CSIS BRIEFS

Cycle Times and Cycles of Acquisition Reform

By Morgan Dwyer, Brenen Tidwell, and Alec Blivas

AUGUST 2020

THE ISSUE

Acquisition reform occurs in cycles. For example, to increase acquisition speed, the most recent cycle restructured the Pentagon to reduce and decentralize the Office of the Secretary of Defense's (OSD) oversight of major defense acquisition programs (MDAPs). Using a qualitative and quantitative analysis of past reform cycles and MDAP cycle times (i.e., the time to field new capabilities), this analysis observes that:

- *Even though OSD oversight activities take time, they do not appreciably slow down MDAP acquisition speed;*
- *Instead, strong, centralized OSD oversight may reduce MDAP cycle times and cycle time growth; and*
- *The Pentagon has historically fielded new MDAP capabilities at average speeds that are comparable to external benchmarks.*

Based on these findings, recent reforms—which reduced and decentralized OSD oversight—may not increase MDAP acquisition speed. And although the Pentagon does field some MDAPs quite slowly, reformers should not use the experience of worst-case programs to motivate future reforms of the entire acquisition system.

INTRODUCTION

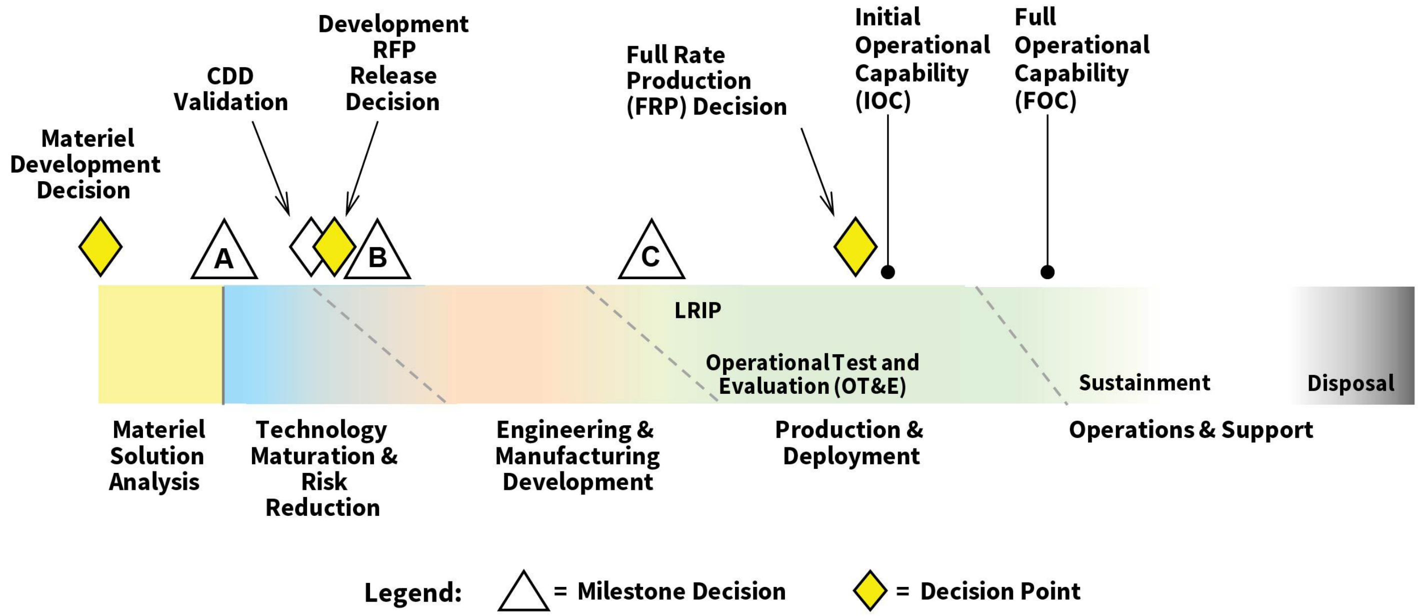
In defense acquisition, reform is constant. Over the past six decades, reforms have been initiated, implemented, and evaluated, only to be initiated all over again. This pattern—and its repetition throughout history—has led some to describe acquisition reform as a "never-ending cycle" whereby discrete periods of time are characterized by different initiatives.[1] Although these initiatives consistently seek to reduce cost, shorten schedules, and increase performance, reformers' priorities have varied throughout history. Today's reformers, for example, are focused primarily on acquisition speed (e.g., see the National Defense Authorization Act (NDAA) 2016 Secs. 804, 810, 821, 823, 825 and NDAA 2017 Secs. 805, 806, 807, 901).[2]

Reformers' focus on speed is due, in part, to perceptions that U.S. technological advantage vis-à-vis its adversaries is eroding and that the timelines to field new capabilities are dramatically different between the Department of Defense (DOD) and the U.S. private sector.[3] To evaluate those perceptions, this brief compares MDAP cycle times to external benchmarks. It also evaluates recent reforms' potential to increase acquisition speed by comparing cycle time statistics across the various cycles of acquisition reform.

ACQUISITION SPEED

Today's reforms aim to speed up the acquisition process as defined by DOD Directive 5000.1. The traditional process, depicted in Figure 1, consists of several milestones. At each milestone, senior DOD officials review progress and determine whether programs should continue to the next phase. Traditionally, officials from the OSD have reviewed and approved DOD's largest programs (i.e., MDAPs).

Figure 1: Traditional Acquisition Process



Source: Department of Defense, *Operation of the Defense Acquisition System* (Washington, DC: Department of Defense, January 2015), Instruction Number 5000.02T, 12, https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002T.PDF?ver=2020-01-23-144112-220.

DOD typically initiates MDAPs at milestone B, after which full-scale system engineering begins. Next, DOD reviews system designs at milestone C. Pending milestone approval, programs begin low-rate production and system testing. Once test results are satisfactory, DOD certifies that programs have reached initial operating capability (IOC) and that systems are ready for use.

Today's reforms aim to shorten the time spent between program initiation and IOC. To achieve this objective, reformers created alternative acquisition pathways (e.g., NDAA 2016 Sec. 804's "middle tier acquisition") that largely eschew traditional, OSD-led oversight activities.[4] Reformers also delegated much of OSD's authority to conduct MDAP milestone reviews back to the military services.[5]

Given their attention to speed, reformers' focus on OSD oversight is unsurprising. Oversight—which often takes the form of reporting requirements and reviews—can lengthen program schedules by adding activities that take time to complete. For example, the Government Accountability Office found that, in a sample of 24 programs, staff spent an average of two years completing the steps necessary to pass an OSD-led milestone review and 5,600 total staff days documenting that work.[6] Relatedly, RAND found that 5 percent of a program office staff's time was dedicated to regulatory and statutory compliance,[7] and researchers at the George Washington University found that between 5 and 40 percent of a contractor's time was spent complying to oversight requirements.[8] By decentralizing and delegating acquisition oversight, today's reformers hope to reduce the time that programs dedicate to OSD-led oversight activities, thereby shortening the duration between program initiation and IOC. DOD, through its *National Defense Strategy,* has embraced reformers' focus on speed and affirmed that it must "deliver performance at the speed of relevance."[9]

REFORM CYCLES

Importantly, today's focus on speed is not unique. Rather, recent moves to decentralize OSD oversight follow nearly six decades and multiple cycles of prior acquisition reform. Although the specifics of each reform initiative are distinct and complex, from a macroscopic perspective it is possible to characterize past cycles according to the mechanisms that reformers employed. This brief focuses on one mechanism—OSD oversight's centralization or decentralization—which has been both the focus of prior research and which uniquely affects MDAPs.[10] The brief acknowledges, however, that reformers sometimes employ multiple mechanisms simultaneously and that these mechanisms may interact in non-simple, non-obvious ways. This analysis, therefore, provides just one perspective on acquisition reform cycles and MDAP cycle times.

