Beating the Air into Submission
Investing in Vertical Lift Modernization

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THE ISSUE
The U.S. military’s vertical lift fleet of helicopters and tiltrotors is aging. With the exception of V-22 Osprey, no completely new aircraft designs have been introduced since the 1980s. Even the V-22 made its first test flight back in the 1980s. And the U.S. Army, which has the largest helicopter fleet and traditionally takes the lead on vertical lift innovation, has not made substantial investments in Research & Development since the cancellation of RAH-66 Comanche.

Today, there are ambitious plans to modernize the entire vertical lift fleet. However, much of the investment path ahead remains unclear. To make informed plans about the future, it is important first to understand how the United States arrived at its current state through past investments.

INTRODUCTION
When it comes to military aircraft, fighters and bombers receive most of the attention. Discussions of next-generation aircraft, for example, tend to focus on sixth-generation fighters and the B-21 bomber. However, vertical lift aircraft (including tiltrotors, such as V-22 Ospreys, and helicopters, such as UH-60 Blackhaws) also play a fundamental national security role.

There are almost as many tiltrotors and helicopters in the U.S. military as there are all other types of manned combat aircraft combined. The size of the U.S. vertical lift fleet, alone, would still put the United States well ahead of Russia with the world’s largest air force. In fact, even after the recent retirement of OH-58 Kiowas, the U.S. Army’s helicopter fleet would be enough to hold the top spot by itself. And the Navy, Marines, and Air Force each have sizeable vertical lift fleets of their own that perform important functions, such as anti-submarine warfare, air assault, and combat rescue.

With more than $8 billion being spent each year on developing and buying new vertical lift aircraft, this category represents one of the most important investments for the Department of Defense. And given future investment plans, we are likely to see a generational leap in vertical lift aircraft well before we see a sixth-generation fighter. Still, while vertical lift modernization plans are ambitious, much about the investment path ahead remains unclear. Understanding the drivers of vertical lift modernization is key to informed decisionmaking about the tradeoffs involved in future investment options. This analysis looks at how the United States arrived at vertical lift modernization’s current state through past investments.

VERTICAL LIFT SPENDING (2009 — 2018)

TOPLINE TRENDS
Over the past decade, the United States spent $113 billion on vertical lift modernization (through both procurement and research, development, test, and evaluation or RDT&E).
Despite this considerable investment, annual spending mostly declined, falling in 7 of these 10 years. This resulted in an overall reduction of more than 40 percent. Over the entire period, procurement made up 84.5 percent of spending, but the balance between procurement and RDT&E shifted. Procurement dropped by about 50 percent, while RDT&E increased by about 9.5 percent. In 2018, procurement made up only 72.1 percent of spending. This is a sharp contrast with overall defense, where research and development (R&D) generally declined as a share of contract obligations. However, the shift towards R&D is largely the result of declining procurement. This suggests less about the U.S. military being poised to make a generational leap forward in vertical lift than it does about the vagaries of sequestration and the Budget Control Act.

**IMPLICATIONS OF SERVICE INVESTMENT APPROACHES**

Despite having, by far, the largest vertical lift fleet, the Army ranked second in modernization spending each year, behind the Navy. Modernization of Marine Corps vertical lift is included in the Navy’s portfolio. In terms of overall expenditures, the Army made up 45.2 percent of spending, while the Navy and Air Force accounted for 49.4 percent and 5.4 percent, respectively. However, in terms of aircraft numbers, the Army makes up roughly 70.6 percent of the overall fleet, while the Navy and Air Force account for 24.8 percent and 4.6 percent, respectively. By the measure of annual spending per aircraft, the Army ranked third behind both the Navy and Air Force: 1) Navy/USMC ($4.05M/aircraft); 2) Air Force ($2.36M/aircraft); 3) Army ($1.30M/aircraft). As the largest customer for vertical lift, the Army is very influential in shaping the market, but the limited nature of Army investments has restrained how aggressively industry pursues improvements in vertical lift.

