Targets and Metrics

Targets and metrics are used to establish the certain values the functions and needs of the design must meet. These define the goals the product will be compared to in order to validate the work done. Each function has a metric, what is used to validate the function, as well as a target, the specific value of the metric. Examples of metrics are the length used to measure an object, determining the volume of container, or using a thermometer to measure the temperature. Examples of targets that match these measuring techniques would be establishing the length as 12 inches, calculating the volume to be 3 cubic-meters, or saying the temperature is 100° Fahrenheit. For our project, we developed targets and metrics for each function. These can be seen in Appendix B. These targets and metrics were developed using data on the Believer 1960 mapping UAV, further research on UAVs, and basic physics concepts. The technical data for the Believer 1960 was used to generate most of the targets in the overall targets and metrics table in Appendix B. However, the data listed for the Believer 1960 was very limited. We had to manipulate the data to create certain targets to match their metrics. Since our primary market is the farming and agricultural industry, we used data based on farm sizes in Florida to acquire some targets too.

In order to test and validate our product and to establish whether our targets were met, many tools will be used. The biggest tool will be a computer and software we can acquire. We will use the computer to manipulate designs, change the material the design is constructed of, and validate targets for functions like the support function. This tool allows us to analyze stress points in our designs too. Another tool we will have to use is a stopwatch. This may be used to time the running endurance of components like battery and motors under certain loads. A third tool we may need to validate our design is a multimeter. A multimeter will be used to analyze currents drawn by electric components as well as voltage differences in the electrical system.

Mission Critical Targets and Metrics:

To help further define the project objective, certain targets and metrics were chosen as critical. These critical targets and metrics are essential for the customer needs to be met as well as the project objective. Table 4 below highlights these critical targets and metrics. If these critical targets and metrics are not met, new designs will have to be created and more work will need to be done to ensure they are met and the project objective is accomplished. These are the main targets and metrics the project is designed around.

Table 4: *Critical Targets and Metrics*

Functions	Metrics	Targets
Bolster Weight	Support moment due to wing	1.128 Nm
Generate Lift	Airfoil produces greater lift force than gross weight	54 Newtons
Couple Payload	Mass of Payload supported	600g
Endurance	Overall Flight Time	60 mins

Bolstering the weight is considered a critical target because in order for the UAV to fly correctly, it needs to be able to support all the components inside the UAV. Supporting the wings is critical to the success of the UAV. The wings are big cantilever structures that need to be supported properly. The moment was calculated assuming all of the weight of the wing was at the tip. The critical target to meet for bolstering the weight is 1.128Nm. In order to test this target, experiments using weights hanging from the wing structure will need to be performed. If the structure of the wing can with stand the tests performed, then the target has been met. This will also allow for further design to push the limits of the structure, trying to reduce as much weight as possible, while still meeting the target.

Generating lift is a critical element of any flying vehicle. The target of greater or equal to 54 Newtons for lift was determined by calculating the required lift the UAV must generate in order to achieve flight (Believer 1960mm, n.d.). To takeoff, the lifting force must be greater than the weight of the UAV. To maintain altitude above the ground, the lifting force must be equal to weight of the UAV. To test our target for generating lift, the profile of the UAV and the estimated airspeed of the UAV will be used to calculate the aerodynamic properties. Trying to maximize weight savings while meeting the critical target is key to the success of the project.

By enabling the drone to transport a camera or some other device, it transforms from a cool toy to a highly valuable piece of equipment for many industries. The target of 600g was obtained by researching cameras designed to be used in small drones (UAV Cameras, n.d.). What is difficult to maintain for this target is comparing the mass of the payload to the quality of the payload. The critical mass target may be met but the video quality may not meet its target leading to further design. To test the UAV’s ability to carry the payload, analyses on the affects the payload has on the center of gravity will be performed. If the payload moves the center of gravity too much, causing instability in the UAV, then a different payload will need to be selected. These calculations can be performed by formulating simple moment equations.

The primary driving force behind the objective of light-weighting a UAV is to increase the flight time. This is not a function of our system but is critical to meeting our objective. The metric that will be used to validate the flight time, or endurance, of the UAV will be time. The target that is paired with this metric is to establish a flight time of 60 minutes. Flight time is a quality of a UAV that is influenced by many factors, the speed the UAV is operated at, the battery charge, etc. To obtain this target, we investigated the listed flight times of multiple drones. The typical flight time of a Quadrotor drone is shy of 30 minutes (Wales, 2020). Some advanced fixed wing mapping drones can operate in the air for over an hour, nearly 90 minutes (Why Fly A Fixed-Wing Drone, 2019). So, having the endurance of our UAV being 60 minutes will allow our UAV to outperform quadrotor drones that are extremely popular and be competitive with other fixed wing drones. To validate whether this target is met, tests will be performed to investigate the battery life while electrical components of the UAV are operating. Once a physical prototype is developed, timing the actual flight time of the UAV in the air can also be used to validate this target. If this target is not met, design changes will be made to the UAV to ensure it is met while maintaining the lightweight project objective.

Appendices

Appendix A: Targets and Metrics

Table 5: *Targets and Metrics for UAV Functions*

Functions	Metrics	Targets
Receive commands	Range	1400 meters
Flight Feedback	Range	1400 meters
Send Video	Bandwidth	10 Mbps for HD feed at 25 FPS
Accelerate	Accelerate from cruising speed	2 m/s^2
Decelerate	Decelerate from cruising speed	2 m/s^2
Adjust Roll, Pitch, & Yaw	Control Ailerons, Elevators, & Rudders	90° range of motion
Power Flight Controls	Voltage supplied by battery	12.0 V
Power Payload	Voltage supplied by battery	12.0 V
Record Visual Data	Video Quality	2.1 Megapixels
Orient Payload	Fixed Position Perpendicular to ground within:	2°
Bolster Weight	Support moment due to wing	1.128 Nm

Generate Lift	Airfoil produces greater lift force than gross weight	54 Newtons
Store Hardware	Volume	$0.001964m^3$
Couple payload	Mass of payload supported	600g
Endurance	Overall Flight Time	60 mins
Transported Easily	Disassembled Dimensions: (L x W x H)	1100mm x 2000mm x 200mm
Battery	Capacity	22,000 mAh
Start of mission	Take off force	9 Newtons
Cruising Speed	Constant Velocity	$20\ m/s^2$