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Programmed to Fail:

The Rise of Central Planning in Defense Acquisition, 1945-1975

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Introduction

> … each new generation of weapons costs several times more than the one it replaces, and the lifespan of new weapons systems is becoming shorter year after year.
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> Neil H. McElroy
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> "Semiannual Report of the Secretary of Defense," 1958

In the years after World War II, a ticket to the movie theater cost only 25 to 50 cents. Fast forward 70 years and movie tickets cost a whopping 10 to 20 dollars. That's a pretty big increase, but we've seen similar magnitudes for groceries, gasoline, and other everyday purchases. Wages have also grown about the same amount, perhaps a little faster.

Now imagine if all other prices remained the same except the price of movie tickets. Rather than costing 10 to 20 bucks, the same movie ticket now costs you anywhere between 100 and 500 dollars. Sure, the seat now reclines, the picture and sound quality is better, and so forth. Still, forking over hundreds to see a movie? Something must be wrong! And yet that is exactly the kind of cost increases we have experienced in the acquisition of weapon systems. The difference

between spending tens and hundreds of dollars is the difference generated by price growth at 5 percent a year and 10 percent a year.[1]

Since World War II, the cost of U.S. weapon systems has rapidly accelerated. For example, the F-86 Sabre jet fighter aircraft cost just over $200,000 on average for each of the first 500 units. It dominated the skies over Korea after its introduction into operations in 1949. Five years later, the comparable cost for the F-100 Super Sabre was about $750 thousand, and in 1960 the F-4B cost over $2 million. Introduced in 1976, the F-15 cost over $11 million, and forty years later, the "bargain buy" F-35A cost $113 million.[2]

Procurement costs for fighter aircraft in the U.S. have on average grown at roughly 10 percent each year.[3] Compare that to prices in the economy at-large, which grew 3 percent annually.[4] Over 70 years' time, the difference is staggering. Whereas average prices have grown by a factor of eight, fighter aircraft costs have grown by a factor of over 600! In other words, it requires 75 times more real resources to buy an aircraft. A similar story is repeated in ships, helicopters, munitions, land vehicles, and missiles. In fact, the cost of weapon systems have grown at a similar rate or faster than healthcare and college tuition, two sectors which receive tremendous public attention due to their skyrocketing prices.[5]

For healthcare and education, higher prices haven't necessarily led to lower consumption. Their share of total spending has cut into other sectors. Healthcare spending, for example, has grown from roughly 5 percent of gross domestic product (GDP) in 1960 to over 17 percent in 2013.[6] Over the same time, spending on the Department of Defense fell from 8 percent of GDP down to near 3 percent.[7] Because the economy has expanded, the diminished share still represents modest growth in real defense spending. However, with system costs growing much faster than defense funding, weapons inventories have shrunk.

The Air Force's active inventory of aircraft dropped 60 percent in the twenty years after 1955.[8] Between 1990 and 2019, the Air Force's tactical aircraft fell again from 3,206 to 1,731, and the number of bombers fell nearly 80 percent.[9] A similar trend is apparent for U.S. Navy ships, falling from roughly 800 ships during the Vietnam War to over 500 during the Persian Gulf War, down to only 275 in the year 2019.[10] As for the Army, it inventoried nearly 9,000 helicopters at the end of the Cold War. Twenty years later, the figure fell to just 3,500.[11]

Higher weapon system costs and lower inventories has been the price of achieving great increases in system performance. The F-35A, for example, has stealth features, advanced

electronics, and other capabilities that could make it worth the cost. The same is true, of course, for other high cost sectors. Healthcare has seen substantial improvements in prescription drugs, surgical procedures, and much more. Similarly, colleges have more "student life" amenities and nicer lab equipment. Adjusting for these quality improvements is a difficult task, fraught with uncertainty. Yet for some weapon systems, higher technology content has not necessarily led to increased performance, as evidenced by the F-35's automated logistics system or the launch and arresting mechanisms on the *Gerald Ford* aircraft carrier.