Acknowledging these limitations, Table 1 identifies eight reform cycles—including today's—and classifies those cycles according to their preference for centralized or decentralized oversight.[11] These cycles are also summarized briefly below:

Table 1: Cycles of Acquisition Reform

Cycle Type	Reform Cycle
Centralized Oversight	McNamara Reforms (FY 1963-1969)
	Brown Strengthens Control (FY 1977-1982)
	Defense Acquisition Board (FY 1990-1993)
	Weapon Systems Acquisition Reform Act (FY 2010-2017)
Decentralized Oversight	Defense Systems Acquisition Reform Council (FY 1970-1976)
	Acquisition Improvement Program (FY 1983-1989)
	Mandate for Change and Transformation (FY 1994-2009)
	Restructuring AT&L (FY 2018-present)

Source: Fox, *Defense Acquisition Reform 1960*-2009; Levine, *Defense Management Reform*; Lewis et al., *Acquisition Reform Regimes on Their Own Terms*; Hunter, "The Cycles of Defense Acquisition Reform and What Comes Next"; McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process* 2014; and CSIS analysis.

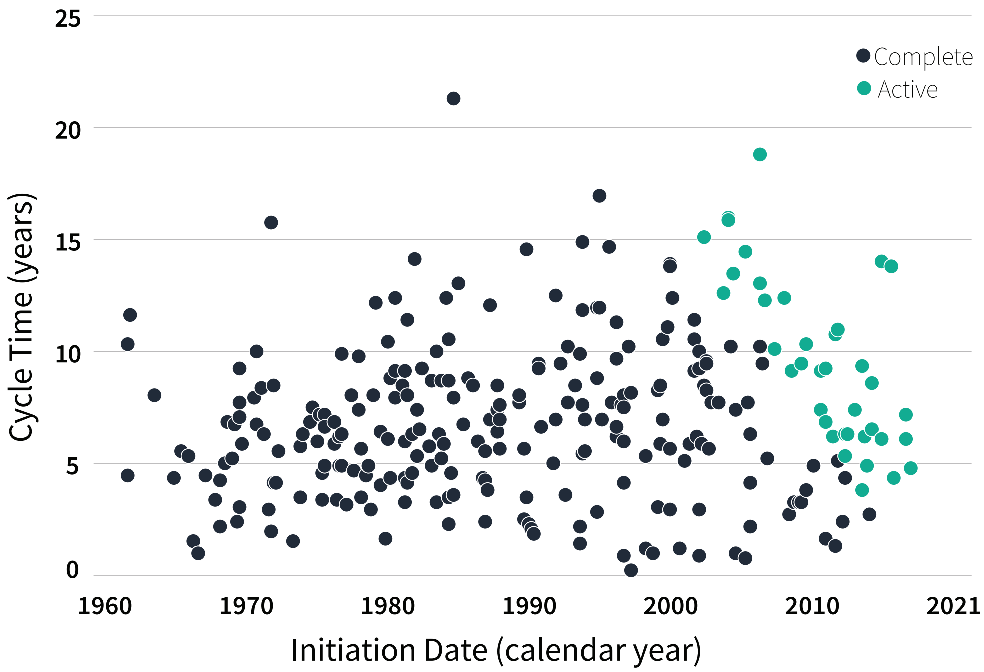
1. **McNamara Reforms:** Secretary Robert McNamara leveraged authorities granted by the DOD Reorganization Act of 1958 to centralize OSD control over military service budgets and major program decisions.[12]
2. **Defense Systems Acquisition Reform Council:** Deputy Secretary David Packard created the Defense Systems Acquisition Reform Council (DSARC) to limit OSD involvement in the acquisition process. Through the DSARC, OSD assessed programs at discrete milestones but otherwise delegated management responsibility to the military services.[13]
3. **Brown Strengthens Control:** In response to Packard's "management by objective" approach, Secretary Harold Brown sought to regain and centralize OSD authority over the acquisition process.[14]
4. **Acquisition Improvement Program:** In response to Brown's tighter OSD control, Secretary Caspar Weinberger and Deputy Secretary Frank Carlucci initiated the Acquisition Improvement Program to enable the "controlled decentralization" of OSD's authority.[15]
5. **Defense Acquisition Board:** Congress initiated a series of reforms—including the creation of an undersecretary of defense for acquisition—aimed at centralizing and strengthening OSD control over the acquisition process.[16] Toward this end, OSD established the Defense Acquisition Board to oversee MDAPs throughout their lifecycle.[17]
6. **Mandate for Change and Transformation:** During this extended period—which spanned nearly two administrations—OSD emphasized deregulation and management streamlining but not scrupulous oversight of early program decisions.[18] DOD also heavily relied on Total System Performance Responsibility (TSPR) contracts during this period. These contracts delegated a significant amount of authority and responsibility to DOD contractors and in doing so eroded the department's ability to conduct rigorous oversight.[19]
7. **Weapon Systems Acquisition Reform Act:** Responding to cost growth during the prior cycle, Congress implemented a series of reforms aimed at centralizing OSD authority—especially over early program milestones.[20] OSD's Better Buying Power initiative attempted to further strengthen program management throughout the system lifecycle.[21]
8. **Restructuring AT&L:** Today's reformers intend to increase acquisition speed and strengthen DOD's technological edge by splitting up the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics into two separate offices. To reduce cycle times, the procurement-focused office has delegated much of its oversight authority to the military services.[22]

These cycles provide a framework for assessing DOD's historic acquisition speed. Specifically, by classifying programs according to reform cycle or cycle type (i.e., centralized or decentralized oversight), it is possible to observe past reforms' macroscopic impact on acquisition speed. This analysis can then be used to inform expectations for today's reforms and to help benchmark DOD's future "speed of relevance."

