *Zumwalt Class* destroyers is too expensive to shoot!³⁶

³¹ [Space News](#), November 13, 2023, Interview with Mr. Kendall.

³² Cost growth for U.S. Major Defense Acquisition Programs (MDAPs) is the *norm* across all war fighting domains, with additional problems of schedule slippage and technical deficiencies all too common. For example, average cost growth for U.S. Navy and U.S. Marine Corps aircraft, missile, ground combat vehicle, ship, satellite, and electronics programs is 36%, measured from the point of development, in then-year dollars. The corresponding figure in constant dollars is 21%.

³³ Conversation with Dr. Rick Burke, former Director, Cost Assessment, OSD CAPE, during the Department of Defense Cost Analysis Symposium (DODCAS), 12 Dec 2024.

³⁴ Dr. Mark Husband and Mr. Keith Kaspersen, “The AoA: An Early Filter to Create an Affordable Program,” [Defense AT&L](#), May-June 2012.

³⁵ “F-35 Sustainment: Costs Continue to Rise While Planned Use and Availability Have Decreased,” Government Accountability Office, 15 April 2024.

³⁶ O&S WBS element 2.2, “Munitions.” The cost of *each* round is \$800,000. The Navy is removing the AGS from its destroyers.

Shortfall in Execution

Even though acquisition affordability has long been a concern for the Pentagon and the Congress, the Department still lacks a coherent, disciplined process for assessments. As a Navy Resource Sponsor suggests, “We’re in the Wild, Wild West when it comes to performing affordability analysis and setting affordability constraints – no framework and no guidance.”³⁷ Figure 6 shows the gaps in execution.

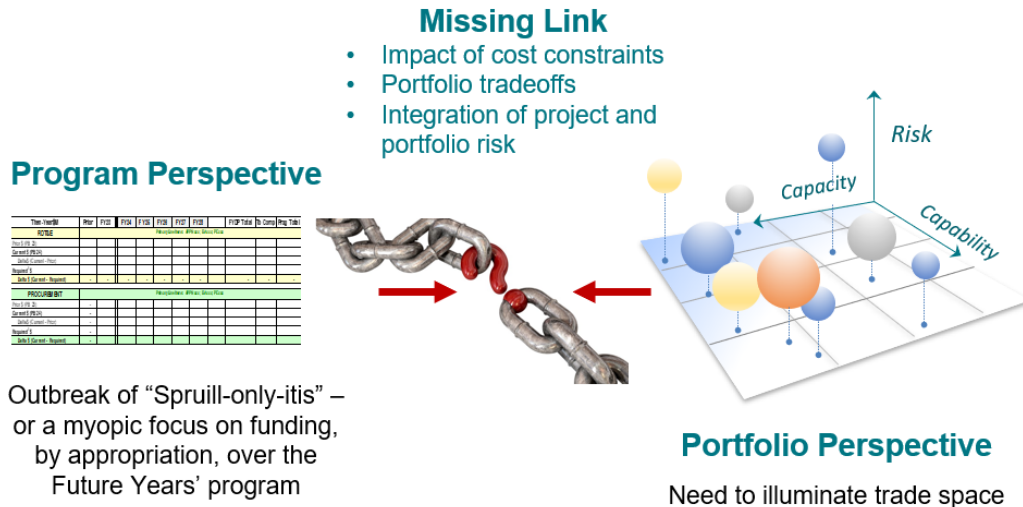


Figure 6: The Missing Link

A review of a dozen recent affordability analyses in several federal government components reveals a major disconnect between project and portfolio. Linkage between the two is superficial at best, with project funding presented as an element within a sand chart of portfolio funding. Absent is risk analysis at both the project and portfolio levels which would provide decision makers with a menu of choices for setting cost constraints and for making tradeoffs in the portfolio.

Further, in some instances the affordability analysis focuses only on funding within the project, as typically seen in a Spruill Chart.³⁸

Figure 7 presents a near worse-case,³⁹ or a truncated version of the Dr. Spruill’s innovation. Unbelievably, the truncation ignores acquisition costs outside of the five-year window, operating and support costs, and impact on the portfolio. Further, it omits

³⁷ Conversation with Dr. Flynn.

³⁸ Developed by Dr. Nancy Spruill, former Director, Acquisition Resource Analysis (ARA), USD(AT&L).

³⁹ The absolutely worse-case is failure to perform any affordability analysis at all, as evidenced in two major AoAs reviewed by the authors.

quantity streams, unit costs, and current versus original estimates – all standard elements of a Spruill Chart.

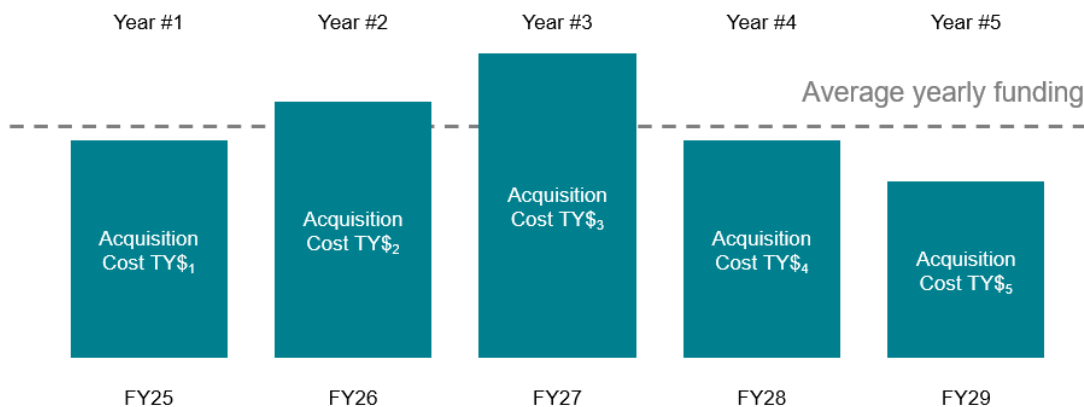


Figure 7: Truncated Spruill Chart

The analysis concludes with the contention that a program is affordable if there's enough money planned for it in a five-year window, as equation (1) shows.

$$(1) \text{ If the funding total } \geq \sum_{i=1}^5 \text{ acquisition}_i, \text{ then the project is affordable.}$$

This myopic fit-within-the-five-year-plan mentality supports *only* near-term programming and budgeting for a program *viewed in isolation*. By omitting the forementioned tenets of affordability established by law and regulation, it leads to a suboptimal allocation of scarce resources.

Solution

Overview

The Technomics' Affordability Analysis Tool (TAAT) provides the missing link between project and portfolio. Through the integration of life-cycle costs, assessments of risk, and evaluation of resource availability, the tool provides leadership with a menu of affordability cost constraints (goals and caps) and potential offsets in the portfolio, as Figure 8 shows.

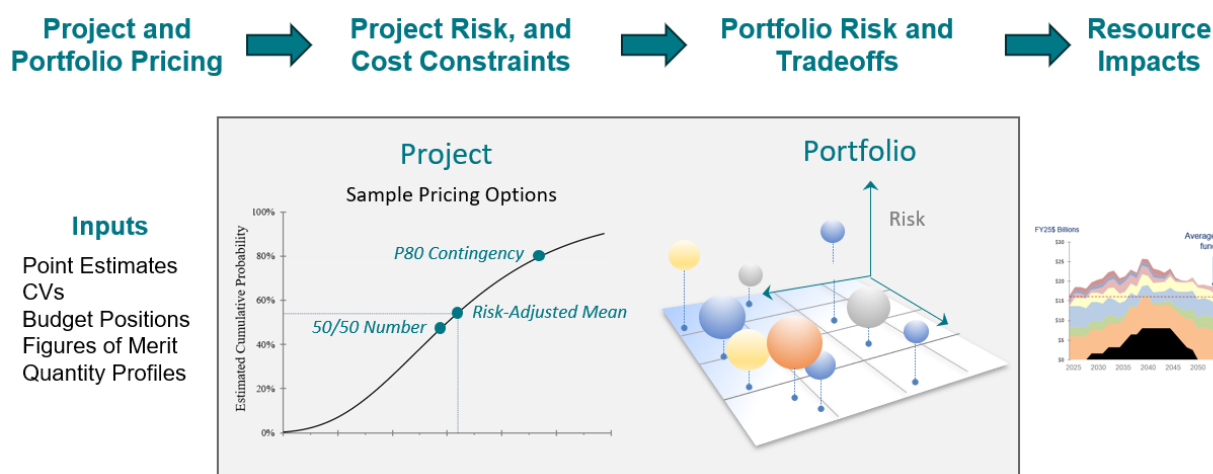


Figure 8: Framework for Technomics' Affordability Analysis Tool

Portfolio offsets are enabled through adjustments to budget risk and/or project punch. The latter, a newly devised metric from the authors, assesses the importance of achieving capacity (quantity) objectives.⁴⁰

Building blocks of the model are

- Coefficients of Variation (CVs)
- S-Curves
- Portfolio Impacts.

