Thesis Project Portfolio

Design of a Light Attack Aircraft for the AIAA Undergraduate Competition

(Technical Report)

Military Funding of 5G Technology and the Spin Around Concept

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Brendan Kroger Schneider
Spring, 2020
Department of Aerospace Engineering

Prospectus

Concept Design of a Light Attack Aircraft
(Technical Topic)

Military Funding: How Military Funding of Research and Development of New Technologies Affects the Trajectory of Societies Technologies
(STS Topic)

By

Brendan Schneider

November 5, 2020

Technical Project Team Members:

Lauren Hancock, Blake Mager, Will Ayscue, David Gibbs, Hope Wheeler, Catherine Hanafin

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: Brendan Schneider

Technical Advisor: Jesse Quinlan

STS Advisor: Sean Ferguson

Introduction

Modern military technologies have become extremely expensive to research and develop. The modern fleet of military aircraft have also been seen as overkill for the current missions they are tasked with. As a result, the market for cheaper attack aircraft has widened, especially in developing countries. As part of my technical capstone project, we are designing a concept light attack aircraft given a list of requirements/constraints that is cost effective in carrying out the air to ground missions of a modern attack helicopter. The importance of the design is that it is cheap relative to modern fighters and has the ability to effectively fight in today's war climate. After researching the incredible cost associated with the research and development of new military technologies it was evident that the U.S. Military invests heavily in new technologies with the goal of continued technological superiority to the rest of the world. This funding, in turn, will orient the private sector of technological research to areas that will benefit military technological superiority. As part of my STS thesis paper, I am researching the effects of military funding on the research of new technologies in the private sector, specifically the U.S. Military's large funding of new 5G research and applications. Military funded research has the potential to produce great technology for society but that is not always its objective. When the military invests in research in the private sector it expects a technology that can be applied for use in the Military to retain the idea of technological superiority. This system of funding could directly impact the trajectory of the technologies developed for improving society.

Technical Topic

We will be competing in the American Institute of Aeronautics and Astronautics undergraduate competition for the design of an Austere Field Light Attack Aircraft. The objective of this project, as listed in the request for proposal (RFP), is to design an affordable

light attack aircraft that can operate from short, austere fields near the front lines to provide close air support to ground forces at short notice and complete some missions currently only feasible with attack helicopters (“AIAA 2021”, 2020). Light attack aircraft seek to fill the need of an affordable aircraft capable of carrying diverse configurations of weapon setups to carry out some of the jobs that are done by more powerful, expensive fighter aircraft and helicopters. The design of this aircraft is certainly not one that was meant to build the absolute best air to ground aircraft with today’s technologies, but, rather, a more affordable practical one for today’s war fighting. Along with the objective listed in the RFP there are a series of requirements or constraints that the design must comply with. Along with a list of requirements in the RFP, there are also two different missions listed that the aircraft must be capable of completing. The first is a typical attack aircraft mission: taking off with full payload, on station for several hours with no stores drop, and returning home with all of the payload as well. The second is what is called a ferry mission and is simply a 900 nautical mile cruise with only 60% of maximum payload (“AIAA 2021”, 2020).

A mission capability that is very important to the design challenge is short take off and landing or vertical take off and landing (STOL/VTOL). This is due to the need for attack aircraft to have the capability of potentially replacing missions that previously could only be done by helicopters due to take off and landing limitations. Attack aircraft must also be very maneuverable to be able to quickly get to the area of attack, deploy ordinance, and return while avoiding any anti aircraft capabilities of the enemy. Helicopters lack this amount of stealth and maneuverability which is one of the main reasons why attack aircraft are being looked at to replace some helicopter missions because an attack aircraft could potentially complete the mission with much lower risk. When most people think of attack aircraft they immediately think

of the FA-18 or F-35 most likely but if you are thinking about a “light” attack aircraft these probably would not fall into that category. Although the FA-18 and F-35 are very good aircraft, a light attack aircraft with a turboprop could perform most of the missions asked of the FA-18 and F-35 for a fraction of the cost.

