Prospectus

Conceptual Design of a Light Attack Aircraft
(Technical Topic)

The Effect of PTSD on Light Attack Aircraft and Unmanned Aerial Vehicle Pilots
(STS Topic)

By

David Gibbs

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Technical Project Team Members:

Will Ayscue, Catherine Hanafin, Black Manger, Brendan Schneider, Hope Wheeler

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

Signed: David Gibbs
Technical Advisor: Jesse Quinlan
STS Advisor: Sean Ferguson

Introduction

Every year the American Institute of Aeronautics and Astronautics (AIAA) proposes design challenges for undergraduate and graduate students to compete in. This year we are competing in a conceptual design challenge to create an Austere field light attack aircraft (LAA). This conceptual design is expected to take over mission profiles originally carried out by attack helicopters, such as the Apache AH-64. While this is a distinguishing feature in our design requirements, thought must go into how this may affect other facets of aircrafts. By coming up with a new LAA it inadvertently changes the arsenal our military can deploy. Unmanned aerial vehicles (UAV) air-to-ground attack capabilities are comparable to our LAAs. Since the war on terror in Afghanistan UAVs have played a role in assisting with air-to-ground attacks, however UAVs had a completely different approach to their targets compared to conventional LAA aircrafts. This is attributed to UAVs ability to remain airborne for up to forty hours, whereas LAAs would remain airborne for only a fraction of that time (Connor, 2019). This exhibits a great difference in lifestyles for conventional pilots and UAV pilots due to their physical location and mission profile. Post-traumatic stress disorder (PTSD) is common amongst military members whoe deployed to combat zones. Limited knowledge about PTSDs effect on UAV pilot's was known before the UAVs first deployment. Since the war on terror PTSD diagnoses has risen across the board (Tanielian & Jaycox, 2008). How has PTSD effected UAV pilots compared to conventional LAA pilots?

Technical Topic

The objective of our technical topic is to create a conceptual design of a LAA. This LAA must be able to take off from an austere airfield, dirt runway, and complete similar mission profiles attack helicopters carry out. Austere airfields are usually auxiliary bases in combat areas with minimal infrastructure (Airfield and Flight Operations Procedures, 2008). Specifically, our austere airfield has a California Baring Ratio (CBR) of 5, meaning the runway is made from silt and clay (California Bearing Ratio, 2018). This runway material poses a major design challenge for the air intake system since foreign object damage (FOD) is more likely. The design proposal from the AIAA also specifies many other additional requirements the LAA must meet, including two different mission profiles, payload requirements, takeoff and landing distances, and other miscellaneous feature such as ejection seats. We are attacking these design challenges by assigning state of the art topics so that each team member contributes to a specific area. I am the survivability expert in our group. Survivability in this context relies on the LAAs ability to avoid radar detection, absorb small caliber ammunition, and counterattack targets. Creating a LAA that can meet these requirements is crucial for providing close air support to troops on the ground in remote locations.

Currently our team has estimated the LAAs initial geometry along with its take off gross weight (TOGW), empty weight, fixed weight and fuel weight. The initial geometry was decided upon after each group member created a three-dimensional model and justified each feature on their respective design. Then, we brainstormed together on which features we should keep in our group's initial geometric configuration. Decisions were made based off prior LAA aircrafts and our design requirements. Ultimately, we came up with a LAA consisting of a rectangular wing, two turboprops, a v-tail, and a slender fuselage. The weights were estimated using a MATLAB coded empirical model based off other aircrafts like ours. We identified these aircrafts to be equivalent to ours based off the type of propulsion devices, geometry, and payload. Along with survivability, I have taken lead on the three-dimensional modeling side of the project using OpenVSP, a parametric geometry tool specifically intended for aircraft modeling.

Our next step is to size the LAA in terms of how much power is needed versus available, geometric sizing and energy sizing. With my three-dimensional model we will run computational fluid dynamics (CFD) tests. These tests will help us determine the coefficient of drag, lift and other aerodynamic parameters. Additionally, running a finite element analysis (FEA) on the geometry will help to estimate the LAAs fame loading parameters. One of the design requirements is to have hardpoints, fasteners on the wing to attach payload or munitions, which act as a concentrated load. These hardpoint require extra structural support. Beyond the three-dimensional model, additional analysis is needed using FLOPS, a NASA developed software, that will aid in estimating takeoff and landing distances. These are essential values since our LAA has restrictions on airfield runway distance. The finalization of these calculations will allow our team to conclude our conceptual design for the AIAA competition in the spring.

