



# The Mitchell Forum

## USAF Fighter Force Procurement: A Comparative Analysis of the F-35 and F-15EX Programs

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### Abstract

As the Air Force anticipates a new period of great power competition, current procurement decisions take on an increasingly critical role. Chief among these is the choice between procuring the F-15EX or expanding the F-35 program. Given the changing threat environment, not only has the criteria necessary to evaluate the two options altered, but this decision also has long-term strategic implications. No longer can the aircraft be compared using purely physical characteristics; they must be analyzed with an eye toward preparing for future combat and future force needs. This mission-centric focus in program analysis sheds new light on the capacity of the F-35 to meet the future needs of the Air Force and emphasizes the importance of prioritizing the F-35 program.

This evaluation was written before the July 2020 F-15EX procurement decision but should still serve as an insight into the tradeoffs being made and the alternative capabilities U.S. defense strategy could pursue.

Military procurement not only decides the allocation of billions of dollars, but the decisions that are made determine the structure of our military forces for years. These decisions are not easy, or even possible, to change. These decisions are even more crucial now as the Air Force faces budgetary limitations and seeks to prepare for future adversaries and the demands of modern air combat.

In this light, the Air Force's decision to advance the F-15EX program in lieu of a larger F-35 procurement becomes much more strategically significant. The current problem facing the Air Force is one of conflicting threats. As our military switches from low-intensity counterinsurgency and counterterrorism operations and prepares to confront high-tech near-peer opponents, the Air Force must modernize and increase the size of its future combat force. At the same time, its current forces are shorthanded and in need of supplementation. A compounding factor is budgetary limitations, which remain low enough to restrict the ability of the Air Force to pursue these divergent goals. As a result, while the Air Force's current planned purchases of the F-35 are intended to form the backbone of its future fighter force, it plans to supplement the F-35 with the purchase of 144 F-15EX aircraft from Boeing over the next ten years.<sup>1</sup>

This paper will lay out the factors affecting this decision in terms of the needs and capabilities of the Air Force, as well as the arguments for each decision. It will show that continuing F-35 procurement and canceling the F-15EX would best allow the Air Force to meet its current requirements while preparing for the challenges of the future. This paper will evaluate the merits of both programs, comparing them across three key categories: current readiness and budget impact, requirements of future air

combat and force needs, and individual airframe performance.

While not the most critical consideration, present day readiness and budget needs are undoubtedly the most immediate. First and foremost, the Air Force is facing a shortage of fighter airframes. This shortage, the product of failures to purchase F-22 and F-35 fighters at planned rates, is compounded by the fact that hundreds of 4<sup>th</sup> Generation fighters, specifically F-15Cs, are nearing the end of their operational lifespan.<sup>2</sup> The result of a deteriorating fighter fleet means that the Air Force needs more fighters. Specifically, the Air Force must buy 72 fighters to merely maintain current fighter inventory at a time where it has expressed an urgent need to grow its fighter forces by seven full squadrons.<sup>3</sup>

To face this shortfall, two options were presented. One, that became part of the 2020 defense budget, argues for the purchase of 144 F-15EX fighters, starting with a plan for eight F-15EXs that would begin delivery in 2025.<sup>4</sup> The new 2021 budget follows up with \$1.6 billion for an additional 12 F-15EXs.<sup>5</sup> The other opportunity, not reflected in either budget, is to expand the existing F-35 program instead, purchasing more of them to cover the shortfall and increase the number of modern 5<sup>th</sup> generation fighters.<sup>6</sup>

The most commonly publicized arguments in favor of the F-15EX are its potential cost advantages. While Boeing's jet has not been built, it is projected to cost \$87.7 million per copy and is seen by some as an opportunity for the Air Force to rapidly obtain more airframes.<sup>7</sup> A more substantial comparison can be made between the sustainment costs of each aircraft. Sustainment, which covers the maintenance, fuel, and other expenses required to operate a jet, is estimated at \$27,000 per flight hour for the F-15EX.<sup>8</sup>

