# The Impact of Cost Plus and Industry Consolidation on the US Defense Sector

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

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**Introduction:**

It was my second year working at Lockheed Martin. Surrounded by state-of-the-art technology, I grabbed my bag to head to my next task: drive three hours into the middle of the desert to pick up a part I could hold in one hand. Because of a peculiarity in the shipping process, parts were consistently sent to the wrong facility. The unfortunate result of this: lower-level engineers like me spent our days driving, not building. My time at Lockheed was filled with quirks like this. Many of the brightest and most motivated engineers I had ever met were forced to spend more time navigating through red tape than building and designing airplanes. Inefficiencies like this are commonplace, but don't present an existential threat to the company (who else is going to build an F-35?) so go on unchecked.

Over the past three decades, the aerospace & defense industry has become increasingly consolidated and slow moving. Many aerospace graduates and students who intern or work for defense contractors find themselves frustrated by the long lead times, bureaucracy, and lack of innovation. In 1995, the US government provided funding for the Joint Strike Fighter and a decade later, the F-35 had yet to fly. A program that was projected to cost $200 billion ballooned to over $400 billion by 2017 (Roblin, 2021). Today, it feels like even as the US pours ever more money into defense technologies the results continue to diminish, and our geopolitical rivals continue to catch up.

It wasn't always this way. During and following WWII, Lockheed Martin's Skunkworks was famous for pushing the envelope and having lightning-fast development times. The P-80 Shooting Star was built in just 143 days and the U2 spy plane developed in just 9 months (Hudson, 2021). Furthermore, much of the innovation tied to Silicon Valley was associated with defense applications (Wolfe, 2022). Many of our most important civilian technologies came from

military research (GPS, microwaves and much more). Unfortunately, today, most of the projects operate on the scale of decades and end up well over budget. Defense contractors struggle to attract and retain top engineering talent. Innovation is increasingly occurring within consumer facing businesses that are highly profitable, but irrelevant to national security. Part of these difficulties are likely linked to the increased technological complexity of 21st century defense projects, but there is a belief among many investors and engineers in the defense space that the industry needs change. Ben Rich, the former director of SkunkWorks lamented in his memoir, "In my forty years at Lockheed I worked on twenty-seven different airplanes. Today's young engineer will be lucky to build even one" (Rich, 1996).

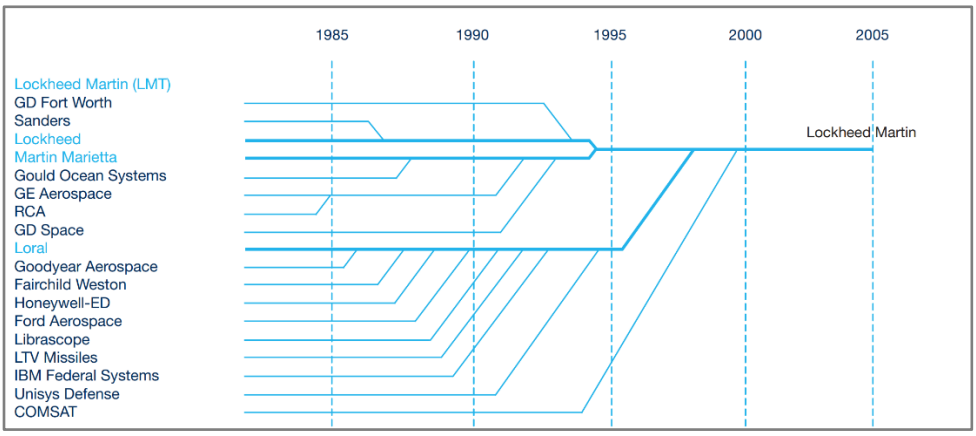
There are a few structural reasons that may be partially responsible for how this industry shaped out and are worth investigating. The cost-plus business model and industry consolidation are likely culprits. As such, this paper will investigate how these factors have influenced the aerospace & defense industry and consider what could change about how business is done in the future. Additionally, the STS framework Actor Network Theory (ANT) will be used to identify how the interplay between players is influencing technological development more than the actions of any one specific entity. This is particularly pertinent to investigate today with several compelling startups attempting to disrupt the space (O'Shaughnessy, 2022). I'm arguing that cost-plus and consolidation are undermining innovation in defense and that a change in existing business models may be needed to revitalize the industry. Although some thoughts on solutions are presented, this paper is mainly intended to highlight current flaws in the public-private defense partnership model.