Each is presented in detail below.

⁴⁰ In DoD, capacity is often expressed as an Authorized Acquisition Objective (AAO).

Coefficients of Variation

A coefficient of variation (CV) is the ratio of a probability distribution's standard deviation to its mean, as equation (2) shows.

$$(2) CV = \frac{\sigma}{\mu}$$

CVs, sometimes called noise-to-signal ratios in the literature, are independent of the scale of measurement, and enable comparisons of the dispersions of two or more distributions of cost, as Figure 9 shows.

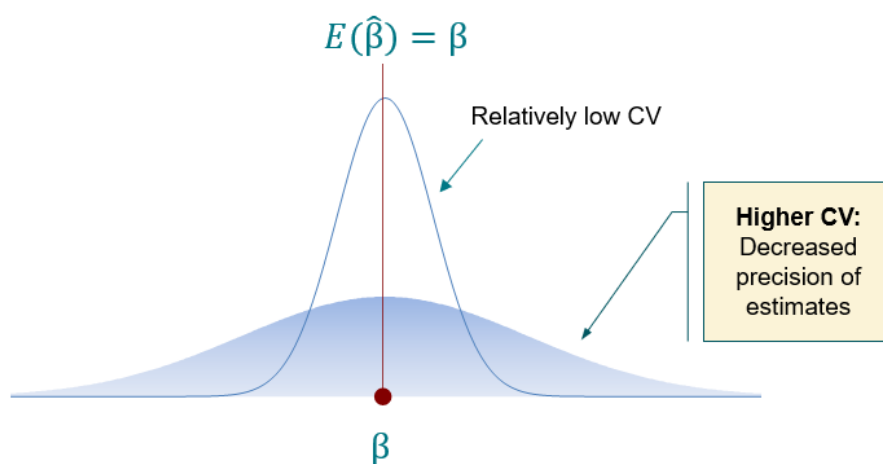
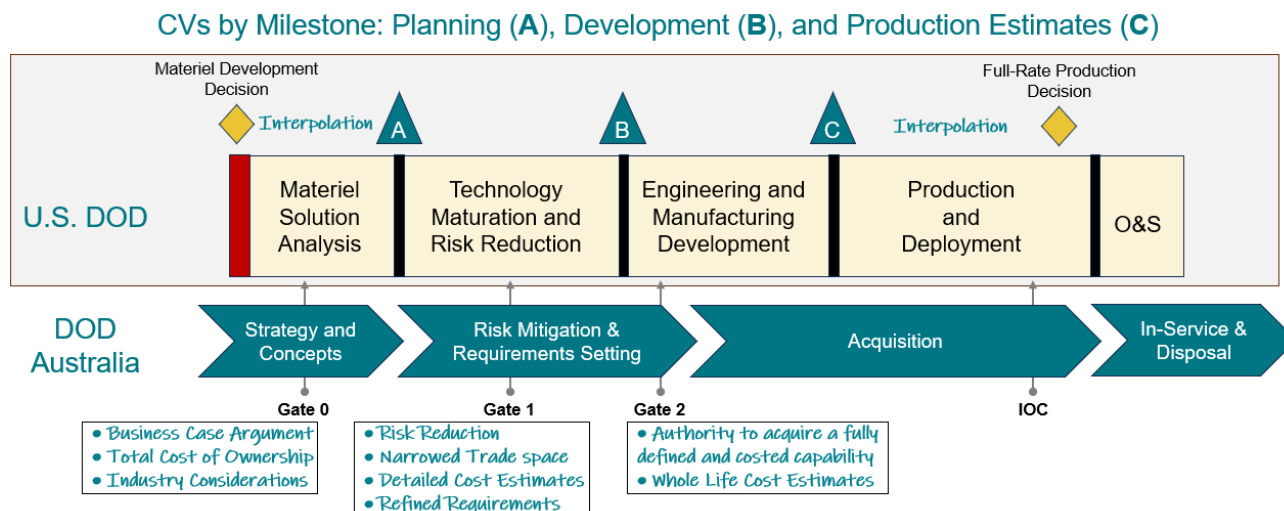


Figure 9: Comparison of CVs

Both distributions are normal. Both have identical means. But they have very different variances, and hence CVs. Sampling from the relatively tall and narrow distribution yields more precise estimates than sampling from the flatter distribution. One is riskier than the other. CVs, then, are best interpreted in relationship to other CVs or to benchmark values.

TAAT leverages Technomics' library of CVs for DoD's acquisition milestones, with mappings available for other organizations such as DoD Australia, as Figure 10 shows.⁴¹ The CVs can be used as primary inputs in TAAT or as invaluable cross checks.

⁴¹ Mappings are available for the National Nuclear Security Administration (NNSA), the Department of Homeland Security (DHS), Public Services and Procurement Canada (PSPC), the Department of National Defence (DND) Canada, and for a notional acquisition framework.



The benchmark CVs, based on actual acquisition results, decrease in magnitude as programs progress from requirements into development and ultimately production. Further, Technomics’ library presents CVs in both constant and then-years dollars, and with and without adjustments for changes in quantity.

S-Curves

The numerator and denominator of the CV, in turn, enable the generation of cumulative probability distributions of costs, or S-curves, for both normally and lognormally distributed variables, commonly used in defense cost analysis.⁴²

Importantly, the S-curves address *probabilistically* a decision maker’s fundamental issue in setting a budget: “*How much will it cost?*” The query, of course, is impossible to answer precisely. Estimates are inherently uncertain. Use of a single number reflects a degree of precision that doesn’t exist.

Instead, use of probability distributions provides leadership with a quantitative basis for establishing the degree of risk when choosing a value for the budget, such as:

- Low budget (e.g., at the 20th percentile) = high probability of overrun
- High budget (e.g., at the 80th percentile) = low probability of overrun.

Finally, as Figure 11 shows, not all S-curves are created equally. Too often optimism bias prevails throughout acquisition and into sustainment, as witnessed by the low CV from the program office (5%). In the authors’ experience, a value this low this early-on

⁴² Both distributions are defined by two parameters, mean and variance.

is insufficient to cover the uncertainty of escalation, let alone other factors present during an Analysis of Alternatives.⁴³

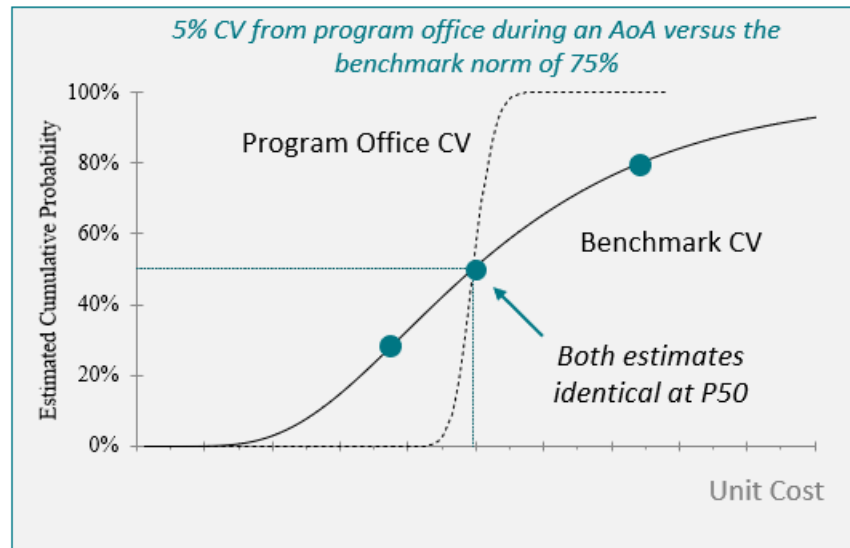


Figure 11: Dueling CVs and S-Curves

The S-curves have high information value to decision makers in setting values of affordability goals and caps. They illuminate the range of possible cost outcomes and their probabilities of occurrence. As Figure 12 shows, unit cost goals might be set at a risk-adjusted mean for the threshold value and at P50 for an objective value. A cap might be set at P80. It's up to the decision maker to decide where to price the program.

To recap, the importance of presenting accurate S-curves is difficult to overstate. Too often they fail to fully address the range of risk and uncertainty of a project.⁴⁴ That's why Technomics' library of CVs is such a crucial building block of TAAT.

