

Background

Throughout the last seven decades, Unmanned Aerial Vehicles (hereafter referred to as UAVs) have slowly been gaining popularity amongst many departments relating to the defense of the United States of America, primarily including the United States Air Force and the Department of Defense. With how rapidly the attention has shifted towards UAVs as a means for national defense, it is critical these departments minimize the costs of UAVs and technology utilized by UAVs while subsequently optimizing results that UAVs provide to defensive capabilities.

Analysis

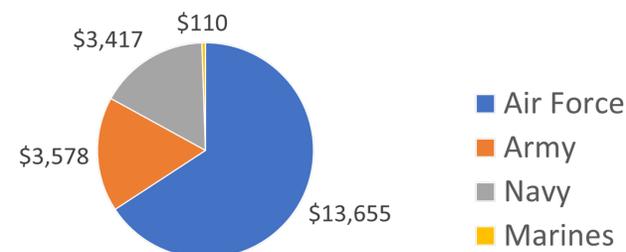
Figure 1 is used to determine the level of focus that the United States Air Force has placed on UAV programs spanning from 1954-1999. The chart indicates that \$13.655 billion has been spent by the Air Force over the course of forty-five years, showing an increasing interest in the value that UAVs provide.

Figure 2 details the spending amounts in millions of dollars per year that the United States Air Force has spent towards major UAV programs. Interest in UAV programs within the Air Force have remained relatively high, except for a small gap of time between 1977-1983.

Table 1 shows data taken from experimentation on the MQ-9 Reaper Air Force UAV to indicate what level of optimization is required to keep UAV costs low and to improve results of UAV defense capabilities. From left to right, λ represents the failure rate due to E or intensity of external threats, τ^* determines the duration in days it takes to create an optimal test to improve the reliability and the cost efficiency, $C(\tau^*)$ (Million\$) represents the total cost of a UAV program, and $C(0) - C(\tau^*)$ (Million\$) represents the minimized cost of the UAV program.

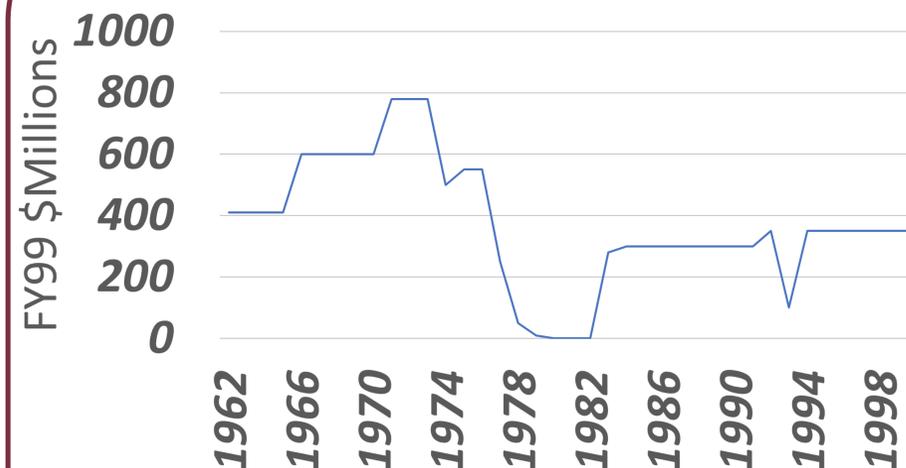
Data

Figure 1: RPA and UAV Program Costs by Service, 1954-1999 (in FY99 \$M)



(Source: Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapon System Innovation, Colonel Thomas P. Ehrhard, June 2000)

Figure 2: Major USAF RPA and UAV Programs



(Source: Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapon System Innovation.)

Table 1: Optimal Test Duration, Overall Cost and Cost Reduction for Different Intensity of External Threats.

λE	τ^*/days	$C(\tau^*)$ (Million\$)	$C(0) - C(\tau^*)$ (Million\$)
0	467.0	21.609	42.919
0.00005	424.4	50.952	38.285
0.0001	386.6	76.972	34.231
0.0002	322.9	120.677	27.558

Results

Since it is known that the United States Air Force has a large focus on developing UAVs due to nearly \$14 billion dollars being deposited into UAV programs over the length of several decades, managing the cost is important to ensure that UAVs work efficiently and can be manufactured for a less overall cost for UAV programs. To reduce the overall cost, anticipated threat levels are determined through repeated testing that can provide a framework to how much money needs to be spent on UAVs when providing national defense. The higher the threat level a UAV will encounter, the more money a UAV program will cost naturally to enhance UAV reliability, leading to the least expensive model to perform for the same amount of time without reducing performance.

Conclusion

Optimized testing of UAVs can significantly reduce the cost of each individual UAV, further reducing the overall cost of UAV programs managed by the United States Air Force. Research targeted to reducing UAV costs for the future should take the costs of newer UAV designs alongside the advanced equipment that is designated to those UAV models and determine the reduced costs.

References

- U.S. air force remotely piloted aircraft and unmanned aerial vehicle strategic vision. (2006). *Star*, 44(17) [https://www.proquest.com/scholarly-journals/u-s-air-force-remotely-piloted-aircraft-unmanned/docview/24042565/se-2Links to an external site.](https://www.proquest.com/scholarly-journals/u-s-air-force-remotely-piloted-aircraft-unmanned/docview/24042565/se-2Links+to+an+external+site)
- Brunton, S. L., Nathan Kutz, J., Manohar, K., Aravkin, A. Y., Morgansen, K., Klemisch, J., Goebel, N., Buttrick, J., Poskin, J., Blom-Schieber, A. W., Hogan, T., & McDonald, D. (2021). Data-Driven aerospace engineering: Reframing the industry with machine learning. *AIAA Journal*, 59(8), 1-26. <https://doi.org/10.2514/1.j060131>
- R., M., & H., H. (2007). Safety and Certification of UAVs. *SAE Technical Paper 2007-01-3922*. <https://doi.org/10.4271/2007-01-3922>
- Alexan, W., Aly, L., Korayem, Y., Gabr, M., El-Damak, D., Fathy, A., & Mansour, H. A. A. (2024). Secure communication of military reconnaissance images over uav-assisted relay networks. *IEEE Access*, 12, 78589-78610. <https://doi.org/10.1109/access.2024.3407838>
- Zhai, Q., & Ye, Z.-S. (2020). How reliable should military uavs be? *IIEE Transactions*, 52(11), 1234-1245. <https://doi.org/10.1080/24725854.2019.1699977>