**TRENDS IN VERTICAL LIFT PROCUREMENT**

In terms of overall procurement, the Army and Navy were roughly on par: 1) Army: $46.2 billion (48.5 percent) 2) Navy: $44.9 billion (47.1 percent) 3) Air Force: $4.3 billion (4.5 percent). Army actually led in procurement spending for six of the past 10 years. Over the past decade, the Army and Navy followed the same, sharp downward trend (over $2.4 billion each) while the Air Force declined more slowly.

**Chart 2: Top Procurement Spending Categories, 2009 — 2018 (over $1B)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount (in $bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osprey</td>
<td>23.53</td>
</tr>
<tr>
<td>Black Hawk</td>
<td>16.44</td>
</tr>
<tr>
<td>Apache</td>
<td>13.80</td>
</tr>
<tr>
<td>Sea Hawk</td>
<td>12.91</td>
</tr>
<tr>
<td>Chinook</td>
<td>12.24</td>
</tr>
<tr>
<td>Cobra/Viper</td>
<td>8.62</td>
</tr>
<tr>
<td>Light Utility Helicopter</td>
<td>2.80</td>
</tr>
<tr>
<td>Sea Stallion/King Stallion</td>
<td>2.06</td>
</tr>
</tbody>
</table>

*Army: green; Navy and/or Air Force: purple*
The largest procurement categories include: 1) V-22 Osprey: $23.5 billion (24.7 percent) 2) UH-60 Blackhawk: $16.4 billion (17.2 percent) 3) AH-64 Apache: $13.8 billion (14.5 percent) 4) SH-60 Sea Hawk: $12.9 billion (13.5 percent) 5) CH-47 Chinook: $12.3 billion (12.8 percent). Of these five categories, three are Army programs (Blackhawk, Apache, and Chinook). However, only one of these five categories is a completely new aircraft design (Osprey). The other categories are all upgrades or redesigns of older aircraft. Given the massive size of the vertical lift fleet, this focus on upgrades to existing platforms is largely to be expected. However, it highlights a strategic dilemma for vertical lift modernization. The services, and especially the Army, are highly challenged to afford both the development and production of new designs and efforts to keep the existing fleet modern.

**TRENDS IN TECHNOLOGY DEVELOPMENT**

Overall RDT&E tells a different story for the Army, which accounts for a much smaller portion of RDT&E: 1) Navy: $10.9 billion (62.1 percent) 2) Army: $4.8 billion (27.5 percent) 3) Air Force $1.8 billion (10.4 percent). With the exception of 2009, the Army spent less than $.7 billion on RDT&E and less than $.5 billion for seven of these 10 years. Even by this overall measure, the Army ranked second behind the Navy in RDT&E spending for all 10 years.

The largest RDT&E categories include: 1) CH-53 Sea/King Stallion: $5.5 billion (31.15 percent) 2) Aviation - General $4.2 billion (24.2 percent) 3) VH-92 Presidential Helicopter Replacement: $3.5 billion (19.7 percent) 4) HH-60 Combat Rescue Helicopter $1.3 billion (7.5 percent) 5) V-22 Osprey $1.1 billion (6.4 percent). Of these five categories, only one is an Army program (Aviation - General), and it is not dedicated to a specific aircraft. About a fifth of overall RDT&E went towards an aircraft that is not even a combat helicopter. And once again, V-22 Osprey is the only “new” aircraft on the list.

**KEY TAKEAWAYS**

The Army and Navy have both led the way in procuring aircraft. However, with the major exception of V-22 Osprey, procurement has been directed towards upgrades of existing aircraft. And while some upgrades have been substantial (certainly in terms of dollar value) and an important source of fleet modernization, there is a limit to the ability to modernize older airframes. The U.S. military is flying and continuing to buy variants of aircraft that were designed decades ago. Even the major new aircraft exception, the V-22 Osprey, first flew in 1989.

With aging aircraft designs that have also been put under tremendous stress in Iraq and Afghanistan, it is not surprising that the U.S. military seeks transformational change. However, recent RDT&E trends reflect an approach that favors incremental improvements, not transformational change. Similar to procurement, even RDT&E spending has gone towards upgrading existing aircraft. This places the U.S. military, especially the Army on the cusp of a major strategic choice in vertical lift modernization.

