G3 Drones For Good

Operational Manual 2018

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1. Introduction

Welcome to the 2018 G3 Drones for Good Operational Manual. It contains the basic information about the competition which consists of the various rules and requirements for entering the competition. The Project Challenge is made up of a presentation of the drone while the UAV Design Challenge encompesses the design process.

2. Participation Requirements

2.1. AMA youth membership with AMA ID number

2.2. FAA drone pilot registration (if student is over 13 or for parents of students who are under 13)

2.3. Liability and photo release form

2.4. Team assurance that all members have read and understand FAA rules and AMA guidelines

2.5. Media Release Form

3. Safety

3.1. Flight safety during competition

3.1.1. Pilots may not fly in an intentionally dangerous manner.

3.1.2. Aircraft may not be armed when being held by any individual.

3.1.3. Aircraft may not be powered during any part of the judging.

3.1.4. When configuring an aircraft using the OpenPilot or any other software, it is imperative that no propellers are attached to said aircraft's motors.

3.1.5. Team members may not fly their aircraft over or near other individuals.

3.1.6. Pilots may only fly their aircraft within the hot zone of the competition field or the practice tent.

3.1.7. Teams may only arm and fly their aircraft when instructed to do so by a field referee or the practice tent manager

3.1.8. Pilots will be asked to crash land or ground their aircraft if it's flight course poses a threat to any individuals or goes beyond the boundaries of the playing field.

3.1.9. Pilots may only connect a battery to the drone when the drone is on the hot table and told to do so by the chief referee or practice tent manager.

3.1.10. The transmitter must be placed on the table and remain untouched when a team member is connecting a battery to the aircraft and placing it on the field.

3.1.11. Pilots and spotters will wear eye protection and safety vests when in the flying area.

3.1.12. Drone teams will adhere to all safety rules and to directions of game officials.

3.2. The Hot and Cold Tables

3.2.1. Each competition field will have a hot table and a cold table. These tables are used for the safety of teams and spectators, allowing them to discern whether or not an aircraft is connected to a power source.

3.2.2. The Cold Table

3.2.2.1. The cold table is the table on which teams and field officials may place any equipment needed for competition and scoring. This is also the table where teams may handle their drones WITHOUT a battery connected.

3.2.3. The Hot Table

3.2.3.1. The hot table is the table specifically for a competing team's aircraft, transmitter, or any other items needed only during the flight competition itself. This is the only table on which a team may connect their battery, unless specified for some other reason by a DFG competition official.

3.3. FAA Regulations and AMA Guidelines:

3.3.1. The FAA Advisory Circular 91-57A is extremely pertinent to the outdoor operation of team designed UAVs. Please take the time for your DFG team to read this document and abide by its rules during outdoor operation.
http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-57A.pdf

3.3.2. Remember that when you fly outside, you are flying in public airspace. This means that no matter the situation, you must ALWAYS GIVE WAY TO THE LARGER MANNED AIRCRAFT. This rule is imperative to the safety of those in the air and the continuation of the UAV hobby in general.

3.3.3. When flying outside within 5 miles of an airport, call prior to flight to ask permission.

3.3.4. Abide by the Academy of Model Aeronautics National Model Aircraft Safety Code: https://www.modelaircraft.org/files/105.pdf

3.3.5. Abide by the Academy of Model Aeronautics sUAS Flight Safety Guide: http://suas.modelaircraft.org/ama/images/sUAS_Safety_Program_web.pdf

3.4. Battery Safety

3.4.1. Team members should always be present during the charging of a lithium polymer (LiPo) battery.

3.4.2. Follow good LiPo treatment practices:

3.4.2.1. Do not discharge batteries below 30%.

3.4.2.2. Do not charge batteries above 90%.

3.4.3. Lithium Polymer battery fires are chemical fires that do not require oxygen to burn, so if a battery ignites:

3.4.3.1. DO NOT POUR WATER ON THE BATTERY. This will only make the fire worse.

3.4.3.2. DO NOT PLACE THE BATTERY IN A SEALED CONTAINER TO SMOTHER THE FIRE. This will create a bomb.

3.4.3.3. DO NOT USE A STANDARD HOUSEHOLD FIRE EXTINGUISHER. This will be ineffective.

3.4.4. If a battery ignites:

3.4.4.1. PLACE THE BATTERY IN A METAL BUCKET OF SAND, THEN COVER THE BATTERY WITH AN ADDITIONAL LAYER OF SAND.

3.4.4.2. PLACE A PLASTIC BAG FULL OF SAND OVER THE BATTERY.

4. DFG Quadcopter Construction Rules

4.1. Materials

4.1.1. Quadcopters will be constructed from materials in the G3 Drones for Good Kit of Parts, from the materials in kits from previous years, and additional materials listed below.

