

NASA 2019-2020 Aeronautics University Design Challenge: Urban Air Mobility, Aerodynamic Team

(Technical Paper)

The Privatization of Spaceflight

(STS Paper)

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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

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Introduction

As long as mankind has walked the earth, there has been an instinctual urge to keep pushing the frontier of knowledge and explore the unknown. Through exploration comes innovation, and through discovering the unknown comes technological advances to combat the unforeseen. Today, the aerospace industry is on the front lines of reshaping society both here on earth and beyond. This paper will discuss a technical project regarding the optimization of urban air mobility, as well as its social implications. This will be viewed through the STS framework of Social Construction of Technology (SCOT) that will be further applied to a case study in the privatization of space flight.

Urban air mobility, specifically fitted to the package delivery industry, brings the speed and flexibility of air flight to improve logistical functions. Over the years society has expanded its ability to deliver goods from horseback to eventually shipping across continents. The logistics of package delivery begins with air transport if needed, and then it is hauled by a truck to a local facility that then takes a company vehicle to deliver a package to the doorstep of the consumer. However this process finds the greatest inefficiency, in regards to resource consumption, during the last mile phase of the delivery. Thus it is desirable to have a system that can complete the last mile delivery quicker, more efficiently, and with less human interaction. The technical topic discussed will develop the push to utilize autonomous flight vehicles to impact the package delivery system in urban spaces.

The privatization of space flight, and the desire to make it widely available to the public, will inevitably bring about a change in the space industry landscape and also affect all competing parties, many of which are country governments which in turn effect the general population and thus bring about major implications to the global community. While the intricacies of how

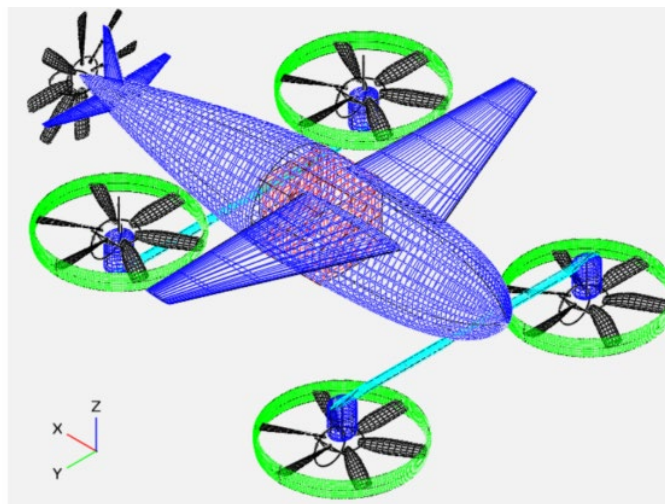
policy affects a population and the complexities of a population's interaction with their national legislature is out of the scope of this paper, the aim is to show competing, or coinciding, interests that will affect the privatization of space flight.

Technical Prospectus

A group of twelve students at the University of Virginia are partaking in the NASA 2019-2020 Aeronautics University Design Challenge, in which a design from start to finish will be formed to meet the project specifications. According to the NASA challenge website the main goal is as followed: "Design a safe, reliable, profitable, low-noise autonomous unmanned aircraft system (UAS), including the ground systems, to deliver small packages via air transport to designated landing platforms." Within this challenge is not only the performance aspect needed to be designed for optimal performance, but also a cost analysis business plan and safety measures in the way it interacts with the public. The design will have to conform to FAA regulations, have details safety measures, as well as meet well defined objectives in both performance as well as functionality.

The parts of the project pertaining to the cost benefit as well as detect and avoid software are outside of the scope of the current report and details will be solidified once the final design is selected upon the current pool. Currently in the process, between the three teams (aerodynamics, propulsion, and performance), a pool of possible designs has been created in order to perform further analysis and then select a design to move forward and finalize during the spring semester. Upon creating these designs, aspects such as VTOL, STOL, lift-cruise configurations, as well as weight have been leading concerns for the designs. As seen in the figure below, this prospective design incorporates a combination of four vertical lift fans as well as traditional wings in order to

takeoff within the allotted distance as well as travel under the prescribed conditions and speeds while at cruise altitude. In order to fulfill all the required tasks, a fixed wing design was desired for stability, range, and power consumption, however due to the runway size of 50 feet, as well as the need to make near vertical maneuvers the four vertical lift fans were also included in the design. The vertical stacking of wings and lift fans reduce turbulent interference and thus raise the efficiency each has on the overall performance of the aircraft.