**CHALLENGES OF MODERNIZATION**

**DEFENSE-WIDE**

The U.S. military confronts a major challenge in modernizing such a large fleet. Many current aircraft are expected to reach the end of their operational capabilities starting around 2030. With a few exceptions, aircraft designs are now 30-50 years old. Extensive upgrade programs, sometimes worth $10 billion a year, have kept these aircraft flying. However, while upgrades have included significant redesigns, the level of change is limited due to the constraints of space, weight, power, and airframe designs. As Navy Capt. Paul Esposito stated, “My helicopters are not Christmas trees, we can’t just keep hanging things off them. Helicopters have a finite size and finite amount of power.”

**Chart 3: Top Research, Development, Test & Evaluation Spending Categories, 2009 — 2018 (over $1B)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Stallion/King Stallion</td>
<td>5.45bn</td>
</tr>
<tr>
<td>Aviation – General</td>
<td>4.23bn</td>
</tr>
<tr>
<td>Marine One (Superhawk)</td>
<td>3.45bn</td>
</tr>
<tr>
<td>Combat Rescue Helicopter</td>
<td>1.32bn</td>
</tr>
<tr>
<td>Osprey</td>
<td>1.12bn</td>
</tr>
</tbody>
</table>

Source: CSIS analysis; Future Years Defense Program
The Army, in particular, faces a challenge in modernizing its fleet. To seek transformational change, the Air Force has the easiest task with only ~257 vertical lift aircraft. The Navy faces a tougher challenge with ~1,376 such aircraft. But Army confronts the toughest challenge with ~3,920 helicopters.

To put it into context, if the Army were to increase its annual spending per aircraft to Navy’s level ($4.06 million/aircraft), Army’s new annual spending level ($15.9 billion) would be more than 1.9 times as much as the entire U.S. military spent on vertical lift this year. It is also not clear from recent investments how much it would take to deliver transformational change. Even with Navy’s substantial investments to its fleet over the past decade, it would be hard to argue that it achieved transformational change.

Army’s size puts it in a position where it confronts large investments to develop a next-generation fleet of aircraft. However, Army vertical lift is where it is today as a result of a failure to deliver on a major vertical lift program. In the 1980s and 1990s, the Army began a program to develop a new helicopter. The goal was to replace several aging lightweight helicopters, such as AH-1 Cobras and OH-58 Kiowas. The program culminated in the development of RAH-66 Comanche, a stealth reconnaissance and attack helicopter. After building only two aircraft, the program was canceled in 2004 for a range of reasons, including cost overruns and other priorities. Much of the funding for this canceled program went into sustaining and upgrading the existing Army vertical fleet. However, Army’s modernization challenge has not gone away; and in response to this challenge, the Army is taking the initial lead on a new joint effort called Future Vertical Lift. In a forthcoming brief, we’ll explore further how these dynamics are likely to shape the progress of vertical lift modernization and Future Vertical Lift.

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5. CSIS analysis; Department of Defense Budget Estimates.

6. Ibid.; these numbers for Procurement and RDT&E are based on the average annual rate of change.


9. CSIS analysis; Department of Defense Budget Estimates.


11. Procurement and RDT&E categories include: Osprey, Black Hawk, Apache, Sea Hawk, Chinook, Cobra/Viper, Sea Stallion/King Stallion, Aviation - General, Marine One (Superhawk), Light Utility Helicopter, Combat Rescue Helicopter, Huey/Iroquois, Kiowa (Warrior), Engines, Huey/Iroquois Replacement, Pave Hawk, Sea Knight, Common Vertical Lift Support Platform (CVLSP), (U)MH-XX.

12. Procurement and RDT&E categories include: Osprey, Black Hawk, Apache, Sea Hawk, Chinook, Cobra/Viper, Sea Stallion/King Stallion, Aviation - General, Marine One (Superhawk), Light Utility Helicopter, Combat Rescue Helicopter, Huey/Iroquois, Kiowa (Warrior), Engines, Huey/Iroquois Replacement, Pave Hawk, Sea Knight, Common Vertical Lift Support Platform (CVLSP), (U)MH-XX.