⁴³ The 5% value is an actual from a program office estimate for a pre-MDAP, witnessed by Dr. Flynn. Escalation typically contributes as much as eight percentage points of an overall CV.

⁴⁴ "Enhanced Scenario-Based Method for Cost Risk Analysis: Theory, Application, and Implementation," *Journal of Cost Analysis and Parametrics*, Dr. Paul R. Garvey, Dr. Brian Flynn, Mr. Peter Braxton, and Mr. Richard Lee.

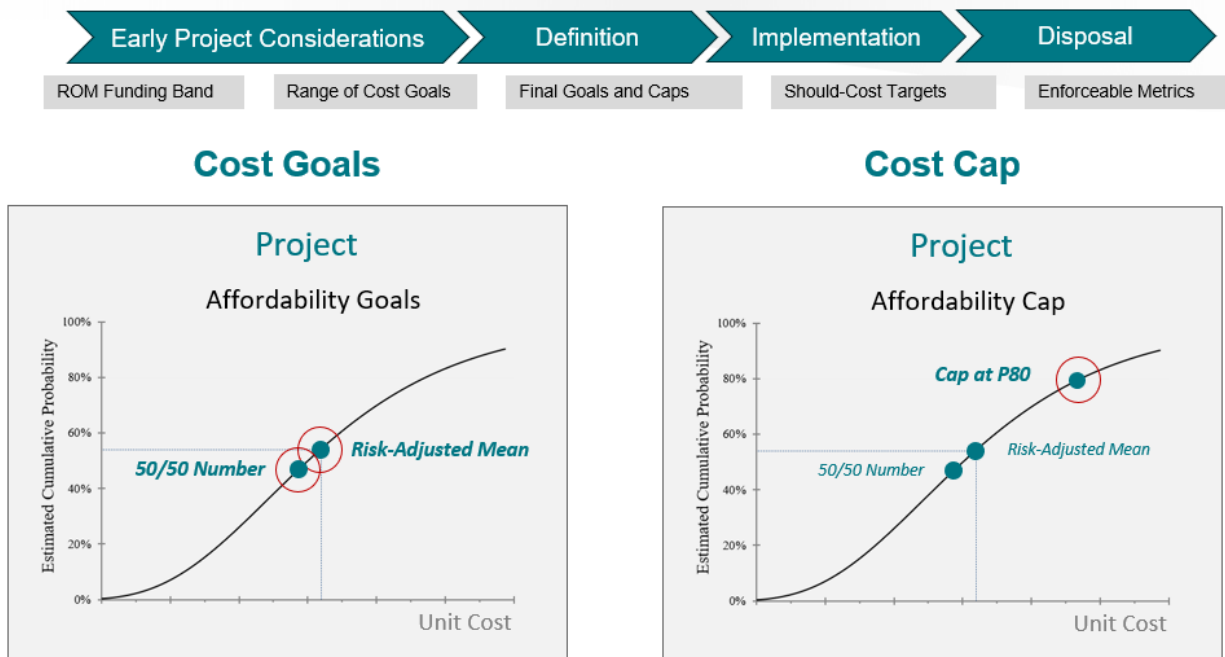


Figure 12: Affordability Cost Constraints

Portfolio Impact

Statute and regulation require that affordability analysis address impacts on the portfolio and potential offsets, as previously mentioned.

Figure 13 presents a notional framework for capability portfolio analysis, leveraging extensive experience by one of the authors in directing a pilot program for the U.S. Department of the Navy and establishing best practices in NATO.⁴⁵

⁴⁵ NATO Systems Analysis and Studies Panel (Task Group SAS-076). With Dr. Flynn as Study Director, SAS-076 sponsored an international conference on defense capability portfolio analysis at École Militaire, Paris, France, with 19 presentations in two days by leading experts from over a dozen countries. SAS-076 identified commonalities and differences in approaches and recommended a set of best practices to guide current efforts in defense planning.

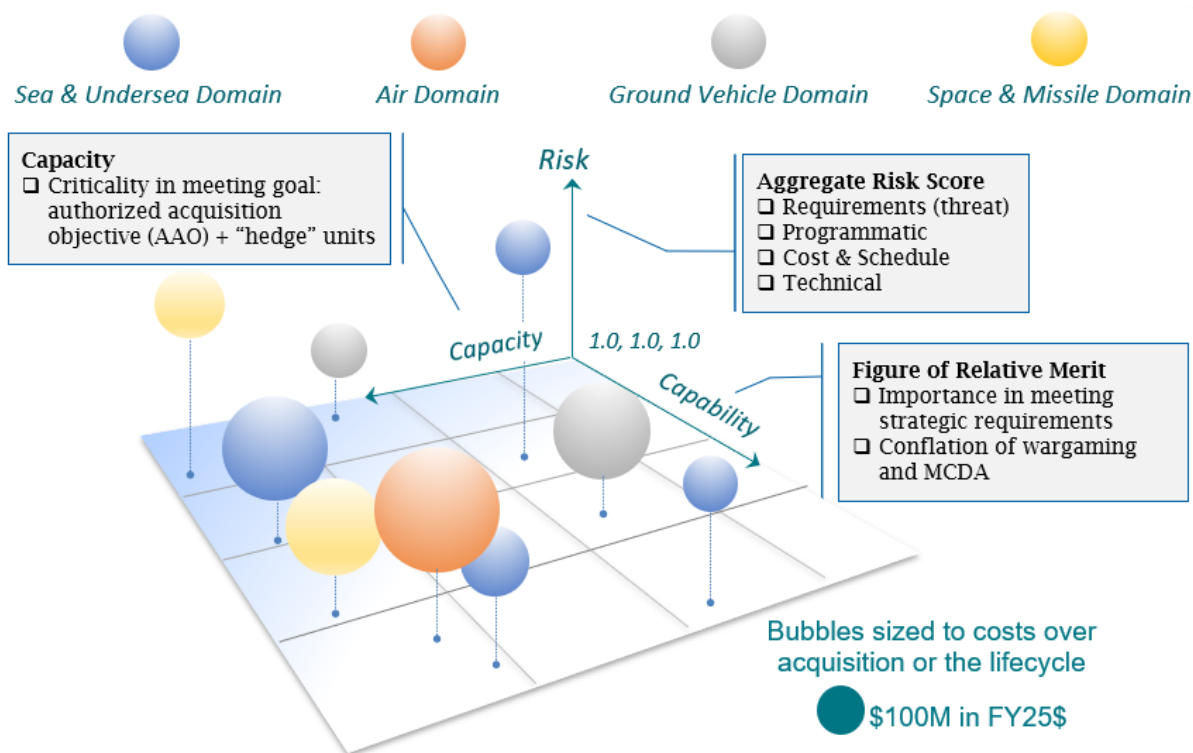


Figure 13: A Portfolio Perspective

Key dimensions of the portfolio are

- Acquisition or life-cycle costs, denoted by bubble size
- Capability, or the ability to achieve a desired outcome in a specific operating environment⁴⁶
- Project risk, spanning the range from a change in requirements to technical issues to cost and schedule growth
- Capacity, or the importance of achieving procurement objectives.

The outputs of capability portfolio analysis serve as levers or inputs for affordability analysis. For example, degree of budget risk might be a consideration in the achievement of offsets, or a change to acquisition quantities, all while treating capability as a constant or exogenous variable.

⁴⁶ In a defense environment, a capability is "The ability to complete a task or execute a course of action under specified conditions and level of performance through a combination of means and ways across the DOTmLPF-P spectrum" [JCIDS Manual]. Note that capabilities are defined in system agnostic terms. For example, the Joint Staff defines tactical missile defense as "... the ability to defend a land or water surface of XXX within distance XXX of a point defense location; against adversary ballistic and cruise missile threats with detectability characteristics of XXX and operating speeds of XXX; with threats operating singly or in salvos of up to XXX; [employing countermeasures XXX]; [with maneuverability characteristics XXX]; with a probability of successful defense of XXX."

To this end, the authors have devised a “project punch” metric, the geometric mean of two scaled variables, as Figure 14 shows. The metric illuminates for a decision maker the impact of cutting acquisition quantities – a common occurrence in planning and programming. Such actions are not without consequence to the warfighter – as the metric makes clear.