**Literature Review:**

In looking at this topic, it is worth first understanding how we got here and what academics think the impact of the current market structure is on how technology in defense is developed. Following the Cold War, defense spending among the US and allies (but primarily driven by the US) plummeted from $142 billion in 1986 to $78 billion in 1996. This resulted in three major shifts that drive how the global defense industry works today. First off, the large contractors in the US began a series of acquisitions to vertically integrate in order to cut costs and increase pricing power. With declining defense budgets, smaller players likely had no reasonable alternative but to sell out to deep pocketed players (Hooke, n.d.). We can see an example of the serial acquisitions that created today's large defense companies in Figure 1 below.

**Figure 1**

*Acquisitions that created Lockheed Martin 1985 – 2005*



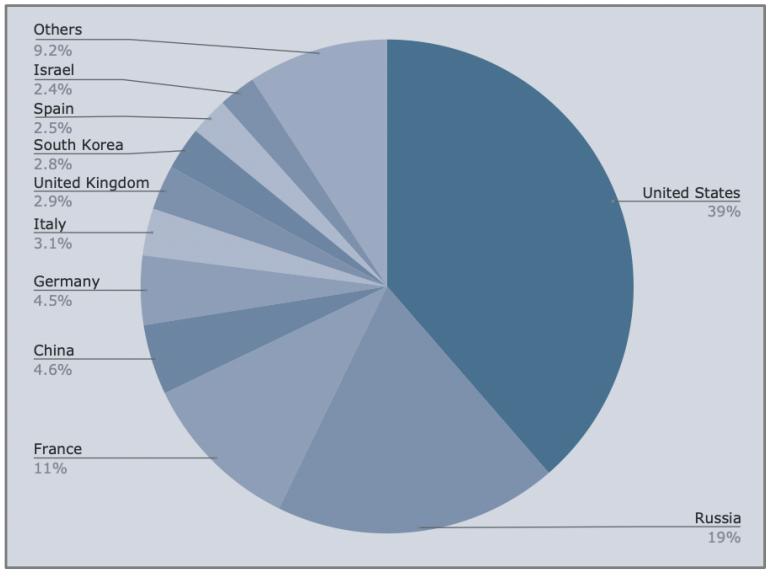

Note: This figure shows the 18 acquisitions that created Lockheed Martin from 1985 – 2005. From "The Defense Industry in the 21st Century," by R. Hooke, n.d., *PriceWaterHouseCoopers*.

Second, with the fall of the Soviet Union, the US deemed it reasonable to begin exporting arms to countries beyond immediate allies, selling to countries in East Asia, the Middle East and Oceania. In 1993 the US accounted for $36 billion or 72% of arms sales in developing countries

(Dorminey & Thrall, 2021). Finally, with US contractors exporting a larger number of arms and defense technology becoming increasingly complex, many nations realized they no longer had the scale or resources to support a domestic defense industry. This resulted in European nations collaborating on projects or in many cases countries recognizing their best bet was to be reliant on US technology. Fast forward to today and it is clear the US dominates global weapons development with the US accounting for 39% of global arms sales worldwide and an even larger share of weapons research and development (Hartung, 2021). This is shown in Figure 2 (Wezeman et al., 2022).