CYCLE TIMES

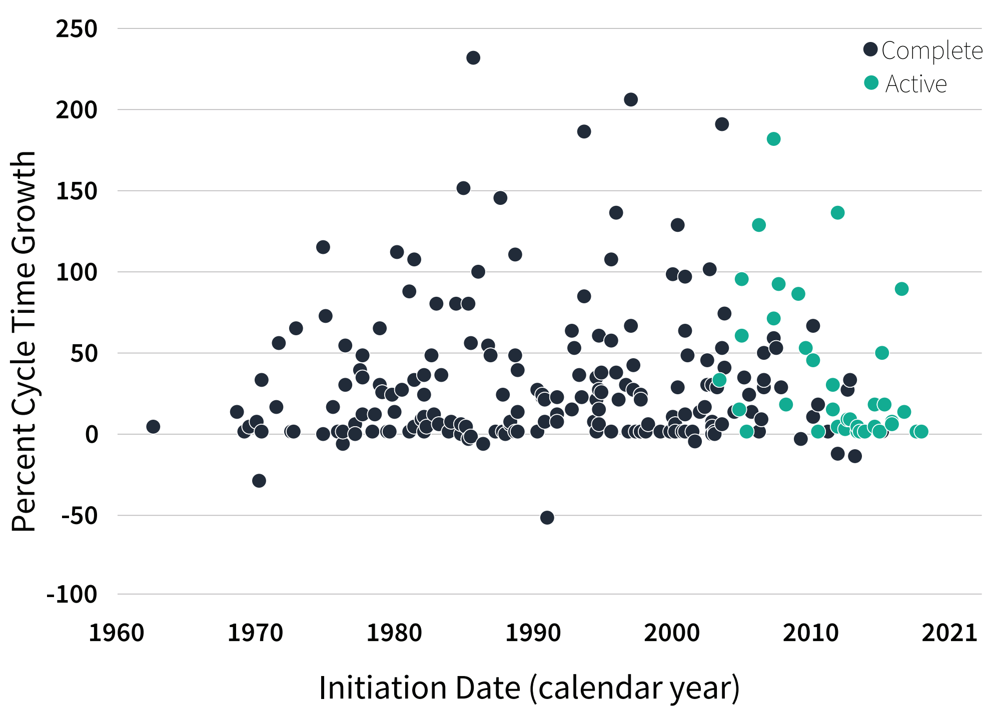
Acquisition speed can be assessed using two variables: **cycle time** and **cycle time growth**. Cycle time is the time elapsed between program initiation (typically milestone B, but sometimes milestone C) and IOC.[23] **Cycle time growth** is the percent change in a program's estimated and actual cycle time.[24] Cycle time, therefore, represents the speed with which DOD fields new capabilities. Cycle time growth represents

Figure 2: Cycle Times (Active and Complete MDAPs, FY 1963-present)



Source: DAMIR; RAND Defense Systems Cost Performance Database; and CSIS analysis.

Figure 3: Cycle Time Growth (Active and Complete MDAPs, FY 1963-present)



Source: DAMIR; RAND Defense Systems Cost Performance Database; and CSIS analysis.

the accuracy with which DOD is able to predict that speed.

Using data from the Defense Acquisition Management Information Retrieval (DAMIR) System and RAND's Defense Systems Cost Performance Database,[25] cycle time and cycle time growth were calculated for all MDAP programs and subprograms for which data was available.[26] MDAPs represent DOD's most costly and complex programs; therefore, in many ways, they are not representative of much of the technology that DOD acquires. However, MDAP data is readily available. Furthermore, changes to OSD oversight affect MDAPs more significantly than any other programs. For these reasons, this analysis and its conclusions are limited to MDAPs only.

Additionally, several assumptions were made when collecting and labeling data. Most importantly, it is assumed that MDAPs are most significantly affected by the policies in place at program initiation.[27] Therefore, even if MDAPs spanned more than one reform cycle, they are classified according to the cycle in which they were initiated. It is also important to note that MDAP schedule data is not always reliable or of high quality; therefore, many other assumptions were also required to collect data and these assumptions may affect the analysis results. For more detail on the data collection and analysis assumptions used in this brief, please refer a forthcoming report on this topic, as well as to the detailed endnotes provided at the conclusion of this brief.[28]

Ultimately, schedule data was collected for over 200 active and complete MDAP programs and subprograms that DOD initiated from fiscal year (FY) 1963 to the present.[29] Using this data, it can be observed that despite numerous reform cycles, acquisition speed has remained

Table 2: Reform Cycles and Cycle Times (Complete and Active, FY 1963-present)

#	Reform Cycle	Type	Mean	Median	Max.	Min.	N
1	McNamara Reforms (FY 1963-1969)	Centralized	5.0 yrs	4.3 yrs	11.5 yrs	0.9 yrs	13
2	Defense Systems Acquisition Reform Council (FY 1970-1976)	Decentralized	6.1 yrs	6.2 yrs	15.7 yrs	1.4 yrs	30
3	Brown Strengthens Control (FY 1977-1982)	Centralized	6.3 yrs	6.0 yrs	12.3 yrs	1.5 yrs	38
4	Acquisition Improvement Program (FY 1983-1989)	Decentralized	7.1 yrs	6.4 yrs	21.2 yrs	2.2 yrs	48
5	Defense Acquisition Board (FY 1990-1993)	Centralized	6.4 yrs	6.6 yrs	14.5 yrs	1.8 yrs	15
6	Mandate for Change and Transformation (FY 1994-2009)	Decentralized	8.0 yrs	7.8 yrs	18.7 yrs	0.1 yrs	90
7	Weapon Systems Acquisition Reform Act (FY 2010-2018)	Centralized	6.0 yrs	5.7 yrs	12.3 yrs	1.3 yrs	26
	Total		*6.9 yrs*	*6.6 yrs*	*21.2 yrs*	*0.1 yrs*	*260*

Source: DAMIR; RAND Defense Systems Cost Performance Database; Fox, *Defense Acquisition Reform 1960*-2009; Levine, *Defense Management Reform*; Lewis et al., *Acquisition Reform Regimes on Their Own Terms*; Hunter, "The Cycles of Defense Acquisition Reform and What Comes Next"; McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process* 2014; and CSIS analysis.

Table 3: Reform Cycles and Cycle Time Growth (Complete and Active MDAPs, FY 1963-present)

#	Reform Cycle	Type	Mean	Median	Max.	Min.	N
1	McNamara Reforms (FY 1963-1969)	Centralized	3.3%	0.8%	11.4%	0.0%	4
2	Defense Systems Acquisition Reform Council (FY 1970-1976)	Decentralized	22.2%	5.3%	112.5%	-31.7%	15
3	Brown Strengthens Control (FY 1977-1982)	Centralized	26.5%	21.4%	110.1%	-8.5%	29
4	Acquisition Improvement Program (FY 1983-1989)	Decentralized	35.4%	7.8%	229.9%	-8.0%	38
5	Defense Acquisition Board (FY 1990-1993)	Centralized	15.4%	18.4%	62.0%	-53.6%	13
6	Mandate for Change and Transformation (FY 1994-2008)	Decentralized	39.4%	25.8%	204.2%	-7.1%	86
7	Weapon Systems Acquisition Reform Act (FY 2010-2017)	Centralized	20.2%	7.5%	134.0%	-15.2%	24
	Total		*31.3%*	*15.4%*	*229.9%*	*-53.6%*	*209*