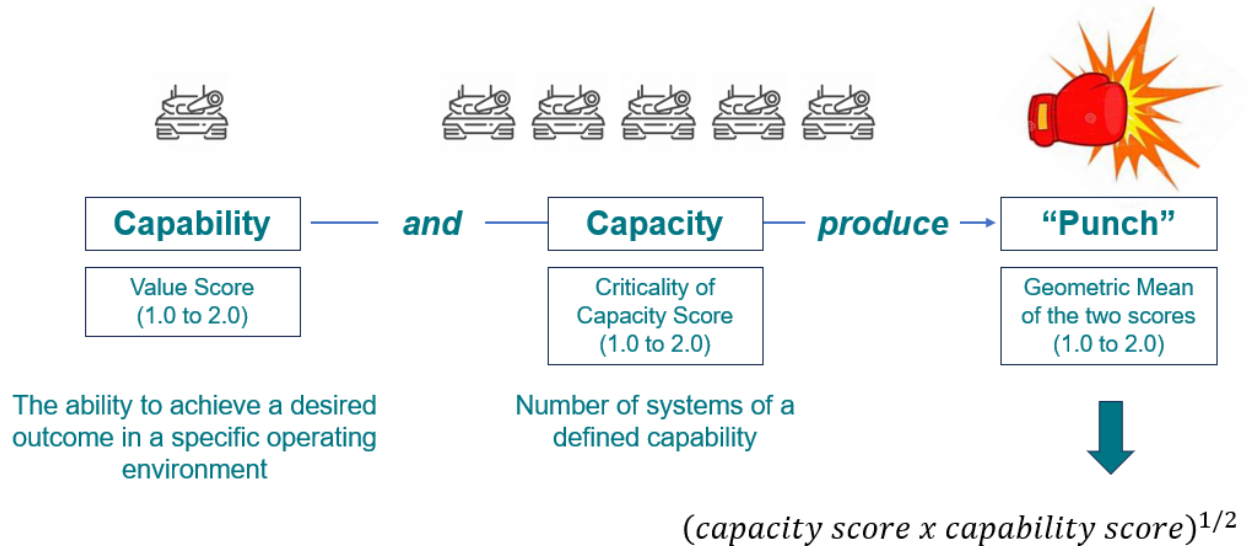


Figure 14: Project Punch

Since each of the components of project punch is a scaled value ranging from 1.0 to 2.0, the geometric mean in turn spans the same range. A value of 1.0 indicates no punch while a value of 2.0 indicates maximum punch.⁴⁷

⁴⁷ For an example of an anchored ratio scale for risk, the vertical axis in the portfolio ranging from 1.0 to 2.0, see “Innovative Risk-Driven Contract Pricing Strategy,” Brian Flynn, Peter Braxton, Bob Nehring, ICEAA 2023. Similar metrics can be developed for the other two axes, with capability values (figures of merit) derived from the output of wargaming, multiple-criteria decision analysis (MCDA), and subject matter expertise. Development of the underlying values of capability is the subject of portfolio analysis rather than affordability analysis. The latter uses output from the former.

Implementation

Overview

TAAT enables rapid analysis in a dynamic resourcing environment according to the mechanics of Figure 15. First, inputs are culled for the costs and budget positions for the current program of record (POR) and for projects in the portfolio, using templates presented below. Then, in a *real-time interactive environment*, decision makers view the impact of setting affordability goals and caps at various positions on an S-curve and impacts of potential offsets in the portfolio – all to support the end goal of affordable solutions.

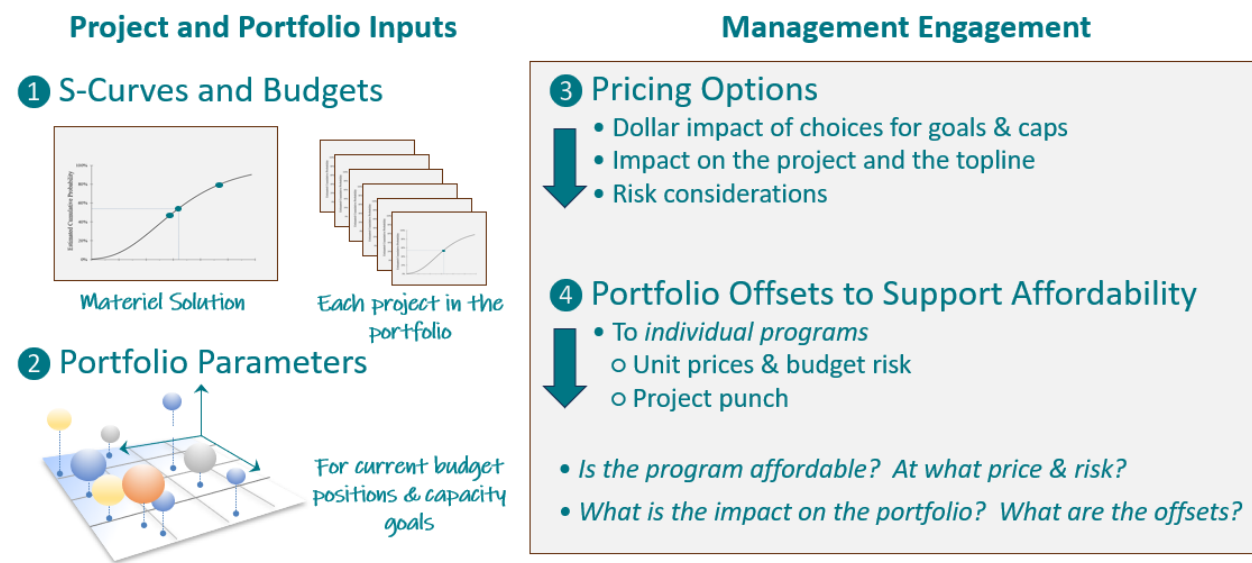


Figure 15: Mechanics of the Model

Project Inputs

Figures 16 and 17 present templates for capturing programmatic, cost, quantity and risk data for the POR. TAAT supports the generation of two S-curves for project costs, a capability especially important to the Services in generating a Component Cost Position.⁴⁸

Programmatic Data

| | | | |
|-------------------------|---|--|--------------------------------------|
| ESTIMATE TITLE | <input style="width: 100%;" type="text"/> | | |
| COST UNITS | <input type="radio"/> \$K | <input checked="" type="radio"/> \$M | <input type="radio"/> \$B |
| DOLLARS TYPE | <input checked="" type="radio"/> Base Year (\$) | | <input type="radio"/> Then Year (\$) |
| ORGANIZATION | <input style="width: 100%;" type="text"/> | | |
| COMMODITY | <input style="width: 100%;" type="text"/> | | |
| Quantity (AAO) | <input style="width: 50%;" type="text"/> | <input style="width: 50%;" type="text"/> | |
| MS OR GATE | <input style="width: 100%;" type="text"/> | | |
| LIFE CYCLE PHASE | <input style="width: 100%;" type="text"/> | | |

- U.S. DoD
- DoD Australia
- Public Services & Procurement Canada

- E.g., Sea Domain, Air Domain

- E.g., U.S. DoD MS A, B, or C; FRP DR

- AoA, TMRR, EMD, Development, Production, O&S

Figure 16: Template for Entering Programmatic Data

Cost Estimates

PRIMARY (E.g., Independent Cost Estimate (ICE))

Distribution Type

Coefficient of Variation (CV)

Unit Cost (Point) Estimate
At the Mean or Median

SECONDARY (E.g., Program Office Estimate (POE))

Distribution Type

Coefficient of Variation (CV)

Unit Cost (Point) Estimate
At the Mean or Median

Same basic inputs

- Normal
- Lognormal

- Benchmarks from Technomics' library
- User Input

- Mean
- Median

Pricing Options

p40 p50 P μ p60 p70 p75

Risk-adjusted mean

Figure 17: Template for Entering Cost Estimates

⁴⁸ A Component Cost Position (CCP) is required by DODI 5000.73, "Cost Analysis Guidance and Procedures," October 24, 2024. A CCP is achieved through a reconciliation process – or adjudicating differences between a Program Office Estimate (POE) and an Independent Cost Estimate (ICE).

Portfolio Inputs

Table 1 presents the template for entering cost, quantity, budget, and funding data on individual projects within the portfolio. Additionally, the template captures capacity, capability, and risk parameters from previously executed portfolio analysis.