**Figure 2**

*Global share of exports of major arms by the 10 largest exporters, 2017–21*



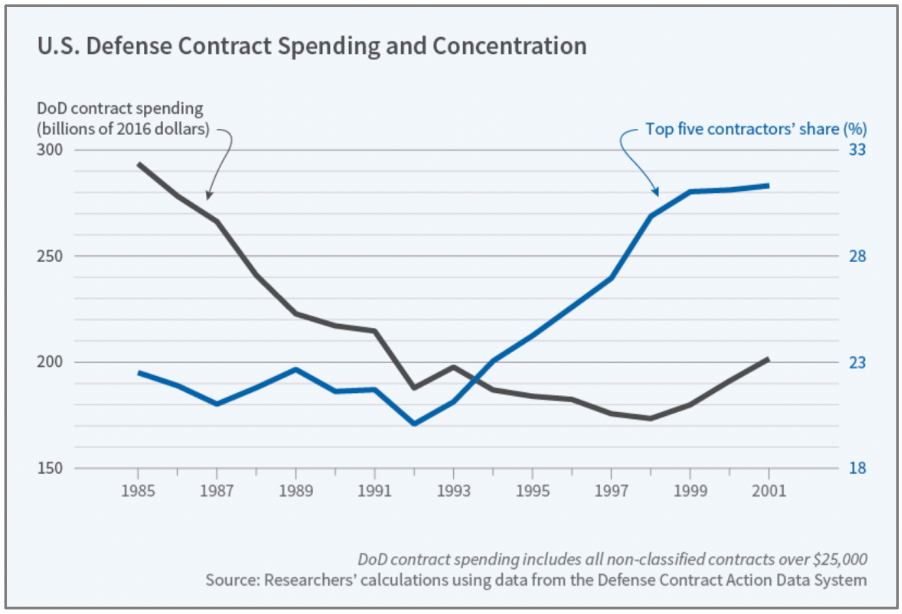

Note: From "Trends in International Arms Transfers, 2021," by P. Wezeman, 2021, *Stockholm International Peace Research Institute.*

Consolidation following the Cold War was a response to the changing defense landscape. Declining budgets killed off many small players and the new export environment meant scale

and the ability to produce for many countries was crucial. Fast forward to today and we can see the lasting of effects. Today, most contracts are awarded to the five defense "primes," these are: Lockheed Martin, Northrop Grumman, Boeing, General Dynamics and Raytheon (Sussman, 2021). These companies have been incredibly successful and have developed compelling products, but we may be starting to see some of the issues with such a consolidated industry. We can see how the share of contracts awarded to the top 5 contractors rose dramatically following the Cold War in Figure 3 below (Sussman, 2021).

**Figure 3**

*US Defense Spend and Market Share of Major Contractors 1985-2001*




Note: Top contractors share of defense spend clearly picks after mergers in the early 90s. From "DOD Contractor Mergers Upped Use of No-Bid Cost-Plus Deals," by A. Sussman, 2021, *National Bureau of Economic Research*.

Numerous studies by academics have indicated that as industries become more concentrated among a few major players, prices increase, productivity growth slows and consumer surplus decreases (Schechter, 2019). A 2017 game theory model by researchers in

Imperial College London found that horizontal mergers reduced the incentives for firms to invest in research and development. A follow up study by the same group further found that price coordination and consumer welfare decreased if the merger didn't result in added cost efficiencies (Federico et al, 2017). Studies looking at the healthcare industry, another industry that is heavily regulated and is also often quite consolidated (when we look at regional healthcare providers) find similar results. Employee wages typically stagnate as the degree of consolidation increases. This makes sense as employees lack alternatives (Prager & Schmidt, 2019). Additionally, the cost of care typically increases as the number of hospitals in an area decreases (Levins, 2023).

