Regarding the Development of New Manufacturing Processes for Legalization and Sales of Unmanned Aerial Vehicles in U.S. Precision Agriculture

Topic Overview

The topic of this document concerns the debate over the usage and implementation of unmanned aerial vehicles (UAVs) in US agriculture. Although scientists have long since held the position that they will present an enormous agricultural and economic benefit for the country, a wide rollout of drones has been continually delayed by the Federal Aviation Administration (FAA). Citing problems in safety, accessibility, personal privacy, and homeland security, the agency has presented a number of federal limitations on all UAVs. These regulations include limits on payload capacity, flight range and altitude, and remote operability. Only drones which have been tested and can be proven to fall under these federal limits are allowed to be freely sold. By following these procedures closely, it is therefore possible to manufacture high-quality drones that can directly be sold to the agricultural market.

Purpose

The purpose of this document is to convince manufacturers to invest in multiple single-purpose agricultural drones as opposed to the current approach to UAV manufacturing, which is to design a single multi-purpose one. Multiple leading UAV manufacturers have already realized the market need for drones in precision agriculture. However, many of them are developing a product in an inefficient manner. They are attempting to build a single machine that would be able to handle multiple tasks at once: crop spraying, camera monitoring, radio communication, and long-distance autonomous navigation capabilities. This is not the solution they should be aiming towards. Firstly, the inclusion of all these components can quickly exceed the 55 lb. weight restriction (Freeman & Freeland, 2014). In addition, FAA guidelines state that the drone must operate within the operator's eyesight, so that autonomy and radio communication capabilities are unnecessary luxuries that only introduce legislative roadblocks.

By focusing instead on manufacturing a line of UAVs each built for a specific purpose, one could achieve similar results with much lower costs. The process would have the added benefit of being much more cost-efficient for the customer; the current most popular all-in-one UAV model has a base price of $100,000 and a premium package costing $230,000 (Amenyo et al., 2014). It also took over twenty years to receive the FAA's approval to sell this model in the US. Three drones accomplishing the same tasks would altogether cost between $10,000 and $50,000 (Freeman & Freeland, 2015) and could receive the approval for sale much more quickly. This would allow UAV companies to greatly profit from having a product that does not struggle

to pass FAA regulation but which does not need to compromise on its capabilities and efficiency to do so.

Genre

The genre of this document will be a proposal, as this document will be making clear how one specific approach to an engineering problem is more commercially and legally viable than the current model adopted by the industry. While a report may also function for this topic, a proposal better enables discussion of the problem-solving approach. It will allow for more depth to present the issue and to address different perspectives. Economically, the proposed approach can allow drones to be made more cheaply and reach the market more quickly. Socially, the agricultural market will be able to use these drones to decrease physical labor requirements and increase crop yield. Legally, the UAVs will be able to garner FAA approval more quickly, resulting in a smoother rollout and implementation. A proposal will allow me to directly state and elaborate upon these positions to indicate how my approach can achieve a better solution in less time than the competition.

Audience

The audience of this report is The Boeing Company, more widely known as Boeing. I will specifically be writing to the Product Strategy & Future Airplane Development division in the New Mid-Market Airplane (NMA) program. Boeing is a US military company with a long history in unmanned aerial vehicle manufacturing, but they also design products for civilian use, which the falls within the NMA's expertise. The Product Strategy subdivision there specifically handles the development of new technologies meant to operate in federal airspace. This enables it to be the best team to implement a strategy to design, manufacture, and release the proposed agricultural UAVs.

Boeing also has a vested interest in pursuing this market, as their competitors have already begun an approach. Boeing's major competitors are other large corporations like Northrop Grumman and Yamaha, which release products targeting similar audiences. Those two companies are currently pursuing a plan to release a new UAV to the US agricultural market which will be a multi-purpose machine costing upwards of $100,000. Boeing would therefore be more receptive to receiving a strategy which can enable them to sell products to the agricultural market more quickly and at a lower cost.

Motive

Much of the industry is exclusively focused on a single machine which can fulfill all the needs on a farm while remaining within FAA guidelines, but they are attempting to solve a nearly

impossible problem. They believe that a solution will enable them to market the UAV as a one-of-a-kind machine with entirely novel technologies supporting it. This is why the argument discussed in this document is not obvious; it falls back to less complex, but still fundamentally sound, engineering as opposed to an elaborate solution. At times, the best solution is the simplest one.

Those companies also believe that the problem is one solvable by research and engineering, but the real constraint they are working with is the FAA, which has shown no inclination to relaxing its guidelines within the next several years. To reach the market more quickly, it is therefore more logical to choose simply to work under the FAA while still delivering products which deliver everything wanted of them. Contrary to standard opinion, new technology is not the solution to this problem. The motive of this proposal is to convince Boeing this is the correct approach. They also have not invested any money into pursuing this market yet, so they would be more amenable to receiving a proposal diverting from the more popular current opinion. A company which has already sunk millions of dollars into research might be more averse to changing their approach midway through their design process.

Persona

For this report, I will be taking on the persona of a university researcher concerned with the fact that every year UAVs are not implemented in agriculture, no parties involved benefit - the farmers, the UAV corporations, and the country itself. My diction will remain succinct and professional, as I personally do not know my audience. For that reason, I will only be writing in third-person POV. My sentences will also be more elaborately written, which is the writing style of most official technical proposals. It will involve use of punctuation such as semicolons, hyphens, and parentheses in order to make the content appear professionally sophisticated. Paragraphs will be approximately the same standard length each, as the overall appearance of the paper is also important. Only black ink will be used, along with standard serif fonts. The use of bright colors or design flourishes which do not directly support the paper's content will appear unprofessional. There will be multiple uses of data figures throughout, with the goal of at least two per paragraph. Again, this lends the paper a more credible stance.