STS Topic

Since the introduction of UAVs, the definition of what a pilot is has begun to take new shapes. Conventional LAA and UAV pilots interact with their aircrafts in completely different manners. Conventional LAA pilots are immersed in the cockpit subjected to the full emotional and physical effects of flying, while UAV pilots can be halfway across the globe watching their controls from the comfort of a trailer. Additionally, UAV pilots can operate their vehicles for longer thanks to the UAVs ability to stay airborne for up to forty hours. During this long period of time UAVs usually loiter over points of interest for reconnaissance or strikes (Connor, 2019). Conventional LAA pilots on the other hand, only stay airborne for a fraction of that time. PTSD has begun to reach record high numbers since the war on terror in Afghanistan and the war in Iraq, 20% of troops returning have been diagnosed with PTSD (Stern, 2014). Considering the diverse nature of each respective pilots experience how does PTSD affect them?

First and foremost, it is important to know if both types of pilots are susceptible to PTSD. In fact, both UAV and conventional LAA pilots experience symptoms of PTSD. An experiment was conducted in 2012 where six women and twenty-four men were split into two experimental groups. The experimental group controlled a UAV simulated strike on multiple targets, then they watched a video of the aftermath. The control group did not control the simulated UAV strikes, but they watched the same aftermath videos. Once each group was finished with their respective task, they were asked to fill out a questionnaire. This questionnaire determined their distress level. They found that the experimental group showed a significantly higher distress level for both genders compared to the control group. Additionally, females were found to have a higher distress level than males, but it is worth noting female participants were limited compared to male (Lowe & Gire, 2012). The framework of this experiment allows us to conclude that distress levels increase when participants control the UAV to conduct a strike. High levels of distress can lead to PTSD symptoms (Matthiesen & Einarsen, 2010).

A key distinction between UAV and conventional LAA pilots is the lack of deployment. Conventional LAA pilots encounter a type of rhythm between deploying to combat zones and living on the home front. UAV pilots, conversely, live on the home front and control a UAV in a combat zone (Fuller, 2018). A retrospective study was conducted in 2013, which analyzed both conventional and UAV pilots and how mental health affected them. One of the subsets of mental health in their case was PTSD. The study was conducted through gathering data from October 1st 2003 to December 31st 2011, 709 service members were UAV pilots and 5,256 were conventional pilots. They calculated PTSD incident rates for UAV and conventional pilots and found that UAV pilots are just a susceptible to PTSD as conventional pilots' (Otto, 2013). While thinking about our LAA this study signifies the similarities in PTSD risk between the two pilot communities given their differences.

The prior two studies indicate both conventional and UAV pilots are at risk for PTSD, although their daily operations are unique. Taking a deeper dive into UAV pilots' lifestyle, majority of the time they are operating they are doing surveillance on specific targets. For instance, a UAV will loiter high above a village and take note of specific instances while conversing with intelligence officers to help identify persons of interest. This can go on for hour, days, or weeks at a time, then the UAV will deliver an air-to-ground strike. Unlike a conventional pilot the UAV pilot sees the repercussions of their strike and how the villagers, they have been watching for weeks on end, are affected (Ricks, 2014). Conventional LAA pilots seem to be disconnected from the events which transpire, while UAV pilots digest it all. This creates two main differences between these pilots, conventional pilots risk their lives while UAV pilots must absorb unsettling consequences due to their actions. However, these two differences in lifestyle lead to similar PTSD effects amongst the pilot communities.

Next Steps

The next steps to integrate our LAA and how PTSD effects these two communities of pilots are to dive deeper into the prescription of UAVs versus LAA in air-to-ground missions. This will help determine the reasoning for deploying one over the other and with this knowledge one could create conclusions as to how PTSD affects them. Additionally, discovering more first-person resources of how each pilot is affected by these missions will help draw conclusions on their PTSD effects. Lastly, finding more experiments and case studies on these topics will benefit the interaction between LAA and UAVs.

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