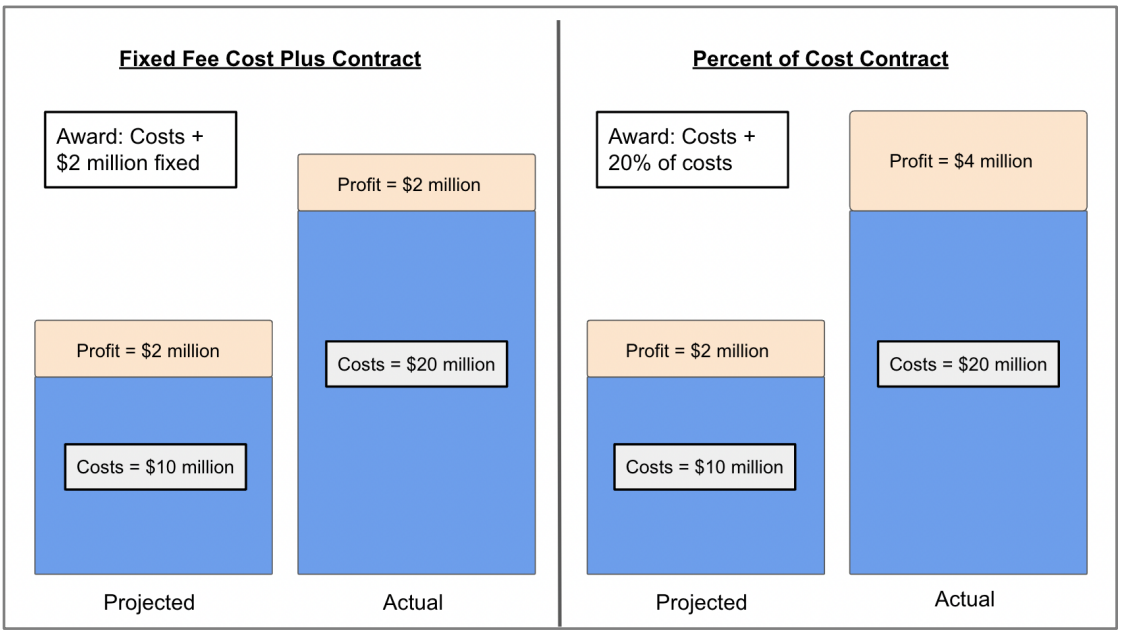
In defense specifically, the impacts of consolidation are known by employees and executives. Ben Rich, the former director of SkunkWorks noted "the open secret in our business was that the government practiced a very obvious form of paternalistic socialism to make certain that its principal weapons suppliers stayed solvent and maintained a skilled workforce" (Rich, 1996). With so few players creating critical equipment, the US government cannot afford to see a Northrop Grumman, or a Boeing fail. A 2018 paper by Stanford economists found that consolidation in defense has decreased competition in the procurement process with an increase of contracts being awarded with single bid solicitations and an increase in cost-plus vs fixed price contracts. On the other hand, the paper did not find evidence that this resulted in an increased acquisition cost of weapons technology. The authors believe because the US government is often the sole customer, this gives the government tremendous negotiating power (Carrill & Duggan, 2018). This is a counterargument worth considering in the analysis section.

Cost plus is the second industry dynamic that is prevalent in defense contracting in a way that it is not in most other industries. Unlike traditional contracts that fix the economics of a

project, cost plus contracts are structured so that the awarded contractor is paid either a fixed amount (fixed fee) or a percentage above the cost (percent of cost) to produce a good or service. DOD cost-plus contracts today use the fixed fee cost plus model because percent of cost contracts incentivize cost overruns as shown in Figure 4 below (profit increases with costs).

**Figure 4**

*Example contract award with the fixed fee cost plus and percent of cost contract models*




The upside of the fixed fee cost-plus arrangement we see today is contractors are willing to take on projects that are difficult, may see cost overruns or have uncertain payoffs. However, even fixed fee cost-plus contracts fail to incentivize cost cutting like we see in industries where customers are price sensitive (contractors profit the same either way since costs are passed onto the government). The dramatic explosion in the price of aerospace parts and technologies is well documented and this may be a large part of the reason. From 2004 to today, the aggregate price of Aerospace parts has increased +60%. This is opposed to a +25% increase in automotive parts

and a 27% decrease in semiconductors (US Bureau of Labor Statistics, 2023). Cost increases are to be expected given general inflationary pressures, but we can see that in other industries selling to consumers companies have found ways to leverage scale and cut costs much more than in Aerospace.

The usage of cost-plus contracts in the United States began in earnest during WWI, but truly took off in the Cold War with fears of the Soviet Union surpassing the US in weapons and space technology. There was a view that the US needed to catch up no matter the cost or risk a national security crisis (Fletcher, 1996). The Apollo program is a great example of this mentality where the US spent an astonishing $257 billion in today's dollars but was able to rapidly catch up and surpass the USSR following Sputnik.

In analyzing this topic, I employed the actor network theory framework. This framework is typically associated with Michel Callon, Bruno Latour and John Law (Callon, 1999; Latour, 1992; Law, 1992). This framework was initially developed to understand the process of innovation and knowledge creation and is particularly useful when applied to the defense sector where so many human and non-human players are involved. Large projects like the F-35 program have thousands of human actors but also regulatory bodies, material constraints and corporate entities that impact how these human actors behave and how technology is developed. Actor network theory also provides support for the idea that even as each actor behaves well, their interactions and the system's structure can create issues.