Source: DAMIR; RAND Defense Systems Cost Performance Database; Fox, *Defense Acquisition Reform 1960*-2009; Levine, *Defense Management Reform*; Lewis et al., *Acquisition Reform Regimes on Their Own Terms*; Hunter, "The Cycles of Defense Acquisition Reform and What Comes Next"; McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process* 2014; and CSIS analysis.

relatively constant throughout history. As can be seen in Figures 2 and 3, acquisition speed—at least for complete MDAPs—has not significantly changed over time.[30] Although an association between speed and initiation date for active programs was observed, these differences are not attributed to distinctions between active and complete MDAPs.[31] Rather, it is more likely that active programs may have optimistically estimated their cycle times and may be too immature to have yet experienced much cycle time growth. To avoid this maturity bias in subsequent analysis, only complete MDAPs or active MDAPs that are at least five years past their initiation date were included.[32]

Overall, DOD has historically fielded MDAPs with average cycle times of 6.9 years and with 31.3 percent cycle time growth. DOD's historic median for cycle time and cycle time growth was 6.6 years and 15.4 percent cycle time growth, respectively. These statistics stand in contrast to much of the rhetoric surrounding recent reforms, which frequently suggests that DOD's historic cycle times are much longer.[33]

The data also yields insights when viewed through the lens of historic reform cycles. Table 2 shows that earlier reform cycles (i.e., cycles #1-3) had lower mean and median cycle times relative to more recent cycles (i.e., cycles #4-6). Although the distribution of cycle times was significantly different between groups, this difference cannot be attributed to changes in oversight type, since OSD oversight was both centralized and decentralized during both periods.[34] Future research, therefore, should explore alternative explanations for the difference between early and later reform cycles.

Tables 2 and 3 also show that cycle #7, which immediately preceded today's reforms, marked an increase in acquisition speed compared to the cycle immediately prior (i.e., cycle #6). In this instance, differences in both the cycle time and

Table 4: Cycle Type and Cycle Times (Complete and Active MDAPs, FY 1963-present)

Cycle Type	Statistics	Mean	Median	Max.	Min.	N
Centralized Oversight	Cycle Time	6.1 yrs	5.7 yrs	14.5 yrs	0.9 yrs	92
	Cycle Time Growth	20.9%	10.9%	134.0%	-53.6%	70
Decentralized Oversight	Cycle Time	7.4 yrs	7.0 yrs	21.2 yrs	0.1 yrs	168
	Cycle Time Growth	36.5%	21.4%	229.9%	-31.7%	139

Source: DAMIR; RAND Defense Systems Cost Performance Database; Fox, *Defense Acquisition Reform 1960*-2009; Levine, *Defense Management Reform*; Lewis et al., *Acquisition Reform Regimes on Their Own Terms*; Hunter, "The Cycles of Defense Acquisition Reform and What Comes Next"; McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process* 2014; and CSIS analysis.

percent cycle time growth distributions were statistically significant.[35] This finding suggests that the reforms implemented during cycle #7 positively impacted program outcomes, at least as compared to the cycle immediately prior. Further, this improvement does not suggest an urgent need to reform the acquisition process, as reformers ultimately did by decentralizing OSD oversight in cycle #8.

Additionally, the historical data shows little evidence that decentralizing OSD oversight actually increases acquisition speed. Instead, as shown in Table 4, MDAPs initiated during periods of decentralized oversight reached IOC an average of 15.6 months slower than MDAPs initiated during periods of centralized oversight. Furthermore, the disparity in medians was also substantial, with MDAPs initiated during periods of decentralized oversight reaching IOC 15.6 months slower. The difference in distributions was also statistically significant: suggesting that decentralizing OSD oversight may not be an effective mechanism for reducing MDAP cycle time.[36]

Similarly, the data shows that MDAPs initiated during periods of decentralized oversight experienced an average of 15.6 percent more cycle time growth. The difference in medians—10.5 percent—was also substantial; however, the difference in distributions had a lower level of statistical significance than the comparisons described above.[37] That said, these results still suggest that decentralizing OSD oversight may not be an effective mechanism for reducing MDAP cycle time growth.

This analysis suggests that even though OSD oversight activities take time, they do not result in appreciably longer MDAP cycle times or higher rates of cycle time growth. Instead, it seems likely that other technical factors—such as system type and complexity—may determine an MDAP's critical path and schedule duration. Additionally, the data suggests that strong, centralized OSD oversight may reduce cycle times and cycle time growth—perhaps by serving as a "check" on the military services' tendency to "sell" their programs using optimistic cost and schedule estimates.[38]

Overall, the data also suggests that today's reforms—cycle #8, which decentralized OSD oversight—may not increase MDAP acquisition speed in the future. Given the *National Defense Strategy's* intent to "deliver performance at the speed of relevance," this outcome seems troubling.[39] Thankfully, by comparing the historic MDAP data to external benchmarks, there are some indications that—despite decades of reform—DOD's acquisition system, on average, may already field systems at the "speed of relevance."

Even though OSD oversight activities take time, they do not result in appreciably longer MDAP cycle times or higher rates of cycle time growth; instead, strong, centralized OSD oversight may help increase MDAP acquisition speed.

ASSESSING THE "SPEED OF RELEVANCE"

To assess whether DOD fields systems at the "speed of relevance," DOD cycle times were compared to external benchmarks from the U.S. private sector and China's People's Liberation Army (PLA). The comparisons are limited, however, by the availability and quality of open-source data. The best option, therefore, is to compare the data set of over 200 MDAP cycle times to a handful of benchmark systems with rough schedule estimates.

To estimate non-DOD cycle times, the analysis leverages a DARPA report that contains data on the U.S. private sector and uses open-source reporting on PLA systems. In both instances, it is assumed that the dates reported are consistent with the definitions of program initiation and IOC the definitions of program initiation and IOC that were used for MDAPs. For PLA systems in particular, program initiation dates were identified using media reports which stated when the PLA began system development or issued contracts. Such assumptions, of course, limit the ability to draw definitive conclusions. As such, U.S. private-sector and PLA cycle times were used only as rough benchmarks for the "speed of relevance."

093 Shang-class submarine and the Type 052A destroyer in approximately 10 years.[44] Notably, the PLA appears to have fielded its new aircraft carrier, the Type 001A *Shandong* (CV-17), rather quickly, in approximately five years.[45] Compared to DOD capabilities, however, many of these benchmark systems appear inferior by at least some performance metrics.[46] In each example, however, the PLA's cycle times do appear to outpace DOD's worst-case cycle times.

Table 5: Cycle Times by Platform Type (Complete and Active MDAPs FY 1963-present)

Platform	Mean	Median	Max.	Min.	N
Aircraft	6.6 yrs	6.4 yrs	14.5 yrs	0.9 yrs	56
C4I	6.6 yrs	6.6 yrs	18.7 yrs	0.1 yrs	51
Helicopter	8.0 yrs	6.5 yrs	21.2 yrs	0.9 yrs	20
Missile/Munitions	6.8 yrs	6.7 yrs	14.6 yrs	1.5 yrs	74
Satellite	8.8 yrs	8.2 yrs	16.8 yrs	4.2 yrs	17
Ship/Sub	7.5 yrs	6.0 yrs	15.8 yrs	1.3 yrs	31
Vehicle	4.6 yrs	4.5 yrs	8.7 yrs	0.7 yrs	11
Total	***6.9 yrs***	***6.6 yrs***	***21.2 yrs***	***0.1 yrs***	***260***

Source: DAMIR; RAND Defense Systems Cost Performance Database; and CSIS analysis.