Organizations frequently use 1-to-n lists, as the first column shows. For each project in the list, P-median or P-mean values are input, which, in turn, define a probability distribution and S-curve. Authorized acquisition quantities (AAO) and so-called hedge units determine capacity goals.⁴⁹

| Program or Project | Median or Mean Unit Cost in FY25\$ M | CV for Point in Acquisition | P-Value at which Budget Set | Quantity: AAO + Hedge Units | % of Quantity Bought | Inputs from Portfolio Analysis (Ratio Scales: 1.0 Low to 2.0 High) | | | Acquisition Funding in FY25\$M | Yearly Average O&S Cost |
|--------------------|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|----------------------|--|----------------|-----------------|--------------------------------|-------------------------|
| | | | | | | Criticality of Capacity | Composite Risk | Figure of Merit | | |
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| ... | | | | | | | | | | |
| n | | | | | | | | | | |

Table 1: Template for Entering Portfolio Data

⁴⁹ The National Nuclear Security Administration uses “hedge units” in its strategic stockpile of nuclear weapons.

Dynamic Decision Dashboard (D³)

Figure 18 presents a dynamic decision dashboard for use by leadership in setting affordability cost constraints for the project under consideration (the Program of Record) and for making affordability offsets in the portfolio.

Step 1 establishes nominal baseline pricing for the POR at P50, with funding an exogenous variable. The Step 2 pane enables decision makers to input *iteratively* a trio of cost constraints (threshold and objective goals and the cap) and to view instantaneously the dollar impact of the choices. Step 3 tracks affordability at the portfolio level, and Step 4 presents trade space for each component of the portfolio. Impacts appear immediately in the Step 3 and 4 panes.

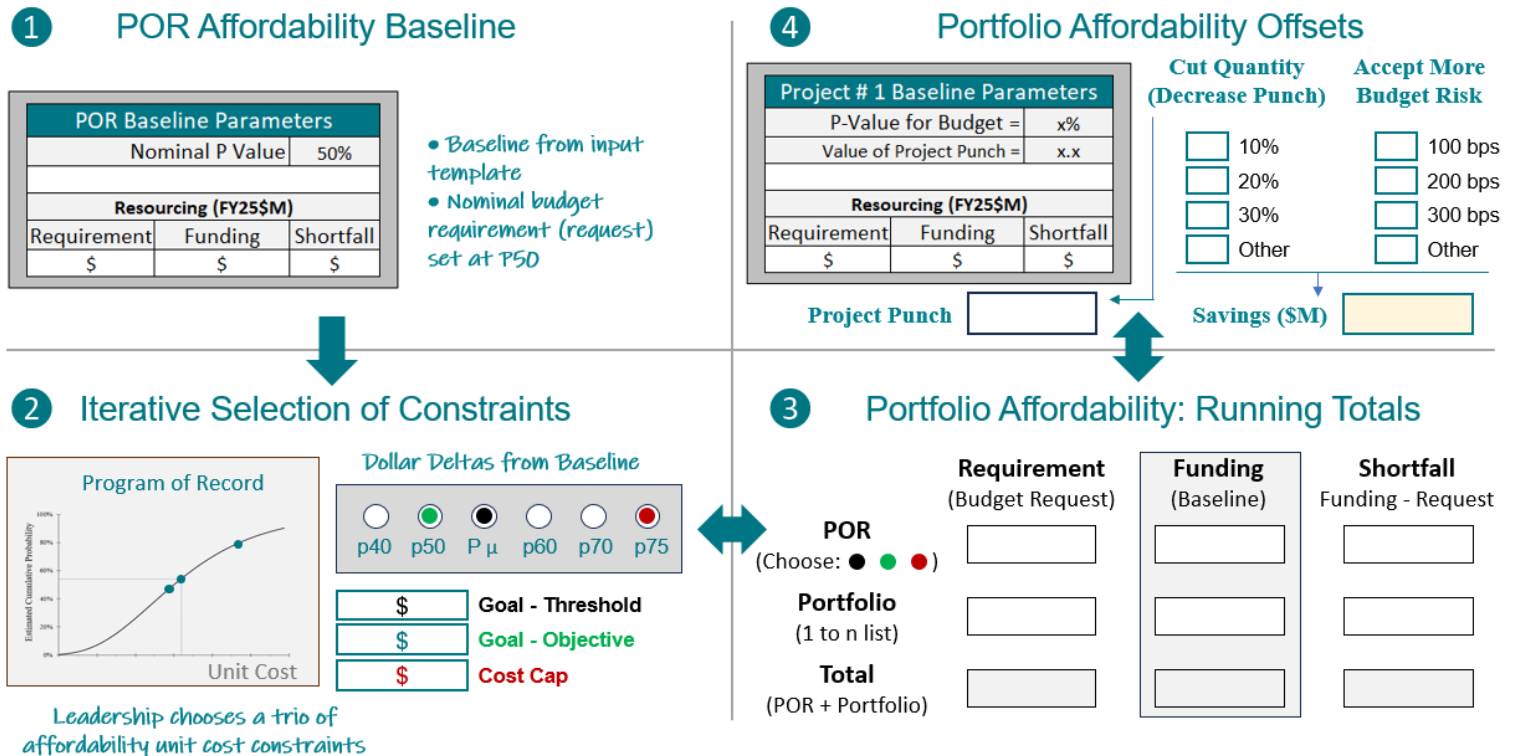


Figure 18: Dynamic Decision Dashboard

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Example

Project Parameters

Applying theory to practice, is the *ICEAA Class* frigate program of Figure 19 affordable as an addition to a naval portfolio of ships and submarines? If so, at what unit prices for the affordability cost constraints, and with what offsets to other projects?



Figure 19: *USS ICEAA Class*

Leveraging sanitized actuals from U.S., Canadian, and Australian projects, TAAT generates the notional S-curves of Figure 20, one a Program Office Estimate (POE) and the other an Independent Cost Estimate (ICE).⁵⁰ As previously mentioned, the POE commonly underestimates risk and uncertainty, especially early on, and often by a wide margin.

The decision maker chooses an initial set of prospective cost constraints ranging from P45 to P80. TAAT plots and labels the corresponding unit prices. Using the ICE numbers, the frigate program is underfunded at any price, for the 30-ship buy, given the budget bogey of \$32B (FY25\$). Offsets in the portfolio are required.⁵¹

⁵⁰ The example focuses exclusively on acquisition costs for ease of exposition and due to limited O&S data from Canada and Australia. Methods and principles hold for inclusion of costs for the sustainment phase – implementable given access to DoD’s Enterprise Visibility and Management of Operating and Support Cost (EVAMOS) system, available from the Office Secretary of Defense, Cost Assessment and Program Evaluation (OSD CAPE).

⁵¹ This assumes, of course, that the frigate program meets all the other requirements for affordability: syncs with strategy, accords with modernization plans, and possesses a superior ROI to alternatives in the portfolio.

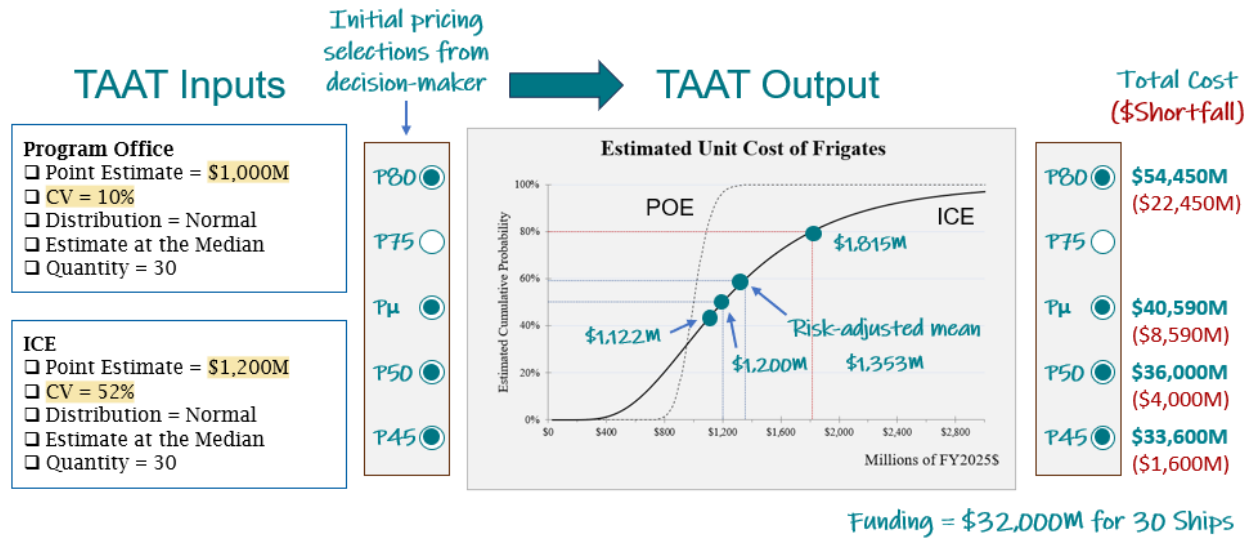


Figure 20: Frigate S-Curves

Portfolio Composition

Table 2 presents budgeting, funding, risk, and project-punch values for the ten-ship portfolio derived from TAAT’s input template, with raw data presented in Appendix 2.