**Methods:**

Data was primarily gathered through academic studies and the use of interviews to see how current executives and DOD officials are viewing the industry. Academic studies were used

both to analyze the history of the defense industry and develop a "base rate" for what typically happens in situations like these. For example, when industries consolidate, what is often the impact, and can we transfer these finding to the defense industry specifically? This is the reason studies on healthcare or game theory analyses are employed. Additionally, Actor Network Theory was employed to show that even as individuals make rational and ethical choices, the incentives and interplay between actors in the defense industry can cause suboptimal outcomes.

**Analysis:**

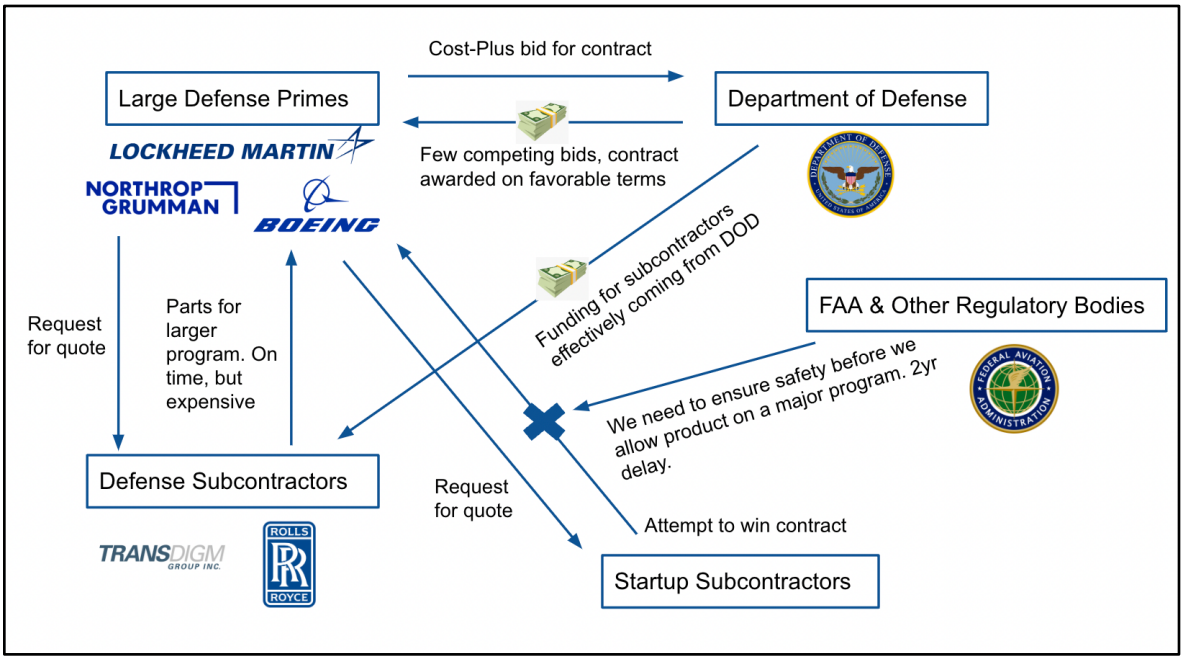
It is clear from the literature review that the defense industry has become incredibly consolidated and that there are often negative consequences of consolidation. This is an issue that is also starting to get increased attention from regulators, engineers, personnel at the Department of Defense (DOD) and investors. A former director of hypersonics at Northrop Grumman commented on the changing attitudes in a 2021 interview: "there have been rumblings among folks within the government [that] there's been too much consolidation certainly within the large defense contractors. And we need to get back to where we had multiple different defense contractors, so we can have competition to reduce costs" (Anonymous, 2021).

If we walk through an example contract award with actor network theory we can see how even as each individual player is acting with good intentions, their interplay can undermine the end goal of efficiently developing technology. Defense contractors bid for contracts with a cost-plus model because it protects their employees' jobs and profit margins if a new technology does not work as expected. Without any competitors willing to offer a fixed price contract and in need of advanced military technology, the government picks between the few prime contractors who submitted a proposal. Once awarded, the prime contractor works with numerous smaller subcontractors to get parts for the large defense project. These subcontractors know the prime

contractor is largely price insensitive (since costs will be passed onto the government) so they are able to charge a premium for parts. They have a duty to their shareholders and employees to do this. Furthermore, since it is extremely difficult to get FAA approval for aircraft parts, subcontractors know it is unlikely a competitor will develop a substitute and undercut their price. Additionally, once a subcontractor is selected for a multiyear program, it likely won't make financial sense to swap to another company mid-way through a program. From the FAAs perspective, regulations are necessary to keep both civilian and military aircraft safe, but this has the unnecessary externality of entrenching existing players. All these actors in this chain of events are acting rationally, but the system has created an actor-network that undermines the rapid innovation seen in other technology industries today or in defense following WWII. If we want sustained change in defense innovation, it is likely the structure of this system that needs to be adjusted. Figure 5 below shows a simplified actor-network for a defense contract award.