4.1.2. There may be no more and no less than four motors used on the quadcopter. Electronics are limited to navigation LED's and those provided in the G3 Drones for Good kit.

4.1.3. Additional K'nex parts may be used.

4.1.4. In addition to the DFG Kit of Parts, only the materials listed below may be used in the construction of the quadcopter. The list of materials you may use are as follows:

- Electrical tape
- Glue
- Cable ties such as Zip Ties or similar
- Heat shrink tubing
- Hook and loop fasteners such as Velcro or similar
- String and Wire
- Screws, washers and nuts
- Tongue depressors or craft sticks
- Ping pong ball
- Craft foam board
- Balsa wood
- Model craft plywood less than ¼ inch
- Sheet PVC
- Bamboo
- Cardboard
- Fiberglass rods and plates
- LED, wire and connectors
- Laminate wood products
- Cork
- PVC (polyvinyl chloride)
- Extruded Nylon (polyamide)
- Extruded ABS (acrylonitrile butadiene styrene)

4.2. Design and Fabrication

4.2.1. Teams are encouraged to develop their own creative quadcopter designs using the materials listed above.

4.2.2. The design and fabrication of quadcopter parts must be completed exclusively by student team members or through collaboration between student team members and mentors.

5. DFG Quadcopter Operation

5.1. The team number must be clearly displayed on each drone so it can be read from the side. The number may be placed on the frame using tape or glue.

5.2. There may be no sharp edges or points that could endanger people or field elements.

5.3. Drone batteries cannot be used at the start of a match if the charge is below 50% (11.3V).

5.4. No bare electrical wiring is allowed. All breaks in the insulation of the drone must be covered in heat shrink or electrical tape.

5.5. The entire team must be knowledgeable and abide by FAA rules.

5.6. Pilots flying during the DFG competition must have an AMA youth license. This license is completely free for children under the age of 18 and provides $2,500,000 of comprehensive general liability protection for model activities for members, clubs, and sponsors. See section 8.2

6. Problem-Solving Challenge

6.1. Each team will identify a problem in their schools, community, city, state, or anywhere in the word and develop a conceptual solution that positively utilizes drone technology.

6.2. Teams will present their project to a panel of qualified judges for evaluation and feedback. Each presentation will last a maximum of 10 minutes, including Q&A.

6.3. Teams may produce prototypes and or visual aides such as display boards, but these are not required.

6.4. Teams may present a video or powerpoint presentation, but they must provide their own computer. This will be set up at the expense of the teams judging time.

6.5. Teams will be evaluated using a rubric. Teams will be judged on the quality of the team's research, the level of innovation demonstrated, and the quality of the presentation itself. Specifically, the following aspects will be considered by the judges:

6.5.1. Research

6.5.1.1. Gives a clear, detailed definition of the problem being studied.

6.5.1.2. Cites a variety of sources such as print media, online sources, and professionals in the field.

6.5.1.3. Studies and analyzes the problem in depth.

6.5.1.4. Reviews and analyzes existing solutions and makes an effort to determine the originality of the team's solution.

6.5.2. Innovative Solution

6.5.2.1. Clearly explains the team's proposed solution

6.5.2.2. Explains how the team's original solution represents adding to society by improving on existing options, developing a new application of existing technology, or solving the problem in a new way.

6.5.2.3. Considers the challenges of implementation (cost, safety, time, etc.) and proposes possible solutions.

6.5.3. Presentation

6.5.3.1. Shares the team's project prior to the tournament with those who might benefit from the team's solution.

6.5.3.2. Delivers their presentation in an imaginative, creative way.

6.5.3.3. Presents the project effectively with a clear message and good organization.

6.5.4. Demonstration of teamwork and distributed decision making among students and adult mentors/coaches as well as an appropriate balance between student responsibility and adult guidance.

6.6. Only student team members may present to the judges. Mentors or parents are not permitted inside of the judging room.

7. UAV Design Challenge

7.1. Teams will present their DFG quadcopter to a panel of qualified judges for evaluation and feedback. Each presentation will last a maximum of 10 minutes including Q&A.

7.2. Teams will be evaluated using a rubric. Teams will be judged on the following criteria:

7.2.1. Discuss the engineering design process that led to their current design and how the members of the team worked with their mentors to achieve the desired result. Specifically:

7.2.1.1. Drone knowledge: Demonstrate a knowledge of the components in the drone, how they work.

7.2.1.2. Discuss the relationship between thrust, total liftoff weight, and battery voltage.

7.2.1.3. Discuss the relationship between battery size, flight time, and liftoff weight.

7.2.1.4. Design Process: Able to explain the improvement cycles where alternatives were considered and narrowed, selections tested, and designs improved.

7.2.1.5. Strategy: Able to clearly define and describe the team's game strategy and how it determined their design.

7.2.1.6. Innovation: Creation of new, unique or unexpected UAV features that are beneficial to performing game tasks.

7.2.1.7. Durability: Evidence of structural integrity and ability to withstand the rigors of competition (including crashes).