A couple existing aircraft that we have been researching that seem to fit the requirements listed in the RFP fairly well are the Embraer A-29 Super Tucano and the Textron AT-6 Wolverine. The Super Tucano is advertised by Embraer as a cheap, light, multifunctional alternative to other heavier modern attack aircraft. Embraer boasts that it has “proven operation in austere fields” with the ability to operate from semi prepared runways. It is also shown as being a practical air to ground offensive with many different weapon configurations for a very diverse air to ground mission abilities (“Super Tucano”, n.d.). Both aircraft were developed from existing trainer aircraft the Tucano and the Textron T-6. They were both given engine and performance upgrades as well as hardpoints for weapons configurations. The importance of weapon loadout diversity is evident in the design of the AT-6, boasting 66 different load configurations possible (“AT-6 Wolverine”, n.d.).

Using OpenVSP (an aircraft design tool) our initial configuration was made based loosely on these two existing aircraft. Various empirical and physics based models will be used to analyze and update our design such as existing aircraft and engine data as well as computational fluid dynamics (CFD). Using these tools and the research of existing light attack aircraft, our team strives to design an affordable light attack aircraft capable of replacing helicopters that are able to last a service life of 25 years.

STS Topic

Of the Department of Defense's (DoD) $636 million budget for 2021, $107 billion will be spent on new technology research (Amaedo, 2020). To put this number into perspective, one of the largest tech companies in the world, Apple, spent $18.75 billion on research and development for the 2020 fiscal year. For a company like Apple, R&D is important to invest in to ensure that they are staying ahead of the competition to maximize their profits in the future (Tankovska, 2020). The DoD has a similar motivation for R&D minus the future profits. After World War II the U.S. learned that superior technology is the key to winning wars. This has motivated the DoD to strive to achieve and maintain technological superiority over the world. With this goal comes large spending in the research of new technologies, as mentioned earlier (Weiss, 2014). One of such investments is the DoD's investment in the development of 5G technologies. Specifically, ways 5G can be used to benefit the U.S. Military, once again striving to maintain that technological superiority. What's worrying about this is does the large amount of money invested in new technology research by the DoD sway the focus and trajectory of private companies and researchers to develop technologies specifically applicable to the military rather than products and technologies for commercial use.

In early October, the DoD announced $600 million in awards for 5G testing and experimentation at various U.S. military sites. With this budget, it represents the largest testing of 5G services in the world. The tests and projects that are planned to run are 5G-engabled augmented/virtual reality for mission planning and training, testing 5G-enabled Smart Warehouses, and evaluating 5G technologies to enhance distributed command and control ("DOD Announces", 2020). Michael Kratsios, the Acting Under Secretary of Defense for Research and Engineering said, "'The Department of Defense is at the forefront of cutting edge 5G testing and experimentation, which will strengthen our Nation's warfighting capabilities'"

("DOD Announces", 2020). An even larger investment in 5G technology from another government source came from the Federal Communications Commission (FCC). The FCC pledged in April of 2020 that it would invest $9 Billion in the expansion of 5G technologies to rural America ("The FCC's 5G FAST Plan", 2020). At the same time, over 330 private companies have invested in 5G in the form of experiments, deployment, and commercialization (Finley, n.d.). So why then, would the government feel the need to invest such a large amount of money in a private sector technology that will only bring profits to said private sector companies.

The framework of the research and STS theories will be based on the theories and practices brought up in *America Inc.? Innovation and Enterprise in the National Security State* by Linda Weiss. The main argument brought up, and one that applies to the issues of military funding of technological research, is that the National Security State of the U.S. (NSS) is the driving force behind technological innovation and growth in America. The NSS, since World War II, has driven the pursuit of new technology and emerging industries which in turn has created a high tech commercial sector. It is important to note, though, that the NSS pursues technological innovation to sustain military primacy not to advance commercial success. This motivation combined with the dwindling number of defense contractors and growing number of private sector technology companies meant the NSS needed to update its business model. The NSS was forced to look outside of its normal defense contractors for technological innovation meaning emphasizing commercial opportunity in military research and endeavors. This caused the lines between commercialized and militarized technologies to be intertwined. With this new strategy of funding private corporations, the NSS now has a greater influence than ever on the trajectory of technology innovation (Weiss, 2014).