Acknowledging these limitations and using DARPA's U.S. private-sector data, commercial aircraft cycle times increased from approximately four to seven years since 1965.[40] Commercial vehicle cycle times decreased during this time, from approximately seven to two years.[41] As shown in Table 5, DOD's mean aircraft and vehicle cycle times are consistent with the U.S. private sector, but DOD's worst-case MDAPs significantly exceeded private-sector cycle times. As above, Table 5 contains all complete MDAPs and active MDAPs initiated between FY 1963 and FY 2014 for which data was available.

Based on limited, open-source data on example PLA systems, DOD average cycle times, for the most part, appear to outpace comparable PLA systems—even though the PLA frequently accelerates technology development using espionage, intellectual property theft, and foreign military procurement.[42] For example, although DOD's mean cycle time for aircraft is 6.6 years, the PLA appears to have fielded the J-20 and the Y-20 in approximately 15 and 10 years, respectively.[43] Compared to the DOD aircraft shown in Table 5, these example PLA cycle times are closer to DOD's worst-case cycle time for aircraft.

DOD's mean cycle time for subs and ships—7.5 years—also appears to outpace some open-source PLA examples. For instance, the PLA appears to have fielded both the Type

While these comparisons are limited by the availability and quality of data, examples of U.S. private-sector and PLA cycle times provide a rough benchmark for the "speed of relevance." Using this benchmark, it appears that DOD's acquisition system has, on average, historically fielded MDAPs at the "speed of relevance." Note, however, that several of DOD's worst-case cycle times did significantly exceed the cycle times of benchmark systems.

For these worst-case programs, further study is needed—ideally using rigorous qualitative methods such as process tracing—to map a program's activities from initiation to IOC and to identify bottlenecks that could be avoided in future programs.[47] Reformers should be cautioned, however, against using these worst-case programs to assess the performance of the *entire* acquisition system. A worst-case MDAP may have been slowed down by a myriad of factors (e.g., issues with requirements, personnel, funding, contracts, or the industrial base) that do not affect other programs in the same way. So, although DOD should learn from and address these issues on a case-by-case basis, the experience of worst-case programs should not be used to motivate future reforms of the entire acquisition system.

It appears that DOD's acquisition system has, on average, historically fielded MDAPs at the "speed of relevance."

THE FUTURE FOR REFORM

This brief demonstrates the utility of using acquisition history to improve the defense community's understanding of current and future reforms. Using a mix of qualitative and quantitative analysis, this brief observes that reforms which decentralize OSD oversight do not appreciably decrease MDAP cycle time. Instead, that centralized OSD oversight may help reduce cycle times and cycle time growth. Based on these findings, recent reforms—which instead decentralized OSD oversight—may be ill-suited to achieve their objective of increasing speed, at least for MDAPs. However, MDAPs are DOD's most costly and complex programs and do not represent all of the technology that DOD acquires. Acquisition reform itself is complex, and countless factors besides OSD oversight—including workforce, industrial base health, budget, and regulations—all affect acquisition speed in non-simple and non-obvious ways. This analysis contributes but one perspective on reform cycles and cycle times within an extensive history of acquisition reform. ■

__Morgan Dwyer__ is a fellow in the International Security Program and deputy director for policy analysis in the Defense-Industrial Initiatives Group at the Center for Strategic and International Studies (CSIS) in Washington, D.C. __Brenen Tidwell__ was a research intern with the Defense-Industrial Initiatives Group at CSIS. __Alec Blivas__ was a program coordinator with the International Security Program at CSIS.

This material is based upon work supported by the Acquisition Research Program under Grant No. HQ00341910011. The views expressed in written materials or publications, and/or made by speakers, moderators, and presenters, do not necessarily reflect the official policies of the Department of Defense nor does mention of trade names, commercial practices, or organizations imply endorsement by the U.S. government.

An earlier version of this paper was published in the Proceedings of the Seventeenth Annual Acquisition Research Symposium.

ENDNOTES

1. Peter Levine, *Defense Management Reform: How to Make the Pentagon Work Better and Cost Less* (Stanford, CA: Stanford University Press, 2020), 83. For additional discussion of reform cycles, please also see: J. Ronald Fox, *Defense Acquisition Reform 1960-2009: An Elusive Goal* (Washington, DC: Center for Military History United States Army, 2011), https://www.hbs.edu/faculty/Publication%20Files/11-120.pdf; Rosalind Lewis et al., *Acquisition Reform Regimes on Their Own Terms: Context, Mechanisms, Effects, and Space Program Impact* (El Segundo, CA: The Aerospace Corporation, 2019), https://aerospace.org/sites/default/files/2019-02/Lewis-Hastings_AcqReform_01302019.pdf; Rhys McCormick, Andrew Hunter, and Gregory Sanders, *Measuring the Outcomes of Acquisition Reform by Major DOD Components* (Washington, DC: CSIS, 2015), https://www.csis.org/analysis/measuring-outcomes-acquisition-reform-major-dod-components; David L. McNicol and Linda Wu, *Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth of Major Defense Acquisition Programs* (Alexandria, VA: Institute for Defense Analyses, 2014), https://apps.dtic.mil/dtic/tr/fulltext/u2/a609472.pdf; and Andrew Hunter, "The Cycles of Defense Acquisition Reform and What Comes Next," *Texas A&M Journal of Property Law* 5, no. 1 (2018): 37-56, https://scholarship.law.tamu.edu/journal-of-property-law/vol5/iss1/3.

2. National Defense Authorization Act for Fiscal Year 2016, Pub. L. 114-92 (2015); and National Defense Authorization Act for Fiscal Year 2017, Pub. L. 114-328 (2016).

3. For example, Senator John McCain stated "America's technological advantage is eroding—and fast. Over the last decade, our adversaries have invested heavily in modernizing their militaries with a focus on anti-access and area denial technologies specifically to counter American military strengths. Our adversaries are building weapon systems while we shuffle paper. If we continue with business as usual, I fear the United States could lose its military technological advantage altogether." See: Ryan Evans, "5 Questions with Sen. John McCain on Defense Acquisition Reform and Drinking with Deng," War on the Rocks, July 2015, https://warontherocks.com/2015/07/5-questions-with-sen-john-mccain-on-defense-acquisition-reform-and-drinking-with-deng/; for another example, Senator McCain also stated, "For years, we have been warned that America is losing its technological advantage . . . that is why the DoD needs acquisition reform. Not just for efficiency or to save money. Simply put we will not be able to address the threats facing this nation with the system of organized irresponsibility that the defense acquisition enterprise has become." See: "Department of Defense Acquisition Reform Efforts," Hearing before the Armed Services Committee, United States Senate, 115th Cong., 1st sess., 2017, https://www.armedservices.senate.gov/hearings/17-12-07-department-of-defense-acquisition-reform-efforts. Finally, as another example, Assistant Secretary of the Air Force for Acquisition Will Roper stated: "We live in a world where we can't wait 10 years to get a program right ultimately because outside technology, commercial technology is driving this." See: Mark Pomerleau, "DOD acquisition not broken, just slow," C4ISRNet, July 2016, https://www.c4isrnet.com/c2-comms/2016/07/20/dod-acquisition-not-broken-just-slow/.

