Design of Autonomous
Unmanned Aircraft System
(Technical Paper)

Comparing Current Drone
Regulations with Public
Concerns
(STS Paper)

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Derrick Devairakkam
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Technical Project Team Members
Joseff Medina, David Normansell,
Philip Hays, Cristhian Vasquez,
Brett Brunsink, Derrick
Devairakkam, Gino Giansante, JD
Parker, Justin Robinson, Alejandro
Britos, Daniel Choi, Timothy
Mather, Walker Smith

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

Signature_____ Date_____
Derrick Devairakkam

Approved_____ Date_____
James McDaniel, Department of Aerospace and Mechanical Engineering

Approved_____ Date _____
Kent Wayland, Department of Engineering and Society

The Biggest Obstacle for Delivery Drones: FAA Regulations

Rapid technological developments in autonomous unmanned aerial vehicles (UAV) and an evolving legislation may soon open the way for their large-scale implementation in the future. The use of drones could drastically decrease labor costs and has high potential to disrupt the parcel delivery industry. Online retailers and delivery companies such as Amazon and UPS, are already filling up patents for the development delivery drones and landing platforms. The technical research topic is to propose a delivery drone system which would prove to be competitive within its market. However, there is a huge barrier which greatly limits the implementation of drones. Currently, the technology available is sufficient for safe autonomous flight as exhibited by Amazon's Prime Air, which is designed to safely deliver packages up to five pounds to customers in 30 minutes or less. In fact, hundreds of companies like Matternet, Flirtey, and Project Wing have autonomous drone delivery technologies. *What is keeping them grounded, however, are FAA regulations; the biggest obstacle facing autonomous delivery drones from entering the market is not the lack of technology but FAA regulations*. Currently, the FAA has rules which make autonomous drones impractical. In this report, I want to look into how current FAA regulations of drones were developed to get a better idea of what forces might shape future regulations.

Design of Autonomous Unmanned Aircraft System

The technical research problem is to *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.* Urban Air Mobility is currently the

fastest growing area of aeronautics. Hundreds of millions of dollars are being invested world-wide and hundreds of companies are scrambling to position themselves to take part in the new, disruptive technologies that will allow lightning-fast delivery of goods and eventually on-demand transport of people in congested urban areas. It's a great time to be involved in aeronautics with many similarities to the beginning days of aviation in the early 1900's. New technologies like electric propulsion, reliable low-cost avionics, and instantaneous connected communications will enable these new areas of expansion in the aviation industry. As such, the technical research problem is set up to make the most of these recent developments. Currently, the aircraft design team is presenting state-of-the-art (SOA) topics related to UAS in order to get a clear idea on available technologies and methods. SOA topics ranged from analyzing the different propulsion systems (electric, gas, hybrid, distributed electric propulsion), different wing structures, noise mitigation methods, safety procedures, detect and avoid methods, etc. This is the first step in designing the UAS and ground systems as it is vital that all options are considered thoroughly. Next, we will sketch aircraft designs that could be potentially work. This is important because these preliminary sketches will allow for mathematical work to be done on them and decide whether such designs would work and thus narrow down the scope of aircrafts. These preliminary sketches will then enable us to do mathematical analysis on the aircrafts and allow us to see if these designs will be able to meet the design criteria. Analysis tools such as computational fluid dynamics (CFD), vehicle sketch pad (VSP), and Flight Stream will be used to perform weight calculations, aerodynamics, and performance calculations. This will narrow down the selection even more and allow for optimization on specific designs. Then, through iteration of the previous steps, the best UAS will be designed.

The Origination of Drone Regulations

The FAA currently requires all commercial drones to remain in the pilot's visual line of sight at all times. In other words, pilots can't use first-person-view (FPV) cameras to control them without direct sight. The FAA also says that commercial drones can only be operated during the day or twilight when proper lighting is used. Most importantly, though, the FAA requires the drone to be flown over people only if they have signed a waiver giving permission to do so (FAA, 2017, n.p.). The STS research problem will look into how current regulations of drones were developed in order to get a better idea of what forces might shape future regulations. So, the title of this paper would be "How current regulations of drones were developed and forces that might shape future regulations."