Table 2: Notional Ship and Submarine Portfolio

| Program or Project | P-Value at which Budget Set | FY25\$ Millions | | | | Quantity Remaining | Project Punch |
|---------------------------|-----------------------------|----------------------|----------------|-----------|-----------|--------------------|---------------|
| | | Unit Cost at P-Value | Budget Request | Funding | Shortfall | | |
| Boomers | 0.64 | \$10,807 | \$102,663 | \$99,750 | \$2,913 | 10 | 1.95 |
| Attack Submarines | 0.54 | \$3,730 | \$100,714 | \$96,000 | \$4,714 | 27 | 1.92 |
| Aircraft Carriers | 0.60 | \$12,003 | \$108,030 | \$108,030 | \$0 | 9 | 1.45 |
| Destroyers | 0.58 | \$3,336 | \$93,399 | \$91,000 | \$2,399 | 28 | 1.45 |
| Command Ships | 0.56 | \$1,952 | \$7,806 | \$7,806 | \$0 | 4 | 1.65 |
| Large Deck Amphibs | 0.75 | \$3,477 | \$93,875 | \$93,875 | \$0 | 27 | 1.37 |
| Mine Countermeasure Ships | 0.70 | \$1,162 | \$37,185 | \$30,000 | \$7,185 | 32 | 1.27 |
| Supply Ships | 0.60 | \$901 | \$37,856 | \$37,100 | \$756 | 42 | 1.70 |
| Fleet Oilers | 0.60 | \$950 | \$34,204 | \$33,300 | \$904 | 36 | 1.70 |
| Unmanned Vessels | 0.75 | \$402 | \$80,352 | \$78,000 | \$2,352 | 200 | 1.82 |

Components of this notional yet realistic portfolio range from the expensive “boomers,” a moniker for the nation’s nuclear-powered submarines carrying intercontinental ballistic missiles, to relatively cheaper ships such as fleet oilers. As frequently seen in defense planning, programming, and acquisition, the portfolio is underfunded, in this case to the tune of \$25B as Figure 21 shows.

Portfolio Affordability: Baseline (FY25\$M)

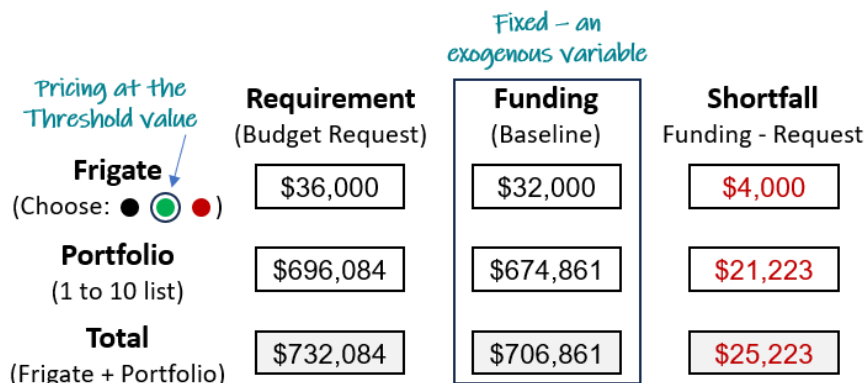


Figure 21: Baseline Portfolio Funding

Sample Offsets

Eschewing the traditional salami-style cuts to budgets, the decision maker instead uses TAAT’s Dynamic Decision Dashboard as a better alternative. After all, not all components of the portfolio are equal in terms of their relative contribution in delivering a suite of capabilities to the warfighter nor in their cost nor in their underlying technical, programmatic, cost, and schedule risk. Uniform cuts would implicitly treat the components equally thereby leading to suboptimal allocations of scarce resources.

Figure 22 presents one out of many possible extracts made using D³, with these offsets:

- Carriers.
 - Budget risk up 6 percentage points (request at P54 versus P60)
 - No change in punch.
- Amphibs.
 - Budget risk up 5 percentage points (request at P70 versus P75)
 - Decrease in punch (5% decrease in quantity).
- Unmanned Vessels.
 - Budget risk up 3 percentage points (request at P72 versus P75)
 - Decrease in punch (10% decrease in quantity).

Together the offsets enable full funding for the frigates at the desired value of affordability (the threshold cost constraint).

Offsets: Carriers

| Carriers: Baseline | | |
|--------------------------|-----------|-----------|
| P-Value for Budget = | 60% | |
| Value of Project Punch = | 1.45 | |
| Resourcing (FY25\$M) | | |
| Requirement | Funding | Shortfall |
| \$108,029 | \$108,029 | \$0 |

| | |
|--------------------------------|---|
| <input type="checkbox"/> 10% | <input type="checkbox"/> 100 bps |
| <input type="checkbox"/> 20% | <input type="checkbox"/> 200 bps |
| <input type="checkbox"/> 30% | <input type="checkbox"/> 300 bps |
| <input type="checkbox"/> Other | <input checked="" type="checkbox"/> Other |

600 bps

Project Punch **1.45** (unchanged) ← Savings (\$M) **\$5,450**

Offsets: Amphibs

| Amphibs: Baseline | | |
|--------------------------|----------|-----------|
| P-Value for Budget = | 75% | |
| Value of Project Punch = | 1.37 | |
| Resourcing (FY25\$M) | | |
| Requirement | Funding | Shortfall |
| \$93,875 | \$93,875 | \$0 |

| | |
|---|---|
| <input type="checkbox"/> 10% | <input type="checkbox"/> 100 bps |
| <input type="checkbox"/> 20% | <input type="checkbox"/> 200 bps |
| <input type="checkbox"/> 30% | <input type="checkbox"/> 300 bps |
| <input checked="" type="checkbox"/> Other | <input checked="" type="checkbox"/> Other |

500 bps

Project Punch **1.35** ← Savings (\$M) **\$8,550**

Offsets: Unmanned Vessels

| Unmanned Vessels: Baseline | | |
|----------------------------|----------|-----------|
| P-Value for Budget = | 75% | |
| Value of Project Punch = | 1.80 | |
| Resourcing (FY25\$M) | | |
| Requirement | Funding | Shortfall |
| \$80,352 | \$78,000 | \$2,352 |

| | |
|---|---|
| <input checked="" type="checkbox"/> 10% | <input type="checkbox"/> 100 bps |
| <input type="checkbox"/> 20% | <input type="checkbox"/> 200 bps |
| <input type="checkbox"/> 30% | <input checked="" type="checkbox"/> 300 bps |
| <input type="checkbox"/> Other | <input type="checkbox"/> Other |

Project Punch **1.72** ← Savings (\$M) **\$11,747**

Portfolio Affordability: Running Totals (FY25\$M)

| | Requirement (Budget Request) | Funding (Baseline) | Shortfall Funding - Request |
|--|---------------------------------|-----------------------|--------------------------------|
| <i>Pricing at the Threshold value</i> Frigate (Choose: ● ● ●) | \$36,000 | \$32,000 | \$4,000 |
| Portfolio (1 to 10 list) | \$670,337 | \$674,861 | \$4,524 |
| Total (Frigate + Portfolio) | \$706,337 | \$706,861 | \$534 |

Figure 22: Sample Offsets in the Portfolio

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TAAT enables decision makers to **view** the impacts and **choose** accordingly.

Governance

Overview

Technomics' affordability analysis framework and tool illuminate trade space for leadership – with a laser focus on risk and impact. But what's the governance structure? Or paraphrasing Kipling, *who* does *what* and *when* and *how* to implement the framework and to execute the analysis?⁵²

To this end, the governance structure addresses:

- Timelines of activities
- Deliverables
- Providers of information
- Stakeholders
- Decision points.

The structure emphasizes the importance of sound, independent cost estimates and *interactive* management engagement in making critical decisions on affordability. It also introduces stringent timelines to ensure that responsible entities have adequate time to perform their tasks, collect necessary data, and validate cost estimates before key decision points.

While presented in the context of DoD acquisition, the basic structure is applicable to other organizations as well.

Timelines and Activities

Figure 23 presents a typical timeline of events and deadlines to support the requirement for affordability analysis during an Analysis of Alternatives and at Milestone A. The deadlines focus on the Cost Review Board (CRB), a venue used by all the Services in generating Component Cost Positions (CCPs), based on a reconciliation of the Program Office Estimate (POE) and the ICE, with engagement from OSD's Office of Cost Assessment Program Evaluation (CAPE).