**Figure 5**

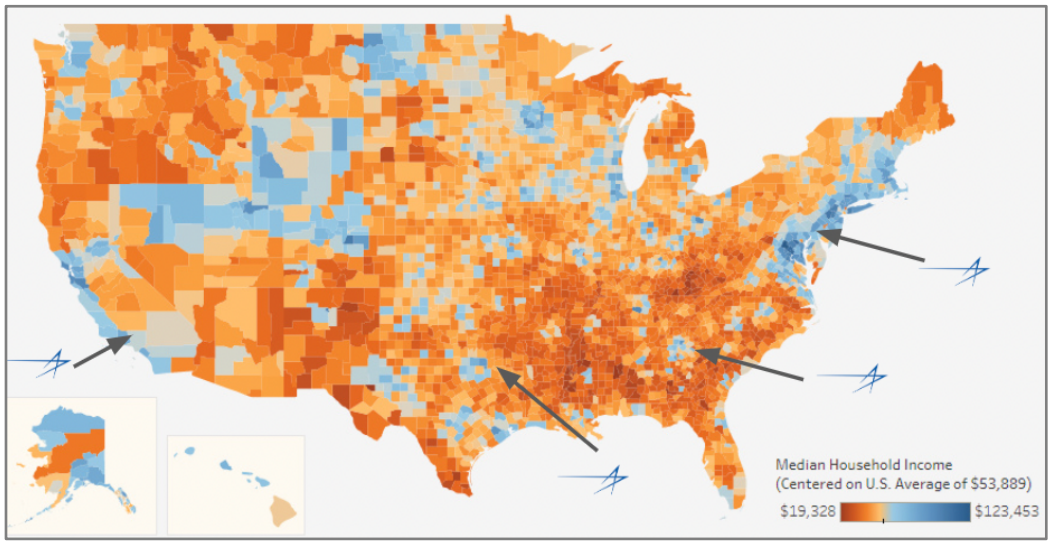
*Example Actor Network for a Defense Contract Award*



This situation becomes even more complicated when we consider politics and lobbying. Lobbying can be an effective tool to inform politicians about prescient issues and argue for a course of action. In the lens of actor network theory, we can consider lobbying as a form of delegation, whereby politicians allow companies and lobbyists to do the legwork of understanding a specific issue, so they don't have to spend hours researching numerous topics themselves. However, it clearly favors those with resources and consolidation has created a few major players that are extremely well funded. The largest defense players can significantly outspend any startups or smaller players on political influence. Furthermore, contractors employ hundreds of thousands of Americans, and these are often high paying jobs in politically important areas. We can see today that major defense contractor locations are clustered around many of the highest income areas in America in Figure 6 below (Desjardins, 2019). There is a feeling this may result in unfair contract awards (Rich, 1996).

**Figure 6**

*US median household income by county overlaid with the approximate location of the 4 largest Lockheed Martin facilities.*



Note: This figure overlays a US median income map with the 4 largest Lockheed Martin facilities in Dallas-Fort Worth, Marietta, Palmdale and Bethesda. Median income map from "Interactive: Visualizing Median Income for all 3,000+ U.S. Counties," by J. Desjardins, 2019. *Visual Capitalist.*