4. For example, see NDAA 2016, Sec. 804.

5. For example, see NDAA 2017, Sec. 901.

6. Government Accountability Office, *Acquisition Reform: DOD Should Streamline Its Decision-Making Process for Weapon Systems to Reduce Inefficiencies* (Washington, DC: 2015), 6, https://www.gao.gov/assets/670/668629.pdf; and Levine; *Defense Management Reform,* 91.

7. Jeffrey A. Drezner et al., *Measuring the Statutory and Regulatory Constraints on Department of Defense Acquisition* (Santa Monica, CA: RAND Corporation, 2007), xii, https://www.rand.org/pubs/monographs/MG569.html.

8. Samantha Brainard and Zoe Szajnfarber, "Understanding the burden of government oversight on engineering work: Adding empirical data to the debate," *Space Policy* 42 (November 2017): 70, doi:10.1016/j.spacepol.2017.07.001.

9. Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC, 2018), 10, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

10. For additional discussion about oversight centralization and decentralization in the context of historic acquisition reforms, please see: Levine, *Defense Management Reform; Fox, Defense Acquisition Reform 1960-2009*; Lewis et al., Acquisition Reform Regimes on Their Own Terms; and Hunter, "Cycles of Defense Acquisition Reform." Further, we also note that, in addition to characterizing reform cycles in terms of oversight centralization and decentralization, it is also possible to characterize reform cycles according to their focus on regulation or deregulation, their preference for commercial products and processes, and their use of specific contract types and approaches. For example, see: Levine, Defense Management Reform, 83. Although we focus on cycles of centralization and decentralization here, we acknowledge that reform cycles come in many types, each of which warrant further study.

11. Where possible, we adopted the reform cycles presented by McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process.* Given our focus on OSD oversight centralization and decentralization, however, we found it necessary to break up or merge several of McNicol and Wu's cycles. The classifications for these cycles, as well as their start and end dates were derived from: Levine, *Defense Management Reform*; Fox, *Defense Acquisition Reform*; Lewis et al., *Acquisition Reform Regimes on Their Own Terms*; and Hunter, "The Cycles of Defense Acquisition Reform and What Comes Next."

12. For additional discussion of the centralization that occurred during this cycle, please see: Fox, *Defense Acquisition Reform*, 35-36. The start date for this cycle was derived from the same source and coincides with the start of Secretary McNamara's tenure at the Pentagon.

13. For additional discussion of the decentralization that occurred during this cycle, please see: Fox, *Defense Acquisition Reform*, 47-61. We derived the cycle start date from an analogous cycle identified by McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process,* 3.

14. For additional discussion of the centralization that occurred during this cycle, please see: Fox, *Defense Acquisition Reform*, 95, 99; and Edward C. Keefer, *Harold Brown Offsetting the Soviet Military Challenge 1977-1981* (Washington, DC: Historical Office, Office of the Secretary of Defense, 2017), 14, https://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol9.pdf. We derived the cycle start date from Fox, *Defense Acquisition Reform*, 95. Note also that Secretary Brown left office in January 1981. We kept the end date of this cycle as FY 1982 to be consistent with McNicol and Wu's subsequent cycle, which started in FY 1983 and which represented further decentralization of OSD's control in response to Brown's tenure; see Fox, *Defense Acquisition Reform*, 95, 99 and McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process*, 3.

15. For additional discussion of the decentralization that occurred during this cycle, please see Fox, *Defense Acquisition Reform*, 99. We derived the cycle start date from an analogous cycle identified by McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process*, 3.

16. For an additional discussion of the centralization that occurred during this cycle, please see: Fox, *Defense Acquisition Reform,* 129 and Levine, *Defense Management Reform*, 109. We derived the cycle start date from an analogous cycle identified by McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process*, 3.

17. Fox, *Defense Acquisition Reform*, 134.

18. For additional discussion of the decentralization that occurred during this cycle, please see: Obaid Younossi et al., *Improving the Cost Estimation of Space Systems: Past Lessons and Future Recommendations* (Santa Monica, CA: RAND Corporation, 2008), 72-81, https://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG690.pdf; and Levine, *Defense Management Reform,* 116-120, 124-129. We derived the cycle start date from an analogous cycle identified by McNicol and Wu, *Evidence on the Effect of DoD Acquisition Policy and Process*, 3.

19. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *Report of the Defense Science Board / Air Force Scientific Advisory Board Joint Task Force on Acquisition of National Security Space Programs* (Washington, DC, 2003), 3, https://apps.dtic.mil/dtic/tr/fulltext/u2/a429180.pdf; Younossi et al., *Improving the Cost Estimation of Space Systems*, 72-81; and Levine, *Defense Management Reform*, 123.
20. For additional discussion of the centralization that occurred during this cycle, please see: Levine, *Defense Management Reform*, 131-133. We derived the cycle start date from an analogous cycle identified by Lewis et al., *Acquisition Reform Regimes on Their Own Terms*, 15.
21. Ibid., 134
22. For an additional discussion of the decentralization that occurred during this cycle, please see: Levine, *Defense Management Reform*, 145. We derived the cycle start date from the date that AT&L formally split (Feb. 1, 2018), see: Aaron Mehta, "The Pentagon's acquisition office is gone. Here's what the next 120 days bring," Defense News, February 1, 2018, https://www.defensenews.com/pentagon/2018/02/01/the-pentagons-acquisition-office-is-gone-heres-what-the-next-120-days-bring/.
23. Our decision to measure cycle time using milestone B or C is consistent with previous cycle time analysis (e.g., see Department of Defense, *Performance of the Defense Acquisition System,* Washington, DC: Department of Defense, October 2016), 45, https://www.acq.osd.mil/fo/docs/Performance-of-Defense-Acquisition-System-2016.pdf). Although a few programs did report milestone A dates, we opted to use their milestone B dates instead. While this decision shortens reported cycle times in a few instances, we sought to maximize consistency across programs and to measure cycle time from the point at which the DOD formally initiates programs and makes resource commitments (i.e., milestone B or C).
24. To calculate cycle time growth, we required a schedule estimate, and two estimate types—development and production—were typically available. When it was available, we used the development estimate, which programs make earlier in their lifecycles. When development estimates were unavailable, we deferred to production estimates. There are risks associated with using only production estimates: namely, that programs may have been re-baselined and production estimates may not accurately reflect the program's initial schedule estimate. In such cases, the reported percent cycle time growth may underestimate the actual percent cycle time growth. We acknowledge these potential data quality issues but ultimately opted to use the best data that was available, rather than potentially limiting our dataset unnecessarily.
25. For more information on the databases we used, see: J.M. Jarvaise, J.A. Drezner, and D. Norton, *The Defense System Cost Performance Database: Cost Growth Analysis Using Selected Acquisition Reports* (Santa Monica, CA: RAND Corporation, 1996), https://www.rand.org/content/dam/rand/pubs/monograph_reports/2007/MR625.pdf; and "Defense Acquisition Programs," Naval Postgraduate School Dudley Knox Library, https://libguides.nps.edu/acqprog/progcost.
26. From the above sources, we collected cycle time and cycle time growth data for all complete MDAP programs and subprograms initiated between FY 1963 and present. We also collected the same data for all active MDAP programs and subprograms initiated before FY 2014. We separated MDAPs into subprograms only if those subprograms' milestone dates were themselves separable. For example, an MDAP consisting of two blocks (e.g., a submarine with block one and block two) was separated into two subprograms if initiation and IOC dates were available for both blocks. An MDAP consisting of two variants (e.g., a helicopter with separate variants for the Army and the Marines Corps) was also separated into two subprograms if both variants had distinct milestone dates. Although it was not always possible to distinguish between subprograms, we included them in our dataset where it was possible. By doing so, we hoped to capture the schedule impacts of acquisition strategies that employ variants or block upgrades. Throughout the paper, when we refer to "MDAPs," we are referring to both the programs and the subprograms which are developed and fielded within the MDAP program management structure.
27. For a similar assumption, see McNicol and Wu, E*vidence on the Effect of DoD Acquisition Policy*, 4.
28. One critical assumption was what alternative milestones to use if milestone B, C, and IOC dates were not explicitly available. In lieu of a milestone B date, we used milestone II, preliminary design review, or critical design review dates. In lieu of IOC dates, we used first unit equipped, required assets available, first satellites launch, initial operational delivery, and initial operational test and evaluation (IOT&E) complete. For data derived from the RAND database, we occasionally substituted the IOT&E complete date for IOC—if that IOT&E complete date occurred after IOC. If none of the aforementioned dates were available, we did not include the MDAP in our database. We also did not include MDAPs in our database if their associated data appeared corrupt (e.g., the date reported for IOC occurred prior to the date reported for program initiation). Where possible, we attempted to identify and correct data corruption, often by consulting external sources or prior years' data. In the handful of cases where we felt confident making manual corrections, we did; otherwise, we excluded the data. Finally, for schedule data prior to 1994, we used RAND's Defense Systems Cost Performance Database. Afterward, we used data pulled from DAMIR in FY 2019. In some instances, milestone data was not available in the FY 2019 DAMIR data. In those cases, we used data from FY 2018.
29. Our cycle time data included 220 and 40 programs or subprograms initiated at milestones B and C, respectively. Our cycle time growth data over the same period included 186 and 23 programs or subprograms initiated at milestones B and C, respectively. Therefore, the majority of the programs or subprograms included in our analysis did include some amount of technology development and full-scale systems engineering prior to milestone C. Also note that we excluded canceled MDAPs because we did not find their schedule data to be reliable. We acknowledge that this may make our findings appear more optimistic than reality, since canceled programs may have longer than average cycle times. We accept this impact, however, because we are focused on time to field systems, and canceled programs, by definition, were never fielded.
30. We ran a simple linear regression of cycle time on complete program start date but did not find a statistically significant association ($p=0.86$, adjusted $R^2<0.01$). We also ran a simple linear regression of percent cycle time growth on program start date and again did not find a statistically significant association ($p=0.54$, adjusted R2<0.01).
31. We ran a simple linear regression of cycle time on active program start date and found a statistically significant association at the one percent level ($p<0.01$, adjusted $R^2=0.52$). We also ran a simple linear regression of percent cycle time growth on active program start date and again found a statistically significant association at the one percent level ($p<0.01$, adjusted R2=0.19). In both cases, however, the residuals were non-normal and heteroscedastic. This suggests that although there is an association between program start date, cycle time, and percent cycle time growth, the input variable is not sufficiently predictive of the outputs.
32. Statistics quoted in the text and shown in Table 2, Table 3, and Table 4 include all complete MDAPs for which data was available and all active MDAPs initiated prior to FY 2015 (canceled MDAPs are excluded). We used FY 2015 as our cut-off date because the most recent data available was from FY 2019 and we wished to ensure that all active programs in our sample were at least five years past initiation. This helps eliminate maturity bias, where relatively young, un-fielded programs have optimistic schedule estimates. Our decision to use a five-year cut-off date is based off of an identical assumption made in McNicol and Wu, *Evidence on the Effect of DoD Acqusition Policy and Process*, 5.
33. For example, in a 2016 op-ed supporting acquisition reform, Ben Fitzgerald wrote: "Adversary adaption is not the only reason for increasing speed with the DOD. We must also compete with the increasing pace of geostrategic and technological change. Over the course of the 22 years it took to build the F-22, the fighter aircraft endured four obsolete processor upgrades and was ultimately deployed into an operational environment defined by the fallout from the Arab Spring, not the Cold War." See: Ben Fitzgerald, "Reforming Acquisitions and the Need for Speed," Defense News, March 30, 2016, https://www.defensenews.

com/opinion/commentary/2016/03/30/reforming-acquisitions-and-the-need-for-speed; and for another example, Senator Angus King stated: "By the way, on procurement, not only is there an issue of cost, there is an issue of time . . . The time it takes Boeing to get a new aircraft from concept to flight is something like seven years. In the military, it is 23 years." See: "Hearing to Consider the Nomination of Patrick M. Shanahan to be Deputy Secretary of Defense," Hearing before the Armed Services Committee, United States Senate, 115th Cong., 1st sess., (2017), 32-33, https://www.armed-services.senate.gov/imo/media/doc/17-61_06-20.

34. Upon visualizing our data, we concluded that it was not consistent with a normal distribution. This observation was confirmed by one of two tests that we ran to check for normality. The Shapiro-Wilk (S-W) test found our data to be non-normal, while the Anderson-Darling (A-D) did find the data to be consistent with a normal distribution. Careful of the skew that we visually observed in our data, we opted to use a non-parametric test. Using a Mann-Whitney U (M-W U) test, we observed a statistically significant difference in distributions ($p<0.01$).

35. Upon visualizing our cycle time data, we observed that it was consistent with a normal distribution. This observation was confirmed by both an S-W and A-D test for normality. To compare cycle time means between cycle #6 and cycle #7, we used a two-sided t-test assuming unequal variances and found the differences in means to be statistically significant ($p=0.02$). For consistency with our analysis of percent cycle time growth, we also compared distributions using a M-W U test and found the differences to be statistically significant as well ($p=0.04$). Upon visualizing our percent cycle time growth data, we observed that it was not consistent with a normal distribution. This observation was also confirmed with S-W and A-D tests for normality. Using a M-W U test, we observed a statistically significant difference in distributions between cycle #6 and cycle #7 ($p=0.02$).