While an exact index of military cost effectiveness is unavailable—and indeed impossible to devise—perennial efforts to reform the defense acquisition process have made clear that its performance is unsatisfactory.[12] In the minds of almost everyone involved, weapon systems cost too much, take too long, and when they are fielded, underperform in almost every characteristic compared to expectations. Past reforms, however, failed to turn the tide. Instead of looking for new solutions, reforms have oscillated within a narrow range of tried-and-true best practices. Experts largely agree on acquisition best practices dating from at least the 1970s, including requirements stability, realistic cost estimating, a "fly-before-you-buy" approach, and so forth. As a result, Frank Kendall speaks of acquisition "improvement" rather than reform. Norm Augustine concluded that "Management 101" is needed rather than new techniques.[13] Harvey Sapolsky advised that we "skip acquisition reform" this time around.[14]

Many experts believe the problem exists not so much with acquisition theory as with the acquisition workforce. In a compendium of 31 expert views submitted to Congress in 2014, over two-thirds pointed to weaknesses in workforce training and incentives leading to the poor execution of well-known best practices.[15] In the consensus view, policies devised during the industrial era need only minor tweaks; the remainder is a proper application of incentives.

One of the foundational works in the consensus view is the 1962 classic *The Weapons Acquisition Process: An Economic Analysis* by Merton Peck and Frederic Scherer. The researchers present two recurring themes: the constant presence of uncertainty and the non-market nature of decision-making. The two themes are indeed proper for any discussion on weapons acquisition, and will in fact reoccur in the following chapters of this book. However, this book applies a different understanding of uncertainty and the market which favors the bottom-up over the top-down, experimentalism over analysis, and a bias toward action rather than concurrence seeking.

Uncertainty

For Harvard researchers Peck and Scherer, uncertainty meant the degree to which contemplated outcomes are unpredictable. The relevant measures of prediction are cost, time, and quality. A distinguishing feature of weapon systems is that when a technical objective is identified, the estimated time and cost to achieve it might not even be in the ballpark of what it really takes. Uncertainty, therefore, was something to be minimized. Success was measured by achieving contemplated outcomes as planned.

The treatment ignores important aspects of uncertainty. Are the program objectives the correct ones? Can technical direction be modified when new knowledge is gained along the way? How quickly can the acquisition system adapt to changing circumstances? When is uncertainty so great as to recommend a diversity of options rather than a single-best choice? These questions stand outside the narrow definition of uncertainty, or the predictability of cost and time for a pre-conceived course of action.

Fixing a course of action makes sense when technology development is viewed as a linear process. The prevailing belief at the time was that engineering solutions could be mathematically derived from the natural laws of science. All that remained was a rigorous analysis to find what was already present in the theoretical model. In this view, the world was a closed-ended system of objective and deterministic phenomena. It made a small group of the best minds well suited to make the important decisions from the top, leading to a "requirements-pull" approach to technology development.

Over the course of the 20th century, evidence began to build that the "Newtonian" view of nature only worked for a small class of circumstances. In most cases of significance, predicting what will happen before experimental evidence becomes available is impossible. For example, U.S. scientists during World War II assumed that radar detection range increased linearly with frequency, leading them to a choice of 1.25 centimeters for aircraft side-looking radar. The choice was unfortunate, as later discovered by British scientists who performed realistic tests. It turned out that range was substantially improved at slightly lower and higher frequencies due to the unexpected effects of atmospheric attenuation. It turned out the function was not linear, as the U.S. scientists presumed in their simplified models.[16]

The 21st century is now dominated by a different paradigm of uncertainty. We live in an open-ended system of subjective and stochastic phenomena. Small—even unnoticeable—prediction

errors have enormous consequences due to nonlinearity. Complex behaviors emerge from simple iterative rules, and in every case of significance have been traced to bottom-up architectures, such as found in "combinatorial innovation." For complex adaptive systems, uncertainty is not a problem to be contained. It provides opportunities for higher-level behaviors. The view leaves space for novelty and diversity. It suggests the wisdom of trial-and-error experimentation; of a "technology-push" approach to complement the "requirements-pull."

The result of complexity is that knowledge about what is likely to be successful is either unavailable or tacitly held by participants. Peck and Scherer deliberately defined uncertainty in the narrow sense because they rejected "fuzzy" notions of subjectivity. We should not reject an idea, however, just because it makes our problem more difficult. As thinkers like Michael Polanyi and Friedrich Hayek understood, a large fraction of scientific and economic information cannot be articulated or aggregated into statistics. It is dispersed across participants. Indeed, if we accept that no one person has but a small part of the total knowledge required to make decisions, and that each one of them has overlapping and even conflicting views of technical or operational feasibility, then subjectivity is a fact of life. The problem then shifts to how local pieces of knowledge can be most effectively coordinated to find out what is successful.

By contrast, Peck and Scherer saw uncertainty as a bug rather than a feature. As a result, they were committed to an optimization approach. Yet such analyses cannot discover anything that was not already provided in the assumptions. The abandonment of tacit knowledge limits the discovery of new technologies by constraining the search to what is known today. The antiquated view of uncertainty, with its emphasis on cost growth rather than the genuine discovery of knowledge, continues to pervade defense acquisition policies in the 21st century.

