Unmanned Aerial Systems Fleet Management Techniques

Jimmy C. Pujols Cruz, Master in Engineering Management
Advisor: Dr. Héctor J. Cruzado, PhD, Graduate School
Polytechnic University of Puerto Rico

Abstract

Unmanned Aerial Systems show great economic potential and their use offer both opportunities and challenges that are unique to this type of aircraft. This study proposes that the challenges presented by their use can be managed using lean and normal management tools. Those tools will allow the Manager of an Unmanned Aerial System Fleet to operate a profitable business operation and predict problems before they happen. Therefore, the tools presented will help future Unmanned Aerial System Fleet Managers make the decisions and analysis needed to enter this exciting aerospace segment.

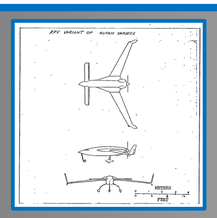

Figure 1:NASA concept for UAS that requires a runway

Introduction

Unmanned Aerial Systems (UAS) are a potential revolution in many fields and this is proven by the fact that the projected UAS impact on the United States economy is high. "The consulting firm Deloitte predicts that total revenue from nonmilitary drones in 2015 will be between $200 million and $400 million. Longer term forecasts are more optimistic, estimating commercial drones could become a billion-dollar industry by the 2020s" [1].

For this industry to grow in sales by 600 million dollars in only five years, there is a need to learn the possible uses of UAS and what regulations from the Federal Aviation Administration (FAA) affect them. The National Aeronautics and Space Administration (NASA) created a list of possible applications for UAS by categories [2]. Some of the categories include small-surveillance the following apply: Security of high-value, Surface-mine patrol, Oil-spill clean-up direction, Wildfire mapping, Ice-floe scouting, Spray block marking and tracking and Ground truth verification. Also, a list of some future UAS applications has been developed [2]. On delivery Amazon Air, UPS and the United States Postal Service among others. Finally, Internet Providing by Facebook and Google.

The focus of this investigation will be on small UAS operations since those are the ones that can be found locally in Puerto Rico and can benefit from this research.

UAS operations are basically a new field since the FAA regulations that govern for profit operations went into effect in 2016 [3] and it can be argued that: With the currently existing Management Tools (Quality and Lean) small UAS operations can be optimized and studied allowing future UAS Fleet Managers to foresee business and regulatory challenges and attack them allowing the growing UAS industry to mature faster than they would without the use of these tools.

Literature Review

UAS's have various definitions, but most deal with the fact that they are remotely operated (meaning the person in control of the aircraft and nobody for that matter is inside the vehicle) and that they are airborne (meaning they operate in the air). Various authors were consulted to get UAS properly defined, but for this project purposes, the Federal Aviation Administration (FAA) definition is the regulatory statement that will be followed for this project. Their definition reads as follows: "Unmanned aircraft means an aircraft operated without the possibility of direct human intervention from within or on the aircraft" [3]. A more detailed definition was found on the UAS Remote Pilot Test Prep and is presented here: The small unmanned aircraft "Weight less than 55 pounds (25 kg), including everything that is onboard or otherwise attached to the aircraft" [3]. "Are operated without the possibility of direct human intervention from within or on the aircraft" [3]. The Federal Aviation Administration rolled out the UAS rules presented on this Literature Review on August 29 2016.

The United States Department of Defense (DoD) also categorizes UAS's, their five categories are based on performance parameters such as weight, maximum attainable altitude and airspeed. Those parameters are not used by the FAA when regulating UAS operations and, as such, they are included just for reference purposes on Table 1.

A search performed on the Polytechnic University of Puerto Rico Library databases yielded no results to searches with the keywords UAS, UAS, Drone and Management tools that take in account the latest FAA regulations. The lack of official research found regarding the subject matter of management tools applied to UAS can be attributed to the fact that the FAA regulations were updated on August 29 of 2016.

