

Thesis Project Portfolio

Student Researched and Developed High Power Rocket

(Technical Report)

Make General Aviation Great Again: The People

(STS Research Paper)

Make General Aviation Great Again: The Airplane

(STS Technical Research Supplement)

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EXECUTIVE SUMMARY

America is a powerful nation, but, as humans, no measure of strength can withstand a disease from within corrupting, corroding, and completely crippling our way of life. A tangible disease is found in an often-overlooked segment of society: General Aviation (GA), which has been in decline in both effectiveness and popularity since the 1970s golden era of GA. This decline is primarily due to the rising cost of GA aircraft, and this research will identify the core problems with these aircraft and attempt to provide a framework for potential solutions. The second disease is not so tangible, but extremely palpable: the declining moral discipline of American youth, which in turn has led to rampant mental health decline. Unfortunately, there are a myriad of causes; nevertheless, there are a plethora of solutions, both of which this research will explore. Similarly to how better nutrition can solve both physical and mental issues in a human body, a revitalized GA program can also help instill in American youth values of personal responsibility, discipline, integrity, etc. As an Aerospace Engineer, I have seen that the human aspect of my field is always somewhat neglected in engineering education, and so using technical research as a solution to these two societal issues is the goal of this paper. Also included is our team Capstone Project, designing a sounding rocket, where, in the technical report, I was the main contributor to the Fins Sub-team sections. I will first preface the technical report and then discuss more in depth about the STS and technical research, as they are completely separate from the Capstone Technical Report.

The goal of the Capstone Project was to design, prototype, fabricate, and test a high-powered rocket capable of deploying an experiment as a payload. While the ultimate goals remained the same throughout the course of this capstone, there were numerous changes to the requirements, which played a large part in how the design and fabrication processes were conducted. The initial requirements were based on those of the Intercollegiate Rocket Engineering Competition, and then those of the Battle of the Rockets at Tripoli Central Virginia. Ultimately, the members of the capstone decided to forgo participation in competitions, as it

restricted our ability to use student-made designs. We agreed that it was more important to get the experience of creating our own components entirely from scratch than it was to see our rocket launched. Despite not being able to launch, it is our hope that our work will provide a valuable knowledge base for our class as we enter the workforce, as well as for future classes working on similar projects. Specific requirements for the rocket are as follows. The design must carry a payload to a target altitude of 4,000 feet while maintaining stability via the fin assembly. Structural system requirements include being able to withstand the loads experienced during takeoff and flight and completing two separation events to facilitate parachute and payload deployment. Mechatronics system requirements include being able to sense when the rocket is at apogee, communicating live data back to the ground, and enabling the execution of separation events. Payload deployment must occur at apogee. The parachute must be deployed at a time that ensures a non-destructive terminal velocity. Propulsion system requirements include being able to achieve an altitude of 4,000 ft. and being able to withstand the forces and thermal conditions associated with launch and flight. The remainder of this Executive Summary will further explain the STS and personal technical research project concerning the state of American youth and General Aviation.

General Aviation, or GA, is the term used to describe anything to do with airplanes, airports, or air in the private sector (meaning this term excludes military and commercial flight). GA is currently a vital element in the nation's economy. Since the beginning of the decline of GA, airports have gone down with hundreds of current airports decaying without sufficient staff and funding to support them. The price of being a part of this field and community has also risen exponentially, and price is a huge roadblock for most potential aviators coming into this field, which limits the number of support jobs available (mechanic, manufacturer, painter, airport operator, etc.), which then in turn begins to push the vital resources GA provides out of reach for the communities it serves. As a former Aircraft Maintenance Technician, student glider pilot, and aerospace engineering student, I have seen areas where the industry could improve

(considering most aircraft designs are from the 1950s still). The goal of my research is to analyze and present a framework whereby this price can be reduced. I will present this framework using several sources of literature describing the state of GA, legal policies regarding it, a maintenance cost analysis, a design environment to improve GA aircraft, and I will compare these sources and my own ideas with the FAA's current plan regarding GA.

From the literature regarding the decline of GA, we can see that there has been a decline since the 1970s, with a huge rise in prices in all areas, and large need for personnel. From the legal policies in place, we can see there have been attempts at revitalizing GA, but none have truly been successful, as the required certification and manufacturing costs for aircraft manufacturers are simply too great for average Americans to be able to afford. There is a lack of manufacturing at scale due to the heavy restrictions in place due to federal regulations, and a combined effort on all sides of GA is required to mitigate it. The maintenance cost analysis is exceptionally thorough, providing the factors that matter most in a total cost estimate of maintenance on GA aircraft intertwined with human resources, time, current industrial standards, etc. This maintenance cost prediction method yields only 13%-20% error, fitting fairly well for a theoretical approach to a varied issue. The design methodology article from the AIAA functions in much the same way, except showing in the aircraft design process the approach taken towards transportation architecture of GA aircraft, illustrating an overview of how the systems in the world operate with respect to GA aircraft as modes of transportation. These methodologies are being taken into consideration in the FAA's plan for GA for 2030, in addition to an analysis of new technologies, automation in manufacturing, and the rise of alternative energy sources. I recommend to take seriously the considerations of all sources in designing new approaches to each aspect of GA (design, manufacturing, advertising, certifications, maintenance, etc.), and further research be done into the legal restraints on GA manufacturing, as that is currently the "rate-limiting step" in revitalizing GA.

Focusing now on the social aspect of this research, the two questions my research will answer are “Why are both the GA sector AND the moral state of American youth (and thereby their mental health) in decline?” and “How can revitalizing GA across the country instill strong moral values to mitigate the mental health crises among the youth of the US?” Clearly, the mental health of the future leaders of this country are of paramount importance, but many average citizens are completely unaware of the importance of GA. General Aviation is a valuable and integral sector of society, being a vital part of Emergency Organ Transplants, Firefighting, Sightseeing, Search and Rescue, Travel (especially in islands and Alaska), Law Enforcement, Humanitarian Aid, Disaster Relief, and so much more. As each of these sectors is necessary for a healthy society, the revitalization of GA has been a topic of research for many years. This paper will analyze various literary sources, use survey results, and cite conducted interviews to prove these problems are real and that the revitalization of GA as a field and community can solve the morality decline and therefore, the mental health issues in rise among American youth.

Using the Actor Network Theory, with an assumption that values of a person at their core define their choices (Virtue Ethics Approach), this paper will show how the problems are related and how they can be solved. The literary analysis takes from various studies done on the effects of technical and cultural changes on the mental health of teenagers, the current “loneliness epidemic,” making a case that loneliness actually increases the risk of disease and death in any person in any given situation, and potential solutions: wilderness therapy and GA in Australia. Survey results from a personally conducted survey to youth ages 14-24 indicate that the claims are what the majority of youth are experiencing. The interviewee, a veteran of GA, also expresses concern of the same problems as presented in this paper, and, without prompt, offers the same solution as this research: an increase of challenging opportunities for youth in GA specifically could help those individuals grow their values to the point of conquering their own mental health problems.

As the current GA costs and perceived risks are much greater than perceived benefits, the success of the revitalization of GA to help youth in their struggles is contingent upon a better GA aircraft allowing entrance into the field and community much more accessible. With a method to develop a cheaper, safer, and more novice-friendly aircraft, including inevitable manufacturing and policy changes, the field will be viewed more as it should be, and the community will be open to more than just the wealthy and lucky. With General Aviation ready to function on a grander scale, the addition of American youth in need of a challenging and positive environment will be enough to fix both issues simultaneously.