This report will research the rulemaking process and procedures relating to drones, from conception to implementation. For this, the methodological approach consists of a research synthesis of UAV regulations, including a thorough literature review. UAV regulations are explored from the perspectives of past, present, and future trends. Steps taken along this research project will involve looking into groups responsible for rulemaking and groups behind the enforcement. In general, the groups involved would be the FAA, the International Civil Aviation Organization (ICAO), Standards and Recommended Practices (SARPs), Procedures for Air Navigation Services (PANS), and the Federal Register. The research will also look into the history of these organizations, their impetus, and how they have developed over the past years. The purpose of inspecting their origin is to find out why these organizations were put together in the first place and to see if any particular event sparked the need for such entities. Therefore, the historical facts that would be gathered would be their date of origin and any push backs or

problems they have had. Another group will be the general public. The FAA website indicates that the general public is welcome to participate in rulemaking by sending comments and petitions for exemptions. As such, looking into events that would have affected the public opinion of aircrafts and unmanned aircraft systems would prove to make clearer the general opinion on UAS and shed light on some of the forces behind FAA regulations. Sources to realize the opinion of the public will include news articles, blog posts, social media interactions, etc. To further this particular endeavor, the extent to which the participation of public influences the actual rules proposed by the FAA will be looked into by comparing the public opinion with FAA regulations. A general consensus of the public's opinion would have been gathered by the aforementioned method. The various forces affecting these organizations will also be looked into in regards to their interest with drone regulations. These forces would be the various institutions behind the rulemaking process. Such forces would be revealed by closely inspecting the various institutions website. The FAA lists a number of different committees involved in rule making. The onus of these committees will be researched as it will add a clearer understanding, and maybe even reveal, the general nature behind rulemaking. Additionally, I will look into UAV/UAS specific incidents reports from journals, newspapers, etc. and analyze their impact on the aforementioned organizations. Understanding This will serve to establish the logic and attitude these organizations of have towards drones.

Literature relating to this topic may come from open access sources journals such as a review done by the faculty of Geo-Information Sciences on the current state of FAA regulations and other similar scholarly sources. This particular article compared drone regulations of different countries. They concluded that all UAV regulations have one common goal—minimizing the risks to other airspace users and to both people and property on the ground but

the administrative processes and the implementation of ethical constraints varied (Stöcker, Bennett, Nex, Gerke, & Zevenbergen, 2017, p.3). This piece of literature helps shed more light on the causal relationship between drones and their imposed regulations. Currently the FAA only does case by case approvals and the Congressional Research Service goes into the current FAA policy approval process and how the FAA regulate small unmanned aircrafts. It states that the developers of small-scale unmanned aircraft are concerned that the FAA has been moving too slowly on measures to safely accommodate these types of aircraft since the FAA only does case by case approvals. It mentions that drones need separate regulations and that a one size fits all approach to regulation would not likely be effective given the wide range of drones and the FAA has not taken any formal action on addressing the regulation of civilian small unmanned aircraft other than streamlining the case by case approval process (Elias, 2012, p. 42). This document would do a great deal towards how the FAA and UAV manufactures interact.

This research investigation is to first provide a holistic overview of the current status of UAV regulations. It further delivers insights into the past, present and future development of legal frameworks that regulate the use of UAVs. By doing this research I want to show the intricacies and complexities faced by the FAA in regulating drones. These complexities come with the bureaucracy associated with dealing with multiple stakeholders. The FAA has to take into account the civilians, the drone industry, and the various rulemaking committees. The drone industry can then be broken down into various subgroups consisting of small-scale UAVs, autonomous UAVs, VTOLs, etc. The complicated network the FAA has to navigate can be seen by the sheer number of different groups involved. Additionally, I will know the extent to which each group affects the rulemaking process and possibly the nature of FAA regulations in the

future. This information will be useful to anyone affected by the drone industry, which mentioned above, is a large number of people.

Conclusion

It is evident how society affects technology and vice versa. The technology would be autonomous UAVs or drones in general and society would be the civilians, FAA, and various other rulemakers. If the rulemaking process is understood and the future path of FAA regulations is known the drone industry could adapt accordingly. This would allow for drones to be built in a way that satisfy FAA regulations and deliver packages in an urban environment. This would enable a whole another market and revolutionize the package delivery system. The use of drones could drastically decrease labor costs and has high potential to disrupt the parcel delivery industry. In turn, new markets in drone development, ground system development and various other technologies could develop. Therefore, it is important to realize the relationship between these two groups as it could prove to make a large impact on society, for the better or worse.

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