Current sustainment for the F-35 is slightly higher, dropping in 2018 to \$30,137 per hour in 2012 dollars.<sup>9</sup> As a benchmark for comparison, the Air Force's current fleet of F-16 fighters costs \$25,541 per hour to operate.<sup>10</sup> Several mitigating factors must be noted. First, as a new program, little actual cost data exists for the F-15EX. Second, as a program still in the early stages, the F-35 has experienced a great deal of flux in sustainment costs. However, these costs have consistently dropped, as is the norm with the maturation of new aircraft. In 2017, the F-35 experienced a drop of \$12,000 per flight hour, and Lockheed Martin has stated that their goal for 2025 is \$25,000 per hour.<sup>11</sup> This is less than the F-15EX and nearly equal to the F-16 that it is replacing.<sup>12</sup>

Similarly, very positive trends can be seen in the unit price of the F-35. The price of the F-35 fell from almost \$130 million in 2008 to under \$90 million in 2018.<sup>13</sup> By 2019, the price was under \$78 million per aircraft.<sup>14</sup> This price is lower than that of the F-15EX according to the 2021 budget request for 12 aircraft, and yet the F-15EX has only a fraction of the capabilities of the F-35.<sup>15</sup>

Given the lack of an advantage in unit cost, a more plausible F-15EX argument is the need to preserve industrial competition in the manufacture and design of fighter aircraft. This argument, rather than support the F-15EX on its merits, argues that buying Boeing's program will ensure a diverse industrial base for the future.<sup>16</sup> While it is true that the F-15EX program would increase the government's support for Boeing and improve their position versus Lockheed, it is not clear that Boeing is in need of such support.<sup>17</sup> One obvious counterargument is the existence of Boeing's T-7 contract, in which it will build over 350 T-7 trainer jets worth \$9.2 billion in total. This program

is more than sufficient to preserve Boeing's capacity to build fighters and other similar airframes, while fulfilling an actual Air Force need.<sup>18</sup>

Beyond the short-term concerns of price and affordability lies the crucial need for the Air Force to procure the proper airframes for the future, aircraft capable of survival and effective operations in modern future air warfare. In recent years, the U.S. military has become increasingly aware of the threats from China and Russia. Transitioning away from a focus on counter-terrorism operations, the United States now sees the need to prepare for conflict with peer and near-peer opponents.<sup>19</sup>

Signs of these new preparations include the Red Flag 2019 training exercise. Its efforts to model the kind of battlespace that will be encountered in future air combat also offer a deeper insight into the requirements that an aircraft needs in this new warfare environment and can point us toward which airframe, F-35 or F-15EX, is most suited for the future battlespace.

In Red Flag 2019, pilots faced an environment vastly different than current counter-insurgency operations. The simulated opposition included modern anti-aircraft missiles and radars meant to represent the growing power of Russian and Chinese anti-access and area-denial (A2/AD) weapons such as the S-400 surface-to-air missile (SAM) air defense system. Aggressor aircraft simulated the modern fighters that China and Russia possess, and the environment also simulated sophisticated electronic warfare.<sup>20</sup>

It is in this complex and highly contested environment that the Air Force is preparing to fight. In the reports from Red Flag, one can also see how aircraft of varying types performed in this environment. The performance of the 5<sup>th</sup> generation aircraft, including the F-35, was a resounding success. F-35s at the 2017

Red Flag were able to rack up a kill ratio of 20:1, despite not yet being at full operating capability.<sup>21</sup> The results of the 2019 Red Flag were similar. Furthermore, it was observed that the F-35 enabled even brand-new F-35 pilots to perform extremely effectively. One pilot reported that his novice wingman, piloting an F-35, was able to provide advance warning to a far more experienced pilot in a 4<sup>th</sup> generation aircraft and then rack up four kills in little more than an hour.<sup>22</sup>

Given such impressive demonstrations of ability, the true impact of the F-35 lies elsewhere. Using their stealth to close with targets in a way that 4<sup>th</sup> generation aircraft cannot match, they use their advanced sensor capabilities and sensor fusion to collect data that, when shared with other airframes, allowed 4<sup>th</sup> generation aircraft to attack the target as well.<sup>23</sup> The unmatched abilities of the F-35, and its fellow 5<sup>th</sup> generation aircraft, the F-22, were noted to be so good that Red Flag and the Aggressors struggled to properly challenge them.<sup>24</sup> Whereas the F-35s were able to impact the mission as critical force multipliers, the F-15s at Red Flag were among the aircraft that relied on information provided by the F-35s to launch their attacks. Brigadier General Novotny, who led the Red Flag exercises, observed that, even as a highly experienced F-15 pilot, he “wouldn’t want to go to war against a high-end threat without those fifth-generation aircraft flying alongside.”<sup>25</sup>