The view that a change is needed in the defense industry is increasingly becoming the consensus, but it is important to also note some important counterarguments to this view. First off, some argue that as projects and technology get more advanced, long development times are inevitable. If you are pushing the boundaries, it is difficult to operate in a low-cost fashion or meet deadlines because by definition, this hasn't been done before. Furthermore, this slowdown in progress also seems to be mirrored in other hardware-based industries over the past three decades. Our ships, infrastructure, cars and houses are largely the same as they were in the 90s. This parallels Peter Thiel's famous "bits vs atoms" thesis, suggesting that we are innovating in computing space but failing to do so in the physical world (Thiel & Masters, 2015). This argument has a lot of merit, and many hardware industries may need a revitalization in order to drive progress outside of software businesses and Silicon Valley. However, the defense industry is unique in its storied history of leading the country in knowledge-creation and then falling off significantly after the structural changes following the Cold War. In 1945 the P-80 shooting star was built in 143 days and later in 1957 the U2 spy plane took just 9 months (Hudson, 2021). Yet more recently, the F-35 took over a decade and the B21 raider (the upgrade to the B2 bomber) came out 30 years after its predecessor. Internal studies have a similar view, in 2022, the US GAO (Government Accountability Office) found that the DOD consistently takes longer and spends more than projected and that this is getting worse. However, it also gave examples of what was done right in projects that were completed on time, indicating we can learn from these

examples (Oakley, 2022). There are instances where we can rapidly innovate, so we need to identify what is going right with these projects and build off this.

A second counterargument is that a newfound focus on costs will fail to incentivize contractors to take on uncertain R&D projects and that cost cutting could undermine their product quality, ultimately hurting US soldiers. This is a fair point, and it is important to recognize that cost is not everything. A lot of this paper has focused on the issues with costs and efficiency present in the defense space, but often, you get what you pay for. Safety, security and ethics are of the utmost importance when dealing with dangerous weapons technology. However, at the same time, there are clear examples of contractors abusing the cost-plus model to charge exorbitant prices that are passed onto the taxpayer. The high-profile example is that of Transdigm, a conglomerate of small aircraft part manufacturers that was found by the Office of the Inspector General to have overcharged for 105/107 of parts sold to the DOD from 2017-2019 (Committee on Oversight and Reform, 2022). Transdigm failed to show accurate cost data to the DOD and saw profit margins exceeding 15% on these 105 parts. Transdigm was also the sole contractor on 94 of these parts. In a highly competitive market or one where costs are heavily scrutinized, it is unlikely Transdigm could have gotten away with this. Additionally, although the worry that cutting costs could undermine quality is important to consider, many companies are able to balance cost and quality, building great products and finding areas to eliminate unnecessary costs. A balance needs to be found if the US is to stay competitive in the defense space. Right now, ballooning costs are slowing down the rate that new technology is developed. The US sets a fixed defense budget every year, if that money can be used more efficiently, everyone benefits.

**Conclusion:**

For better or for worse, developing new defense technologies is crucial for the national security of the US and its allies. Russia's unprovoked invasion of Ukraine is evidence of what can occur when an enemy nation state believes they have a military advantage (Pfifer, 2020). Many of us can have an impact on this vitally important space, investors can fund the companies they believe need to exist in defense, engineers can work for organizations that embody the culture they want to see, and policy makers can reevaluate how contracts are awarded, or how defense is regulated. I'm hopeful that by reading this paper, all these actors can be better informed on making these decisions and better understand some of the flaws with the current model.

This paper seeks to provide evidence on some of the areas that need to change. However, although pushing for change is important, we need to be very careful and deliberate about how exactly the future system should be structured. Today's defense industry does many things right and it is vital not to move backwards in trying to fix the current flaws. This is the natural extension to this paper, what should the future of the US defense industry look like? Future research to answer this question needs to be done. Furthermore, a more quantitative analysis on this topic could be particularly useful since one of the shortcomings of my current methodology is a lack of quantitative evidence. A study like the one referenced in this paper by the GAO (but one going further and more standardized) could help supplement the argument presented in this paper. A systematic review of the cost and timeline of hundreds of government projects could provide the hard evidence necessary to fuel change, since policy and decision makers are often more receptive to data gathered in a standardized and quantitative fashion.

Yes, there are flaws with the way the system is currently set up, but there remains a huge pool of talent and decades of research to build on. Not only can we change how the defense industry is structured, but this has also already begun. Startups like Anduril and SpaceX are attempting to revitalize the culture in the industry and seeing tremendous success. The prime contractors also don't need to be replaced, they have some of the most knowledgeable personnel and valuable intellectual property in the world. The talent, resources and motivation are there and have always been there. Now it's time to tweak the industry's structure so innovation can flourish.

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