Non-market characteristics

The unpredictability of outcomes was seen by Peck and Scherer as unique to weapons acquisition; commercial firms encountered nothing close to the uncertainty of weapon systems. They pointed to the intensity of research and development as a good proxy for expected uncertainty. Even in research-oriented commercial industries like scientific instruments and chemicals, the researchers found that R&D expenditures amounted to only 5.4% and 2.9% of 1956 sales, respectively. By contrast, firms participating in the aircraft and parts industry put 19.1% of total sales towards R&D.

Times have changed. For the commercial firm Alphabet—which holds Google—R&D expenditures were 15.7% of sales in 2018.[17] Many of their projects are moonshots, both risky and

highly uncertain. Compare that to the largest defense seller in the world, Lockheed Martin, which safely spent 2.4% of its sales on sure-fire internal R&D.[18] Modern tech giants also have incredible scale to achieve major programs. Amazon's 2018 R&D expenditures, for example, rivaled the entire fiscal year 2019 RDT&E appropriation for the Army and the Navy *combined*.[19]

Commercial firms in the 21st century don't just spend a great deal of cash on research and development. The nature of their business has changed substantially. No longer are commercial firms characterized by repetitive manufacturing of tangible goods. They no longer produce known things using known methods, where a bulk of the value comes from deploying physical capital, routine labor, and raw materials. Business value is now in the creation of intangible assets such as software, databases, platform design, supply chains, employee training, and business processes. These are precisely the qualities of investment that add value—and also uncertainty—to weapon systems. Over the years, commercial firms have charged ahead of defense firms in many important areas of technology development. Still managed by industrial era concepts, the Department of Defense struggles to keep pace with the rapid innovation happening in the market economy.

It was widely assumed in the 1950s and 1960s that technology development required government funding to large monopolistic firms. Famed economist John Kenneth Galbraith believed that the biggest firms would continue racing ahead in technology.[20] Galbraith, like other industrial era thinkers, could not conceive of small firms disrupting large incumbents. Yet experience has now shown cycles of small firms creating exciting technologies and growing rapidly, only to be disrupted themselves by a different set of firms. In the 21st century, technological disruption has become cliché.[21] Firms try to disrupt themselves.

It is now clear that uncertainty is not a defining characteristic of weapons acquisition. The uncertainty associated with the post-industrial economy has not caused market failures, but rather market innovations.[22] However, non-market decision-making—characterized by central planning and resource allocation—remains important. Centralized control is still alive within firms. They are "islands of consciousness" in a sea of market exchanges. Yet even the largest firm is relatively small compared to the overall coordination happening through exchanges.

The defense marketplace has greater non-market aspects because the government not only regulates the industry, it actively participates as the industry's only buyer. Back in the 1940s and 1950s, however, the government buyer was really fractured into multiple independent agencies that both cooperated and competed with one another. The Navy's Bureau of Ships relied on

market-like exchanges with the Navy's Bureau of Ordnance for the armament of its ships, while the Bureau of Ordnance competed against the Navy's Bureau of Aeronautics to develop missiles.

Throughout the 1950s, government in-house organizations retained a significant technical staff. It helped them develop systems and evaluate the output of contractors. Even though the government made more technical choices internally—indicating the non-market nature of defense—it was pluralistic and competitive.

Central allocation didn't fully replace market-like exchanges until Robert McNamara's managerial revolution of 1961-1968. The in-house bureaus and technical services, crucial for generating the knowledge to become a smart buyer, were almost totally abolished. Weapons acquisition focused on planning the total defense program from the top. Basically all detailed work was outsourced to a single prime contractor through a dedicated program office. While such increased use of contracts may appear to have made greater use of market mechanisms, they were in fact an extension of the central allocation scheme. The entirety of the defense ecosystem then came under control of a single resource allocation mechanism that continues to exist well into the 21st century, the Planning-Programming-Budgeting System.

Summary

This book attempts to fill a gap in the literature on weapon systems acquisition. Whereas Peck and Scherer, and indeed nearly all other major works, remained committed to an optimization approach of resource allocation from the top-down, this book explores the concepts behind a diversification and selection approach focused on exchange from the bottom-up. In exploring new reforms for a post-industrial world, it is necessary to first understand the history. The following is dedicated to resurrecting the debates occurring between World War II and the 1970s, the period when the modern acquisition system grew into maturity. It finds how important thinkers dissented to the consensus view including Armen Alchian, John Boyd, Hyman Rickover, and many others.