Table 1: List of UAS categories per the United States Department of Defense [5]

UAS Category	Max Gross Takeoff Weight	Normal Operating Altitude (ft)	Airspeed
Group 1	<20 pounds	<1200 above ground level (AGL)	<100 knots
Group 2	21–55 pounds	<3500 AGL	< 250 knots
Group 3	<1320 pounds	<18,000 mean sea level (MSL)	
Group 4	>1320 pounds		Any airspeed
Group 5		>18,000 MSL	

Note: If a UAS has even one characteristic of the next higher level, it is classified in that level.

Analysis and Results

After applying some of the Quality/Lean tools to the for profit operations of small UAS fleets in Puerto Rico the following can be reported regarding the Gemba Walk. It was performed on the meeting of the Phantom Drone PR Club in Isabela (a locally operated UAS club) on Wednesday September 28 of 2016. The first step was to assess the spatial restrains for UAS operations (see Figure 3). Some of the operation requirements of UAS were confirmed on the visit.

- Minimum takeoff area 20 ft by 20 ft.
- Zone must be clear of aerial obstacles such as trees and electric lines.
- Operational ceiling of 400 ft is enforced by the use of software within the UAS.
- Global Positioning Systems (GPS) within the UAS serves to enforce the no-fly zones determined by the FAA such as airports..
- One of the operational problems experienced was weather conditions.
- Charging time could be a potential interference to their business or future business in general, since they can take up to 4 hours to charge and only be used for 15 to 30 minutes.

The survey of the Phantom Drone PR Club was performed on 8 members that were present during the visit. The survey started with a question to know how many UAS's they have and, also, if they used them for recreation or business purposes. If they used them for business, they were asked to specify the kind of business between photography, agriculture, security or other. The survey showed that 50% of the members possess more than 3 UAS's and the remaining 50% only one. It also shows that 3 out of 8 use them for business purposes. They specified that they only use the Phantom UAS brand. The most common application was photography with a 62.5% and video recording (25%). Since photography is the most common use on the group, it can be concluded that the market needs are higher for this kind of service.

The flight time provided by the battery is 30 minutes or less, depending of the UAS. 62.5% of them give maintenance to their UAS every hour and 25% every 100 hours of flight. This depends on its use. Also, 75% report a maintenance cost lower than $50 and 25% admit to having paid more than $100 in repairs to their equipment. One of the most important things regarding a business using UAS is the access to the replacement parts. 100% of the members agree that there is no specific part that fails more than the others. 87.5% of them think that the replacement parts are easy to find online and that they arrive in a short amount of time.

The last part of the survey was performed to gain insight of how many of the members have the UAS license required by FAA to operate an UAS for business purposes. The results show that 50% of the members are in the process to obtaining it and that the process for them takes less than 20 hours of preparation due to the knowledge that they already have of UAS systems and also because the FAA has already given orientations to the club regarding the latest UAS regulations. Only three out of eight members have the license. This could be caused by the fact that there is only one place in Puerto Rico that offers the test.

The Value Stream Mapping results are shown in Figure 2 and Figure 3 and are discussed on the conclusions section. The benchmark tool used is implicit on the Gemba Walk, the survey, the literature review and the visit performed to Isla Grande Flying School. Basically, the information gathered on the Gemba and the VSM is analog to the output of a formal benchmark study. Another finding form the Benchmark study is that the creation of a decision tree for managers will help make the decision if UAS's are the best option for a given task.