The Thesis paper plans to explore the relationship between the DoD's motivation to fund research and development and how this has intertwined with the research and development of 5G technology across America. The actors at play are the U.S. government and their investment in 5G technologies, the private companies manufacturing and distributing the 5G technology (Huawei), and the intended users of the 5G technology (commercial use). It is important to note that the company Huawei, which is set to construct the necessary infrastructure in 30 countries for 5G use, is Chinese and received government subsidies from the Chinese government ("United States, Congressional Research Service", 2020). This has led to a National Security Concern with regards to the privacy of information being transmitted through these Chinese manufactured 5G infrastructures. So, whatever the motivation of the DoD is to invest in this technology, can it be shown that through those investments 5G innovation was steered in a direction to benefit the motives of the NSS while also providing commercial success for private companies.

Next Steps

More research will need to be done in the timeline of when 5G technology was first being developed and when the U.S. government got involved in the form of investments and military research. This can then be used to help determine what impact the investment of the U.S. government had on the research and development of 5G technology. Also, more research will need to be done on why 5G technology was researched in the first place. What motivations did tech companies have to put money into this program? Was a potential monetary partnership with the U.S. government in mind when initial research began? Also, using theories from *America Inc.?*, is 5G an example of a spin on or spin off product or does it lie somewhere in between.

This will give great insight into how much the U.S. military affected the direction of 5G technology.

References

AIAA 2021 Undergrad Team Aircraft Design RFP - Light Attack Aircraft [PDF]. (n.d.). American Institute of Aeronautics and Astronautics.

Amadeo, K. (2020, September 03). U.S. Military Budget, Its Components, Challenges, and Growth. Retrieved November 05, 2020, from https://www.thebalance.com/u-s-military-budget-components-challenges-growth-3306320

AT-6 Wolverine Light-Attack Aircraft. (n.d.). Retrieved November 05, 2020, from https://www.airforce-technology.com/projects/6-wolverine-light-attack-aircraft/

Carichner, G. E., & Nicolai, L. M. (2013). *Fundamentals of aircraft and airship design*. Reston, VA: American Institute of Aeronautics and Astronautics.

DOD Announces $600 Million for 5G Experimentation and Testing at Five Installations. (2020, October 8). Retrieved November 05, 2020, from https://www.defense.gov/Newsroom/Releases/Release/Article/2376743/dod-announces-600-million-for-5g-experimentation-and-testing-at-five-installati/

The FCC's 5G FAST Plan. (2020, August 07). Retrieved November 05, 2020, from https://www.fcc.gov/5G

Finley, K. (n.d.). The WIRED Guide to 5G. Retrieved November 05, 2020, from https://www.wired.com/story/wired-guide-5g/

Foster, K. R. (2019, September 16). 5G Is Coming: How Worried Should We Be about the Health Risks? Retrieved November 05, 2020, from https://blogs.scientificamerican.com/observations/5g-is-coming-how-worried-should-we-be-about-the-health-risks/

Super Tucano. (n.d.). Retrieved November 05, 2020, from https://defense.embraer.com/global/en/super-tucano

Tankovska, H. (2020, October 30). Apple's research and development expenditure 2007-2020. Retrieved November 05, 2020, from https://www.statista.com/statistics/273006/apple-expenses-for-research-and-development/

United States, Congressional Research Service. (n.d.). *National Security Implications of Fifth Generation (5G) Mobile Technologies*.

United States, Federal Communications Commission. (2020). *Office of Economics and Analytics and Wireline Competition Bureau Seek Comment on Adjustment Factor Values for the 5G Fund*.

Weiss, L. (2014). *America Inc.?: Innovation and Enterprise in the National Security State*. Ithaca, NY: Cornell University Press.