7.2.1.8. Mechanical Efficiency: Economic use of parts and time, easy to repair and modify.

7.2.1.9. Flight characteristics: Ability of the UAV to fly at an appropriate speed, maneuver accurately, and good balance of power and weight.

7.2.2. Demonstrate knowledge and understanding of the physical principles upon which multirotor UAVs operated.

7.2.3. Demonstrate knowledge and understanding of good drone safety practices and FAA rules that must be followed when operating UAVs. Teams should use Section 2 of this manual as a starting point for their knowledge base for safety and FAA rules, but teams are encouraged to do further research on their own.

7.2.4. Demonstration of teamwork and distributed decision making among students and adult mentors/coaches as well as an appropriate balance between student responsibility and adult guidance.

7.3. Only student team members may present to the judges.

7.4. At no point during the judging may the drone be powered.

8. Awards

8.1. Two awards will be presented in each of the three drone groups: the UAV Design Award and the Problem-Solving & Research Award. In addition there will be one Champion Award candidate from each group.

8.1.1. **UAV Design Award**: The team that best demonstrates the fulfillment of the UAV Design criteria described in Section 8.

8.1.2. **Problem-Solving & Research Award**: The team that best demonstrates the fulfillment of the Problem-solving Project criteria described in Section 5 as determined by the judges.

8.2. **Flight Award**: The team with the highest score in the flight challenge (a.k.a. "The Game.") among all teams in all Drone Groups.

8.3. **Champion's Award**: The three best overall teams when considering Flight, UAV Design, and Problem-Solving/Research will be awarded the Champion's Award.

8.3.1. Champions Award Determination: Each of the DFG challenges will be equally weighted (Flight, UAV Design, and Problem-Solving/Research) except in the case of a tie. The top twelve teams will ranked in each challenge.

8.3.1.1. In the Flight challenge, teams will be ranked by total score.

8.3.1.2. In the UAV Design and Problem-Solving/Research challenges, judges will rank the top 12 teams based upon their interviews.

8.3.1.3. Only teams that are ranked in the top twelve for all three challenges will be eligible for the Champion's Award.

8.3.1.4. Each Champion's-eligible team will have three scores that correspond to their rank in each challenge. The sum of these three scores will be used to

determine Champion's Award Score. For example, if Team A ranks 1st in Flight, 3rd in UAV Design, and 5th in Problem-solving, their Champion's Award Score would be 1+3+5 = 9.

8.3.1.5. The team with the *lowest* Champion's Award Score will be awarded the Champion's Award. For example, if Team A's Champion's Award Score is 1+3+5 = 9, but Team B's score is 2+2+2 = 6, then Team B would win.

8.3.1.6. Ties in Champion's Award Scores will determined by UAV Design Rankings. For example, if Team B's score is 2+2+2 = 6 and Team C's score is 4+1+1 = 6, then Team C wins since their UAV Design rank of 1 is higher than Team B's UAV Design rank of 2.

9. Definitions

9.1. DFG Team: A Drones for Good (DFG) team consists of between 5 and 10 students in grades 5 - 8 and one or two adult coaches or mentors.

9.2. FAA: The Federal Aviation Administration. A government organization responsible for the advancement, safety and regulation of civil aviation, as well as overseeing the development of air traffic control systems.

9.3. AMA: The Academy of Model Aeronautics. A non-profit organization dedicated to the promotion of model aviation as a recognized sport as well as a recreational activity.

9.4. UAV: Unmanned Aerial Vehicle.

9.5. Multirotor: A UAV that uses multiple motors and propellers as its primary method of flight and thrust generation.

9.6. Quadcopter: A multirotor utilizing four motors as its primary method of flight and thrust generation. Also known as a drone.

9.7. Drone: Multirotor aerial vehicle

9.8. LiPo: Lithium Polymer battery. These batteries are used to provide power to DFG multirotors.

9.9. Flight Team: A two man team composed of a team selected pilot and spotter.

9.10. Pilot: The operator of the DFG Team's multirotor in a DFG competition event.

9.11. Spotter: The pilot's assistant. The spotter may provide advice to the pilot and help them make judgement and strategy decisions during flight along with ensuring the pilot follows proper safety precautions.

9.12. UAS: Unmanned Aerial System: also known as a drone.

9.13. Drone Group: Each team competes in a Drone Group. The drone groups are:

9.13.1. Wright Brothers

9.13.2. Yeager

9.13.3. Earhart

10. Other Resources

10.1. FAA Advisory Circular 91-57A: http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-57A.pdf

10.2. AMA Youth Membership:

http://www.modelaircraft.org/membership/youth.aspx

10.3. Drones for Good Official Website

10.4. http://www.g3robotics.com/dfg/