This success is largely the product of two unique capabilities of the F-35 that the F-15EX lacks. One is stealth, a capability which has been increasingly regarded as the “price of admission” for the modern battlespace. As air defense systems increase in capability and radars become able to detect aircraft at greater ranges, stealth switches from a niche capability found on a limited number of specialized airframes

to being a necessary requirement for the modern battlespace.<sup>26</sup> The United States currently holds the primary advantage of stealth capabilities, but both Russia and China are working to develop stealth aircraft as well. Fully supporting the F-35 program will allow the Air Force to continue to sustain its stealth advantage.<sup>27</sup> The F-15EX, despite improvements over the current F-15, remains a non-stealthy design. This precludes its ability to penetrate advanced integrated air defenses and will leave it extremely vulnerable to Russian and Chinese aircraft, both stealthy and non-stealthy. This drawback also ties back into the debate on costs. Even if an F-15EX was cheaper than the F-35—which it is not—the lack of stealth and the resulting higher rates of lost aircraft would easily overshadow anything the F-15EX might save the Air Force.<sup>28</sup>

The other central capability that modern warfare demands is that of sensor fusion. In a large and complex battlespace, being able to rapidly identify situations and targets enables decisions to be made at a far faster rate. The F-15EX is a large step up from previous 4<sup>th</sup> generation aircraft in terms of sensors, boasting a greatly improved radar array, better electronics, and infrared sensors.<sup>29</sup> However, while an incremental improvement on the F-15C and F-15E models currently in service, F-15EXs still compare less than favorably to F-35s. The F-35 not only possesses a comparable radar to the F-15EX, it also has the ability to generate far more power than previous designs, which greatly boosts its other capabilities.<sup>30</sup> In addition, several sensor capabilities on the F-35, such as the electro-optical targeting system, give it advanced sensor capabilities while allowing it to remain stealthy and undetected. Furthermore, the internal nature of the F-35 sensors, including its infrared sensors, offers performance advantages beyond

just sensing. When sensors are located in an external pod, such as with the F-15EX Legion Pod, its external nature increases drag and radar visibility and can also reduce the amount of g-force the aircraft can pull, due to the limits of the hardpoint mount.<sup>31</sup>

Beyond any advantage in sensors, an additional strength of the F-35 lies in its integrated sensor fusion. This refers to its ability to integrate information from a vast array of sensors, both on and off the aircraft, and fuse it all into a single, coherent picture, dramatically increasing the pilot's situational awareness. In legacy 4<sup>th</sup> generation aircraft, sensor systems and the data that they generate are "federated"—that is, they are largely independent systems.<sup>32</sup> The information that they produce is displayed to the pilot separately. This means that the pilot is responsible for manually assembling and assimilating information from separate sensors, comparing inputs, mentally extracting key information, and building a cohesive picture of the battlespace in their head. The disadvantages of this kind of battlefield management are clear. Not only is this an additional load on the pilot, but the battlespace picture is limited by the pilot's ability to synthesize information quickly and cannot be easily shared.<sup>33</sup> Sensor fusion changes a human limitation into a battlespace advantage. The F-35's integral fusion engine is capable of fusing together immense amounts of data. This data comes from many sources, including the wide range of sensors on the F-35 itself. This information is combined, producing a singular and cohesive view. Large amounts of data from other F-35s is shared using a system called the Multifunction Advanced Data Link (MADL). It is a fast switching narrow directional communications datalink between stealth aircraft.<sup>34</sup> This system, found

only on the F-35 and the B-2 bomber, is difficult to jam and can transmit vast amounts of data. The resulting shared view allows for excellent coordination, including using the shared picture to guide missiles and bombs to long-range, out of sight targets. This shared picture can be sent to 4<sup>th</sup> generation aircraft, but given that they lack MADL, it must be done through the older Link 16 system.<sup>35</sup>

Viewed as a whole, modern and future air combat revolves around engaging capable enemy aircraft and surviving highly integrated air defense systems. The capabilities that have been shown to have the largest effect against these threats—stealth and sensor fusion—are force multipliers that the F-35 is uniquely capable of using. Even if the F-15EX had completely identical sensor capabilities, its lack of stealth and federated sensors would severely undercut its impact in a highly contested battlespace. Beyond the more complex topic of which airframe is most suited to modern operational needs lies the more fundamental topic of individual aircraft performance. This argument focuses entirely on quantifiable performance metrics such as maneuverability, payload, and survivability, and it is a popular talking point among proponents of the F-15EX and opponents of the F-35, who often argue that the F-35 is incapable of dogfighting and carries a much smaller payload than the F-15EX.