This book is primarily a history and synthesis of ideas. It finds substantial precedent for an alternative paradigm to weapons acquisition that follows two related concepts. First, liberal concepts of individualism, property rights, subjectivity of cost, and rules-based order are crucial to any reorganization away from top-down allocation. Briefly, effective outcomes require the alignment of decision rights and production knowledge. Second is the multi-disciplinary studies of complex adaptive systems, which provides a scientific foundation for self-organization,

emergent order, and resiliency. Here, we gain an intuition for why rivalry and redundancy are essential to technological progress.

While the historical framework integrates many concepts, it frequently draws the reader's attention to the central role of the budget process. The output-oriented budget implemented by Robert McNamara under the banner of the Planning-Programming-Budgeting System (PPBS) represents a major break from the liberal institutions of the United States. In the place of pluralism and exchange, the PPBS creates a central plan for future action.

The PPBS remains the most important barrier to achieving the intended effects of acquisition reform. Re-installing a traditional budget based on organization and object avoids the lock-in effect of central planning. It allows managers to take advantage of real options, incorporate intangibles into decision-making, and pursue "non-consensual" projects which, as tech entrepreneur Marc Andreessen has found, are the only ones that have a chance of big returns. Perhaps most importantly, the traditional budget process helps align authority, responsibility, and accountability, which is currently dispersed across numerous layers of bureaucracy.

This book argues that failure is built into modern defense acquisition. Attempts to detail financial plans by program output has corrupted the decision-making process. Hundreds of requirements are levied from all corners of the bureaucracy. Dozens of approvals are required to authorize funds. Years pass before the program can proceed, and once it does, plans become locked-in for five, ten, or twenty years into the future. The programming aspect of the budget is the ultimate source of rigidity in acquisition. Hence, the book is titled *Programmed to Fail*.

The first chapter of the book explores the administrative unification of the War and Navy Departments in the years after World War II. It shows how the prevailing attitudes at the time favored centralized planning and reviled competition. The chapter features the first Secretary of Defense, James Forrestal, a man who found himself increasingly broken by his attempts to slow the encroachment of centralization.

The program budget is discussed in the second chapter, proclaimed by its advocates to be the most important tool for unified decision-making. In 1954, administrative expert Frederick Mosher documented the implications of a program-oriented budget. Though he convincingly argued how programming presents many difficulties and should have been abandoned, he was later swayed by its proponents—at least in the special case of defense acquisition.

The third chapter introduces systems analysis, a set of mathematical techniques intended to solve questions of program choice. Developed primarily at RAND, systems analysis attempted to predict future technologies and the cost of their achievement. A separate contingent of RAND analysts led by economist Armen Alchian countered that technological uncertainty was too great for a systems analysis to recommend the single-best choice. Instead, they advocated for a diversification approach to R&D, relegating optimizations to more well-defined areas of procurement and operations.

The twin concepts of the program budget and systems analysis were only partially installed in the 1950s. It wasn't until 1961 that they became the foundation for a defense management revolution under Robert McNamara. The fourth chapter examines the rise of the Planning-Programming-Budgeting System, and puts it in the context of the broader debate on socialist planning. The chapter features insights from Friedrich Hayek on the problems of unified resource allocation, Karl Popper on learning by trial-and-error, and Harvey Sapolsky on the myth of scientific management.

The fifth chapter explains how the PPBS led to the demise of in-house technical staffs under the Navy bureaus and Army technical services. In their place, program offices with a single prime contractor put an emphasis on contractual agreements. It features critiques of defense contracting schemes by RAND analysts William Meckling and Oliver Williamson.

The sixth chapter focuses on the defense innovation process. It describes the daunting prospect of starting a new program and the linear stage-gate model of technology development. It examines European and Soviet innovation policies as described by Robert Perry and Arthur Alexander. A case study of the lightweight fighter program, led by John Boyd and the fighter mafia, is used to demonstrate how fragile and unlikely non-consensual developments are in U.S. acquisition.

The seventh chapter follows John Boyd's work as it moved from aircraft design into complexity studies. The chapter explains how the reductionist view of science has been replaced by a richer understanding of the inherent uncertainty built into our universe. It explains how order emerges from the bottom-up, not only in the economy and society, but in all complex physical phenomena. While military operations have started to reorient themselves to a complex adaptive systems view, the acquisition process remains trapped in the realm of linear thinking.

Competition is the focus of the eighth chapter. It describes how economic rivalry acts as a procedure for discovering knowledge that wouldn't otherwise be available to a central planner. It