The process begins early on, with initial affordability goals developed and presented in the draft Capability Development Document (CDD), per requirement from the Joint Staff. Active engagement with enterprise-level leadership takes place downrange – the component-level authority on setting the affordability metrics.

⁵² Rudyard Kipling: "I keep six honest serving-men (They taught me all I knew); their names are **What** and **Why** and **When** and **How** and **Where** and **Who**."

Finally, a similar timeline to support affordability-analysis decisions at Milestone B is presented in Appendix 3.

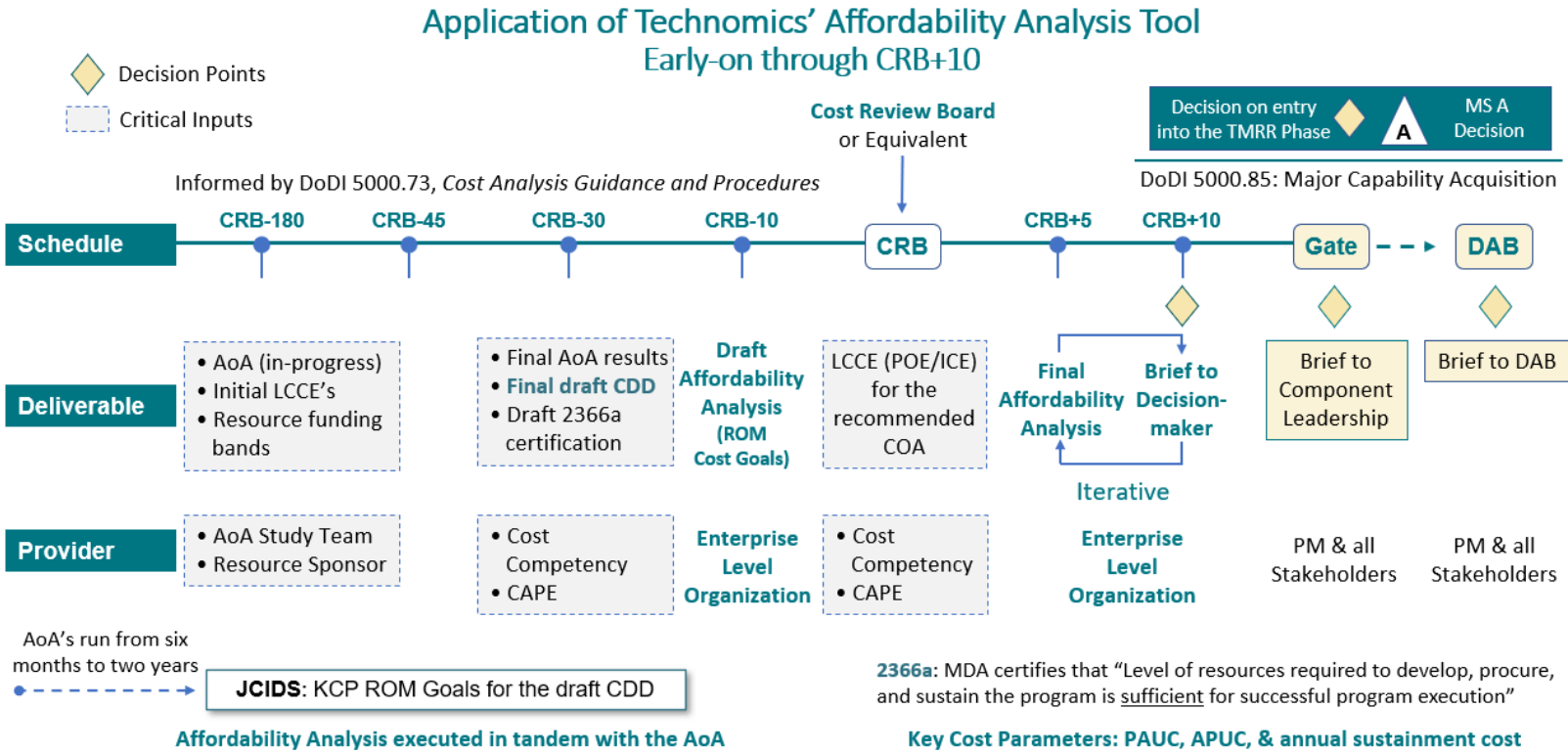


Figure 23: Affordability Analysis Timelines and Activities for MS A

Summary

Technomics' innovative framework for affordability analysis reshapes how organizations approach costs, performance, and value. The innovation punctures traditional thinking with its myopic reliance on sand charts and a fit-to-the-five-year-program mentality.

By integrating program or project costs, funding, and risk with strategic decision-making, the product transforms financial constraints into opportunities to right-size the portfolio while meeting statutory and regulatory requirements for affordability.

It's the right product at the right time as our national debt balloons and the government seeks to improve efficiency.

Appendix 1

CV Mapping for NNSA

Figure 24 maps DoD’s CVs to DOE/NNSA’s Acquisition of Capital Assets (CD) Process while Figure 25 maps the CVs to NNSA’s Weapons Modernization (Phase X and 6.X) processes.⁵³

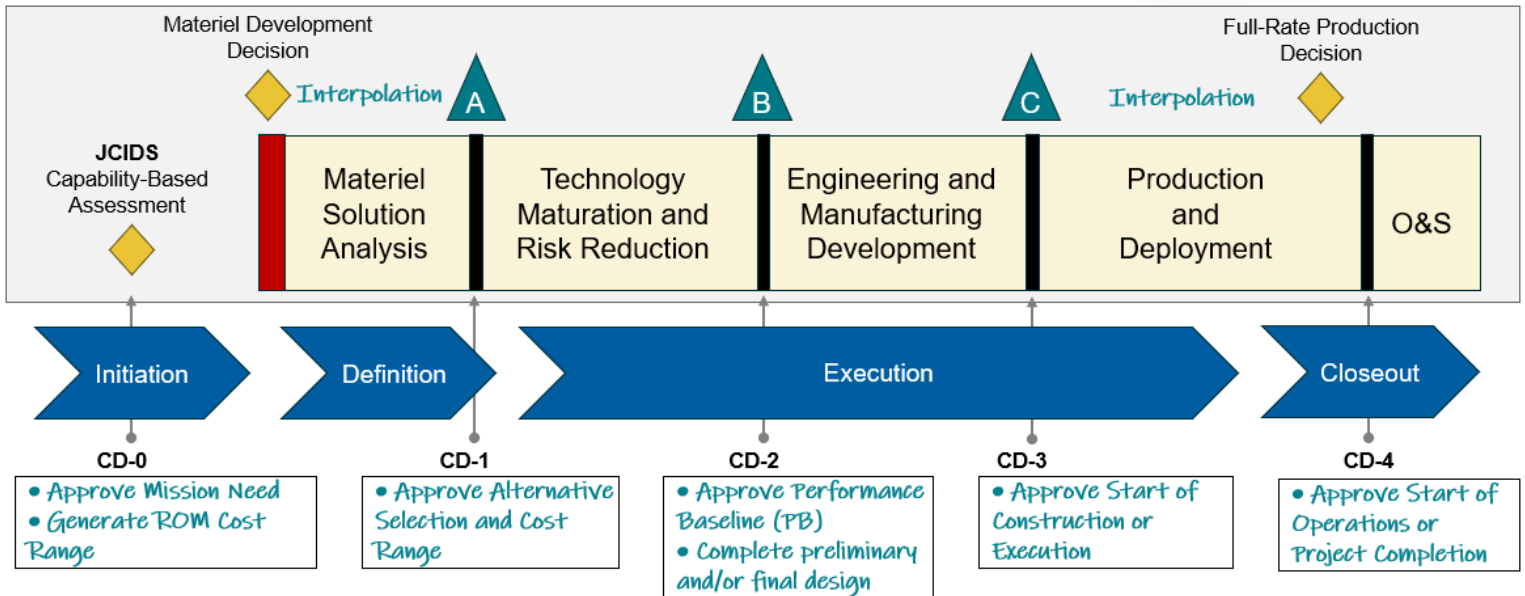


Figure 24: Mapping CVs to the CD Process

⁵³ Source: DOE Order 413.3B Change 7 06-21-2023. For an example of cost estimates generated for the CD phases, see “Benchmarking Tool for Planning and Assessing Construction Estimates,” 2021, NA-MB-90.