Tentative Outline:

1. Introduction
    1. Thesis: propose refined approach to introducing UAVs to precision agriculture market
    2. Discuss benefits of proposed approach
    - Faster lead-time in research and manufacturing
    - Greater efficiency

- Lower price for customers
- Easily meets FAA restrictions

2. Design Criteria for Agricultural UAV
    1. Briefly discuss major FAA policies which this proposal will specifically be targeting
    - Payload
    - Altitude
    - Autonomy
    - Visibility
    2. Explain why current approach falls short of meeting design criterion due to excessive payload requirements and unnecessary autonomous capabilities
    3. Note how proposed approach meets criterion while remaining economically viable
3. Economic Motivation
    1. Note data on cost of drones following current approach
    - Specify metrics on most present competition: Yamaha RMax
    2. Note data on cost of drones following proposed approach
    3. Discuss additional lowering of costs
    - Reduced lead-time on manufacturing
    - Lower need for new research & innovation, as majority of currently published research already focuses on these topics
    - Ability to reach wider market of consumers
4. Approach to Solution: Research
    1. Explain basic research requirements necessary to reach goal
    2. Discuss range and impact of published research
    3. Contrast with current approach to problem, which requires massive costs to solve a problem which is essentially impossible to solve with an engineering-focused approach
5. Approach to Solution: Implementation
    1. Indicate a potential system of goals and checkpoints that can be quickly implemented
    - Complete research
    - Design drones to meet specific requirements
    - Manufacture small number to test internationally and pass FAA policy tests
    - Sell directly to consumers
    2. Explain why this method of implementation also surpasses current approach
6. Conclusion
    1. Conclude by concisely reiterating numerous benefits of proposed approach

Annotated Bibliography:

1. Freeman, P.K., & Freeland, R.S. (2015, December). Agricultural UAVs in the U.S.: potential, policy, and hype. *Remote Sensing Application: Society and Environment*, *2*, 35

This document is critical in establishing the FAA's arguments against a wide rollout of UAVs in the US, and also includes a passage documenting the process the Yamaha RMax went through for domestic approval. The source considers a perspective often not thought of by researchers, which is an unbiased examination of the FAA's policies. Most papers are either combative or entirely disregard them. As this paper is not taking an antagonistic view of the FAA, the content of this paper becomes additionally important. However, the method established in this paper is fundamentally different in purpose from my proposal, as it is a report on the obstacles facing UAV rollout. It does not attempt to find or document any solutions.

2. E. Borgogno Mondino & M. Gajetti (2017). Preliminary considerations about costs and potential market of remote sensing from UAV in the Italian viticulture context, *European Journal of Remote Sensing, 50*(1), 310-319

This is a research paper documenting considerations regarding drone costs. It includes multiple test cases and data taken with different UAV variables, such as flight type, payload capacity, and battery lifecycle. While most of this data was collected in regards to Italian laws on UAVs, there are test cases which fall within US standards as well. This document does not address the wide implementation of drones in any location, and is merely a report documenting limiting factors in flight and productivity. I will be using this paper to support arguments on the cost efficiency of my proposal.

3. Zhang, C. & Kovacs, J.M. (2012, December). The application of small unmanned aerial systems for precision agriculture: a review. *Precision Agriculture*, *13*(6), 693-712

This research paper specifically targets the capabilities and applications of small UAVs in agriculture. It considers FAA regulations as well, tailoring test cases with variables set to fall under US aviation guidelines. The document does not place its research within the scope of a country-wide implementation, though. It reports on both the positives and negatives of small drones but leaves the final interpretation to the reader. My paper will primarily draw on the benefits it points out while addressing the concerns; this is necessary to anticipate and prepare for arguments against my proposal.

4. Freeman, P.K., & Freeland, R.S. (2014, December). Politics & technology: U.S. polices restricting unmanned aerial systems in agriculture. *Food Policy, 49*(1), 302-311

This paper is a compilation of FAA restrictions on UAVs in the country, and will serve a crucial role for my proposal. It will allow me to establish criterion and goals for my proposal to meet, as I am aiming specifically to build a fleet of drones which will strictly follow legal procedures. This paper also notes how these regulations are affecting the agricultural economy, which provide additional data points I can use in support of my argument for immediate action. This paper does not propose any solution, as it only represents a compilation and explanation of FAA policies.

Citations

1. Amenyo, J.-T., Phelps, D., Oladipo, O., Sewovoe-Ekuoe, F., Jadoonanan, S., Jadoonanan, S., … Kublal, A. (2014, December). MedizDroids Project: Ultra-low cost, low-altitude, affordable and sustainable UAV multicopter drones for mosquito vector control in malaria disease management. *IEEE Global Humanitarian Technology Conference (GHTC 2014).*
2. Freeman, P.K., & Freeland, R.S. (2014, December). Politics & technology: U.S. polices restricting unmanned aerial systems in agriculture. *Food Policy, 49*(1), 302-311
3. Freeman, P.K., & Freeland, R.S. (2015, December). Agricultural UAVs in the U.S.: potential, policy, and hype. *Remote Sensing Application: Society and Environment*, *2*, 35