36. Again, after visualizing our data and performing both an S-W and A-D test, we concluded that it was not consistent with a normal distribution. Therefore, we used a M-W U test to compare distributions and found the differences between groups to be statistically significant ($p<0.01$).

37. As above, after visualizing our data and performing both an S-W and A-D test, we concluded that it was not consistent with a normal distribution. Therefore, we used an M-W U test to compare distributions and found the differences between groups to be statistically significant at the 10 percent level ($p=0.07$).

38. McNicol provides an excellent analogy to illustrate the relationship between OSD and the military services in terms of speed limit enforcement, where the military services tend to speed (i.e., be optimistic about costs) and various OSD components serve as traffic cops or courts. The same dynamic likely occurs for schedule estimates as well. For more description, see David L. McNicol, "Cost Growth in Major Weapon Procurement Programs," Institute for Defense Analyses, IDA Paper P-3832, 2004, 41, https://catalyst.library.jhu.edu/catalog/bib_2681939; or see a summary of McNicol's discussion in, Levine, *Defense Management Reform*, 109-110.

39. Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC: 2018), 10, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

40. Tim Grayson, *Mosaic Warfare* (Arlington, VA: DARPA, 2018), https://www.darpa.mil/attachments/STO-Mosaic-Distro-A.pdf.

41. Ibid.

42. For example, see: Andrea Gilli and Mauro Gilli, "Why China Has Not Caught Up Yet: Military-Technological Superiority and the Limits of Imitation, Reverse Engineering, and Cyber Espionage," *International Security* 43, no. 3 (Winter 2018/2019): 141-189, doi:10.1162/ISEC_a_00337.

43. "The Chinese People's Liberation Army Air Force. (Briefs).(rolls out program for the development of a new stealth fighter, the J-X)," *Journal of Electronic Defense,* January 1, 2003, https://web.archive.org/web/20150924165623/http://www.highbeam.com/doc/1G1-97131209.html; For example, see: Gilli and Gilli, "Why China Has Not Caught Up Yet," 179; Minnie Chan, "Why China's first stealth fighter was rushed into service with inferior engines," *South China Morning Post*, February 10, 2018, https://www.scmp.com/news/china/diplomacy-defence/article/2130718/why-chinas-first-stealth-fighter-was-rushed-service; Dave Majumdar, "China's New J-20 Stealth Fighter Has Officially Entered Service," *National Interest*, September 28, 2017, https://nationalinterest.org/blog/the-buzz/chinas-new-j-20-stealth-fighter-has-officially-entered-22529; Wendell Minnick, "China Reports Y-20 Aircraft IOC in 2017," Defense News, March 1, 2016, https://www.defensenews.com/breaking-news/2016/03/01/china-reports-y-20-aircraft-ioc-in-2017; and Sebastien Roblin, "Forget about China's stealth fighter or aircraft carriers. This is the plane America needs to worry about," *National Interest*, September 15, 2018, https://nationalinterest.org/blog/buzz/forget-about-chinas-stealth-fighter-or-aircraft-carriers-plane-america-needs-worry-about.

44. Office of Naval Intelligence, *The PLA Navy: New Capabilities and Missions for the 21st Century* (Washington, DC: 2015), 16, https://www.oni.navy.mil/Portals/12/Intel%20agencies/China_Media/2015_PLA_NAVY_PUB_Interactive.pdf?ver=2015-12-02-081058-483; "Luyang-III Class/Type 052 Destroyers," Naval Technology, 2020, https://www.naval-technology.com/projects/luyang-052d-destroyers; "Type 052 Luhu Class," Sino Defense, September 3, 2017, http://sinodefence.com/type-052-luhu-class/; and "Type 052 *Luhu*-class Multirole Destroyer," Global Security, last modified October 14, 2019, https://www.globalsecurity.org/military/world/china/luhu.htm.

45. China Power Team, "What do we know (so far) about China's second aircraft carrier?," CSIS, December 17, 2017, https://chinapower.csis.org/china-aircraft-carrier-type-001a/; Kristen Huang, "China's Type 001A aircraft carrier sets off on latest sea trial as navy prepares to commission ship 'within months'," *South China Morning Post*, October 17, 2019, https://www.scmp.com/news/china/military/article/3033392/chinas-type-001a-aircraft-carrier-sets-latest-sea-trial-navy; Rick Joe, "A Mid-2019 Guide to Chinese Aircraft Carriers: What is the future trajectory of the Chinese People's Liberation Navy carrier program?," *Diplomat*, July 18, 2019, https://thediplomat.com/2019/06/a-mid-2019-guide-to-chinese-aircraft-carriers/; and Ben Blanchard, "China's new aircraft carrier enters service at South China Sea base," Reuters, December 17, 2019, https://www.reuters.com/article/us-china-defence-carrier/chinas-new-aircraft-carrier-enters-service-at-south-china-sea-base-idUSKBN1YL136.

46. For some comparisons between DOD and PLA capabilities, please see: Gilli and Gilli, "Why China Has Not Caught Up Yet," 180,182; Roblin, "Forget about China's stealth fighter or aircraft carriers"; Office of Naval Intelligence, *The PLA Navy: New Capabilities and Missions for the 21st Century,* 22; Toshi Yoshihara and James R. Holmes, "The Master 'PLAN': China's New Guided Missile Destroyer," *Diplomat*, September 4, 2012, https://thediplomat.com/2012/09/the-master-plan-chinas-new-guided-missile-destroyer/; Minnie Chan, "China Just Launched 2 More Advanced Destroyers – Here's How They Stack Up Against the US Navy's Arleigh Burke-Class Destroyers," *South China Morning Post*, May 14, 2019, https://www.scmp.com/news/china/diplomacy/article/3010060/china-launches-two-new-type-052d-destroyers-it-continues-drive; China Power Team, "What do we know (so far) about China's second aircraft carrier?"; Ankit Panda, "China's Type 001A Carrier Continues Sea Trials Amid Possible Complications," *Diplomat*, August 4, 2019, https://thediplomat.com/2019/08/chinas-type-001a-carrier-continues-sea-trials-amid-possible-complications; and Franz-Stefan Gady, "China to Likely Induct New Aircraft Carrier Ahead of Schedule," *Diplomat*, August 7, 2017, https://thediplomat.com/2017/08/china-to-likely-induct-new-aircraft-carrier-ahead-of-schedule.

47. For a discussion of process tracing and other qualitative research methodologies that could be applied to study schedule bottlenecks, please see: Alexander L. George and Andrew Bennet, *Case Studies and Theory Development in Social Sciences* (Cambridge, MA: The MIT Press, 2005). For an example of how researchers can apply these methods to study acquisition programs, please see the lead author's doctoral dissertation: Morgan Dwyer, "The Cost of Jointness: Insights from Environmental Monitoring Systems in Low-Earth Orbit," Doctoral Dissertation, Massachusetts Institute of Technology, 2014, http://systemarchitect.mit.edu/docs/dwyer14e.pdf.