The general process will be as follows: Once a design is created in Vehicle Sketch Pad software, it is then further analyzed to see values for lift, drag, and other key aerodynamic factors. This step occurs using the software Flightstream. After this is performed, the next iteration of adjustments will be made to the design and then narrowed until the competing designs utilize different configurations. The current process includes eight designs that will be evaluated and upon completion of the semester no more than three designs (one per configuration) will be selected to further analyze in the spring and fulfill required analysis.

During the early stages of the conceptual design process much thought needs to be given to how this proposed technology will interact with the world around it. For one, it affects the way

logistical companies will be able to deliver small items and could greatly help in the last mile, and help reduce operational costs in the long run due to its autonomy. It also must be taken into consideration the way in which it will interact with those receiving packages and what that interaction will entail. While all these factors seem to be of importance during the final stages, there is a great amount of relevancy during the early conceptual phases, as many forms of delivery and also placement of rotos have been rejected due to their impact with these other social groups.

STS Prospectus

The dream of mankind has always been to travel to the stars and be able to visit the unknown. While this once was a part of science fiction, the technology of today has made it possible, and as technology further develops it is no longer infrequent and inefficient launches, but the push has gone to a privatization of space flight which has brought about a great influx of launches as well as talks about even possibly reusing spacecraft, as seen with the emergence of companies such as SpaceX. However, before noting the emergence of the private sector within the space industry, it is important to note some trends within the space industry itself. There has been an increase in collaboration between governments in an effort to achieve greater feats, as well as keep maintenance with the use of the International Space System. To organize the framework of how privatization affects society, the following parties involved will be used as a reference: private companies, governments, and the general public. Using these social groups, further investigation will be held into the benefits and emergence of the privatization of spaceflight.

To define privatization, Henry R. Hertzfeld (2000) defines privatization as “the process of applying a market-oriented approach to government programs, with the objective of moving the program's activities and assets out of direct government management, control, and ultimately ownership.” (p. 1). The appeal to achieve space flight and the emergence of entrepreneurs who have the capital to become relevant players has brought to the forefront the question of how this technology should be handled. When it comes to space flight, there is a high amount of infrastructure needed, such as launch pads and control centers, as well as significant aviation coordination so that there is no interference with aircraft during the launch sequence. Initially the space industry was dominated by government, meaning there was only internal coordination needed, and all infrastructure had become publicly subsidized.

However, given the slow privatization of spaceflight, and thus an ever-growing market, the problem of funding arises. In his paper on global space trends, Shamim A. Rahman (2010) notes the 2007 Space Report showing the industry to be a \$251 billion economy (p. 1), while more recent estimates show increases of nearly 50% to that number. With an industry of this size, it's clear that taxpayers will not be able to cover operational costs of launch pads for long, especially if said launch pads are being used by private companies. This very situation will require careful regulations as well as detailed agreements in order not only to share orbit space, but also the vast ground networks needed to upkeep a space company.

This intertwined and complicated future didn't just come out of nowhere, rather it is the very situation in which the technology developed, only recently have the outcomes manifested. When spaceflight was young and the space race was underway to put a man on the moon in the 1960's, all sectors worked together to achieve this purpose and produce the subsequent technology under the label of national pride as well as hope. Since space travel has been in the desire of men for

centuries, this hope of being able to finally realize this dream united all parties of private and public sector to achieve this goal. At the time the market environment and technology didn't facilitate a shift towards privatization in spaceflight, although the social environment was very much interconnected. Thus, today as technology has developed in this environment, it is no surprise there is a push to privatize spaceflight and to not only use space to make a political statement, or conduct scientific research, but to open up a new world of travel and high class leisure that has been inevitable since a hope inspired origin of space flight.

The proposed plan for further research will look not only on what each social group has to gain or lose from the privatization of spaceflight, or even their relations to each other in the process. Rather the focus moving forward will shift to use the analysis of how things have developed to interpret the space industry today and interpret the future direction of the quickly expanding industry.

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