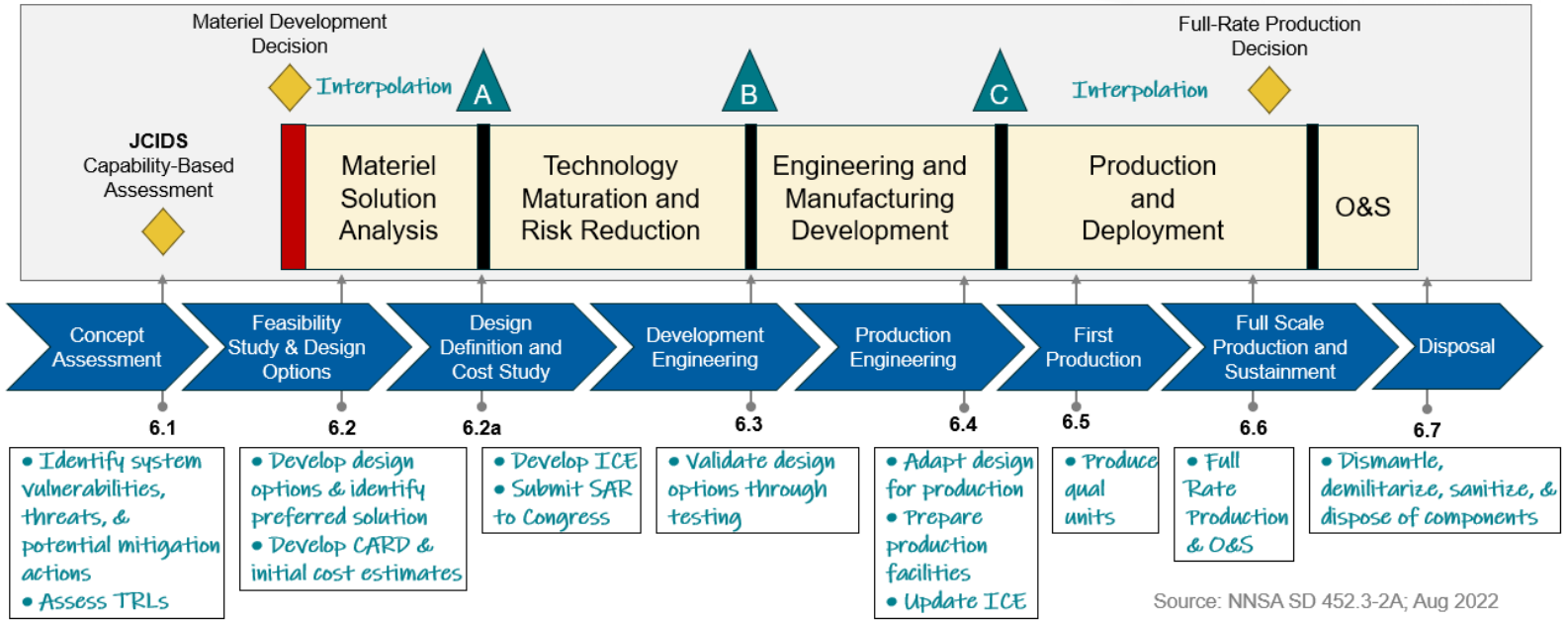


Figure 25: Mapping CVs to the Phase 6 and 6.X Processes

Appendix 2

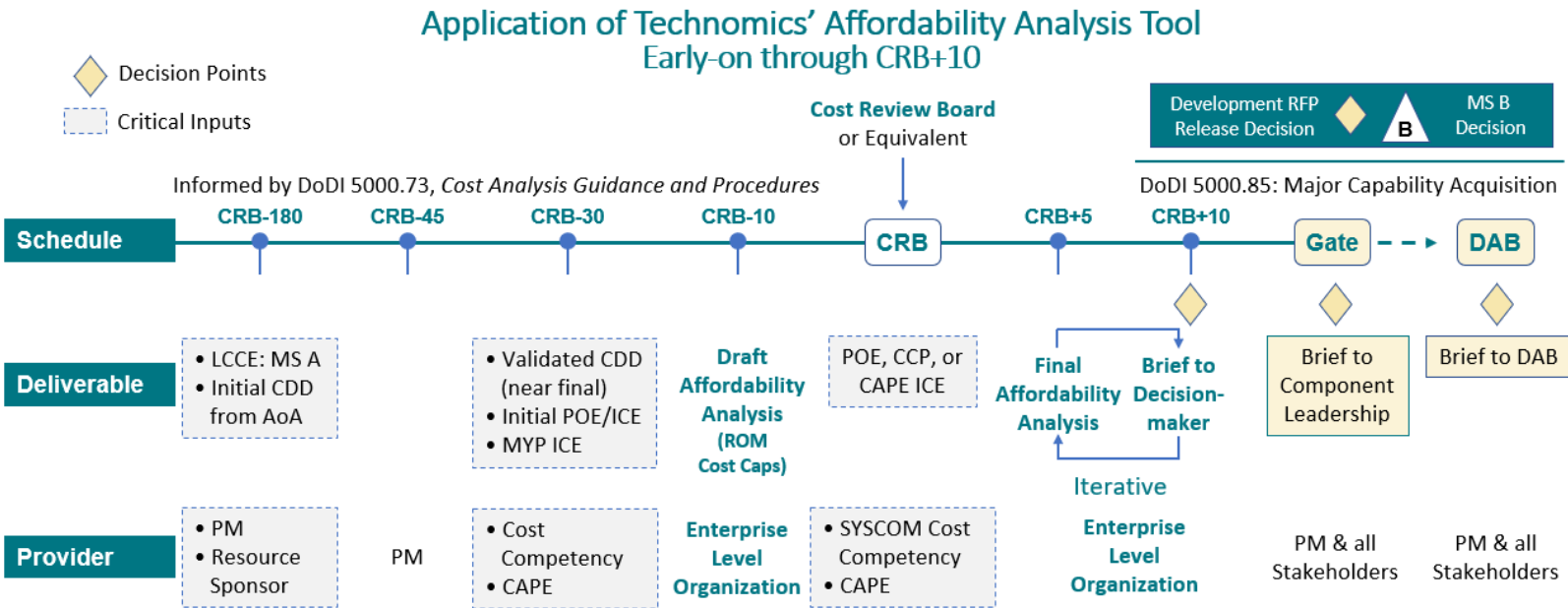
Portfolio Composition and Inputs

Table 3: Portfolio Data Inputs

| Program or Project | Median or Mean Unit Cost in FY25\$ M | CV for Point in Acquisition | P-Value at which Budget Set | Quantity: AAO + Hedge Units | % of Quantity Bought | Inputs from Portfolio Analysis (Ratio Scales: 1.0 Low to 2.0 High) | | | Total Acquisition Funding in FY25\$M |
|---------------------------|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|----------------------|--|----------------|-----------------|--------------------------------------|
| | | | | | | Criticality of Capacity | Composite Risk | Figure of Merit | |
| Boomers | \$9,000 | 0.56 | 0.64 | 10 | 5% | 1.90 | 1.75 | 2.00 | \$105,000 |
| Attack Submarines | \$3,600 | 0.36 | 0.54 | 45 | 40% | 1.90 | 1.60 | 1.95 | \$160,000 |
| Aircraft Carriers | \$11,000 | 0.36 | 0.60 | 10 | 10% | 1.40 | 1.70 | 1.50 | \$120,033 |
| Destroyers | \$3,200 | 0.21 | 0.58 | 40 | 30% | 1.40 | 1.40 | 1.50 | \$130,000 |
| Command Ships | \$1,900 | 0.18 | 0.56 | 5 | 20% | 1.60 | 1.40 | 1.70 | \$9,758 |
| Large Deck Amphibs | \$2,600 | 0.50 | 0.75 | 30 | 10% | 1.30 | 1.50 | 1.45 | \$104,305 |
| Mine Countermeasure Ships | \$850 | 0.70 | 0.70 | 32 | 0% | 1.25 | 1.70 | 1.30 | \$30,000 |
| Supply Ships | \$800 | 0.50 | 0.60 | 60 | 30% | 1.70 | 1.60 | 1.70 | \$53,000 |
| Fleet Oilers | \$790 | 0.80 | 0.60 | 40 | 10% | 1.70 | 1.60 | 1.70 | \$37,000 |
| Unmanned Vessels | \$250 | 0.90 | 0.75 | 200 | 0% | 1.85 | 1.90 | 1.80 | \$78,000 |

Appendix 3

Governance Structure for Milestone B



POE: Program Office Estimate; CCP: Component Cost Position; CDD: Capability Development Document; MYP: Multi-Year Procurement; CAPE: Cost Assessment Program Evaluation

Figure 26: Timelines and Activities for Milestone B