Comparing the payloads of the F-15EX and F-35 is easily subject to misinterpretation. Due to the stealth characteristics of the F-35, armaments are normally carried internally, while the F-15EX, a non-stealthy design, carries everything externally. In this apples to oranges comparison, the 5,700-lb capacity of the F-35 pales in comparison to the 29,000-lb capacity of the F-15EX.<sup>36</sup> It neglects that the F-35 has external hardpoints as well,

and, by mounting ordnance to them, the F-35 can exchange its stealth for a greatly increased payload. In this “beast mode” configuration, the F-35 can carry 22,000 lb—although still slightly lower than the F-15EX, a far more comparable payload.<sup>37</sup> This straight comparison also neglects the importance of the F-35’s mission flexibility. If the situation calls for stealth and survivability, the F-35 can meet those needs by carrying weapons internally. If the mission requires a powerful strike, the F-35 can use its external ordnance mounts at the cost of higher visibility. The F-15EX can make no such trade and is unable to adapt to those situations, and it retains high visibility, regardless of payload.

Perhaps of greater importance to future operations is acknowledging the fact that dogfighting is a largely obsolete form of aerial combat due to several technological innovations. First and foremost, with modern, long-range missiles and powerful radar systems, fighters are capable of engaging enemies beyond visual range—well before dogfighting range. While guns made up 65 percent of air-to-air kills between 1962 and 1969, missile kills represented roughly 90 percent of all air-to-air kills from 1990 to 2002, the vast majority of which were made beyond visual range.<sup>38</sup>

However, dogfighting performance remains an effective measure of aircraft capabilities. For this reason, proponents of the F-15EX point to early reports on the F-35 that indicate that it performed poorly in dogfights with the 4<sup>th</sup> generation F-16.<sup>39</sup> These early reports are heavily misleading, as the F-35s tied to that testing and reporting lacked stealth materials and were not equipped with the full capabilities of the F-35 helmet—one designed for situational awareness, a key attribute in a dogfight. Furthermore, as an early prototype, it

was restricted to only 5.5 g maneuvers, significantly less than the 9 g that the F-16 and an unrestricted F-35 can pull.<sup>40</sup>

In contrast, current reports on the F-35 indicate impressive aerial maneuverability. Due to the removal of performance restrictions and a better understanding of the airframe, pilots have reported improved levels of performance. One Norwegian pilot compared it very favorably to the F-16, his previous jet, citing its ability to maintain higher angles of attack, make rapid pedal turns, and “hit the brakes,” as well as excellent stability.<sup>41</sup>

Given that the F-15EX has not yet been built or tested, its exact flight capabilities are unknown. However, its performance should be similar to the F-15C, which it is intended to replace, and the F-15E, of which it is a derivative. These airframes can be used to approximate the performance of the F-15EX. In terms of raw performance statistics, the results are mixed. Both airframes can pull equal g-force. The F-15EX is faster and has extended range, although neither have significant impact on dogfights.<sup>42</sup> The F-35 has a higher sustained rate of turn and can manage very high angles of attack.<sup>43</sup> Beyond the statistics, the most effective comparison relies on the pilots themselves. In interviews with pilots who have flown both the F-35 and either the F-15C or F-15E, the pilots preferred the F-35 over the F-15E in every dogfighting situation, and over the F-15C in four out of five situations.<sup>44</sup>

In conclusion, weighing the costs and benefits of the F-35 and the F-15EX comes down to an issue of vision. In terms of individual performance, the F-35 delivers comparable aerodynamic performance while offering stealth and sensor fusion capabilities unmatched by the F-15EX. Not only are these capabilities revolutionary, but

they are the exact capabilities that future air combat requires for success. Furthermore, growing efficiencies in the F-35 program are steadily reducing costs and eliminating any F-15EX cost advantage. The current fighter shortage needs to be prudently addressed. The current choice of an F-15EX program may address immediate shortfalls, but it ultimately fails to anticipate or

prepare for a much more demanding future combat environment. By contrast, an expanded F-35 program not only meets current needs but will build a fighter force made to dominate future battlespace and ensure the success of the U.S. Air Force. Expanded investment in the F-35 program is a clear choice. ★

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