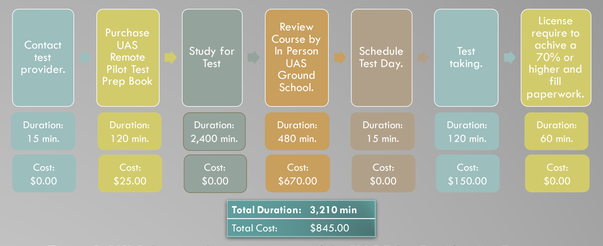

Figure 2: VSM showing the current state of the UAS Pilot Certification Process

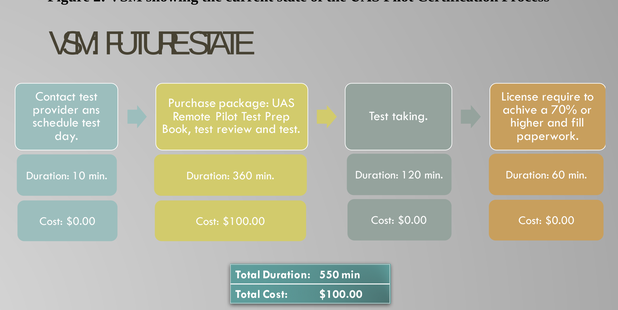

Figure 3: VSM showing the future (optimized) state of the UAS Pilot Certification Process

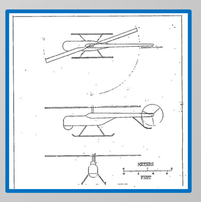

Figure 4: NASA concept for UAS that has Vertical Takeoff and Landing (VTOL) capability

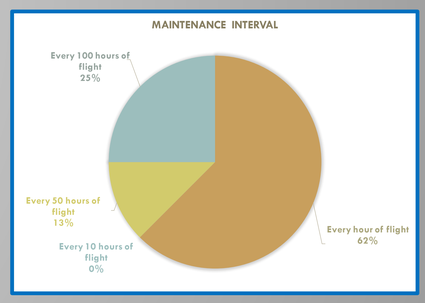

Figure 5: Maintenance Intervals of UAS according to the Survey

Conclusions

For the operation of small scale UAS Fleets (less than 10 UAS), the use of Gemba, VSM and Benchmarking can give insight into the planning of an UAS operation. Two combinations of time/money were found that can allow a person to pass the UAS pilot certification test. The main problems are the steep cost/time combination and the monopoly in Puerto Rico of Isla Grande Flying School as the only test center are barriers to get pilots certified for UAS operations.

From the VSM the FAA in conjunction with test providers should offer test-review packages that cover the test material and the test on the same day with an overall cost of about $100. Even though the test requires the pilots to be proficient in English during the Gemba walk none of the members of the Isabela Phantom Drone club mentioned that as a barrier. The process time of the proposed future state is reduced by 2,660 minutes and the cost is reduced by $745. This type of optimization on a process that is relatively new is only possible with the use of kaizen and VSM tools.

Additional barriers to the use of UAS on for profit operations are the weight limitation of 55 pounds, the operations ceiling of 400 ft, line of sight and daytime operations restrictions. While these restrictions were placed by the FAA to keep airspaces safe but it should be noted that they restrict UAS operations to the point that companies like Amazon have suggested they hinder progress in the UAS field and even may affect the competitiveness of the United States in the UAS field [5}. This would be an example of barriers that affect the creation of medium and large scale UAS operations in United States airspace.

The limitations to this research were mainly of time and therefore of scope, there are many Management tools that were not included in this article and that can and should be applied to small, medium and large scale UAS Fleet operations. Also, Military applications were not taken into account, where supply chain management would be even more critical while the regulatory aspects of those UAS are not as restrictive as on commercial operations. With the use of simple Management tools challenges to operation of small UAS fleets were identified beforehand and Managers can take corrective actions to overcome them and be more competitive on the UAS market.

About the Author

Jimmy C. Pujols Cruz is a Mechanical Engineer that in 2007 completed his Bachelor's Degree on the University of Puerto Rico, Mayaguez Campus. During that year, he started his tenure as a Mechanical Designer and Structural Analyst of Aerospace Systems in Infotech Aerospace Services. Also, from 2008 to 2012 he sought and completed a Master's Degree in Mechanical Engineering from the University of Puerto Rico, Mayaguez Campus. Being the External's Design Quality Leader for more than four years helped shape his Lean/Quality approach to problems that in conjunction with the knowledge gained from his current pursuit of a Master in Engineering Management from the Polytechnic University of Puerto Rico showed him that Management tools can and should be applied on all fields with positive results, even emergent fields such as Unmanned Aerial Systems (UAS).

Figure 6: Sample of UAS's owned by the Isabela Phantom Drone Club

References

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