SEARCH AND RESCUE
CHALLENGE

UAS4STEM

TEAM RULE BOOK

AMA
ACADEMY OF MODEL AERONAUTICS

Academy of Model Aeronautics
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If you have questions about the UAS4STEM program, please contact Jessica Symmes at jessys@modelaircraft.org, or by calling 1-888-829-4060.

TEAM RULE BOOK

1.   CONCEPT OF OPERATIONS (CONOPS)

A small group of hikers have gone missing in a remote area. While rescuers have determined a search area, they are unsure of the exact whereabouts and conditions of the hikers. Your team has been called upon to provide rapid response, via an Unmanned Aircraft System (UAS), that can support the Search and Rescue (SAR) mission. In order to support this mission, your UAS must comply with Special Instructions (SPINS) for departure and arrival procedures, and then remain within assigned airspace. It will be tasked to search an area for items of interest and to conduct point reconnaissance. A UAS that can also accurately deliver supplies and information where directed will be in high demand.

2.   INTRODUCTION

2.1.   THRUST

2.1.1.   The principal thrust of the Search and Rescue Challenge is the safe application and execution of Systems Engineering principles to develop and operate a Quadzilla UAS to successfully accomplish the mission tasks.

2.2.   SCORED ELEMENTS

2.2.1.   The Scored elements of this competition are:

2.2.1.1.   Flight Plan Report

2.2.1.2.   Oral Briefing of a Flight Readiness Review (FRR)

2.2.1.3.   Flight Mission Demonstration

2.3.   OPPORTUNITIES

2.3.1.   Student teams will be judged based on their performance and that of their system. Trophies will be awarded for top performances. Opportunities for interaction with UAS engineers, scientists and leadership will be provided.

2.4.   RULES

2.4.1.   The Search and Rescue competition will be based upon the competition rules outlined within this document containing administrative and performance objectives. These rules are aimed at a high school level curriculum. These rules may be updated with clarifications or updates and posted as the official rules for competition.The UAS4STEM committee reserves the right to make changes to these rules and issue updates or addendums at any time.

3. SCHEDULE

3.1   DATES AND LOCATIONS (subject to change)

8/15/15 Registration Begins

9/1/15 Competition Rules and Guidelines delivered to prospective teams

9/1/15 Online curriculum logins go live

12/31/15 Registration Due 11:59 pm EST

11/1/15 UAS4STEM Kits Begin Shipping to Teams

Spring 2016 Regional Competitions. Final location and dates TBD by 11/1/15

August 2016 National Competition. Held at AMA National Flying Site, Muncie, IN

4. MAJOR ELEMENTS OF THE COMPETITION

4.1   REGISTRATION PROCESS

4.1.1   Once the teachers/sponsors send their email address via the registration form, logins for teachers/students for online curriculum will be created.

4.1.2   It is required that all student members of the team successfully complete an online Fly Robotics course on UAVs and become student members of Academy of Model Aeronautics (AMA). http://www.fly-robotics.com/education/course/index.php?categoryid=9

4.1.3   By participating in the Search and Rescue competition, the team, advisors and all support members, as well as judges and volunteers, agree to have any pictures of persons, vehicles or equipment photographed and released to the public on web pages, in papers and published trade magazines and journals, or posters.

4.2   FACT SHEET and PROGRESS CHECK

4.2.1   The Fact Sheet and Progress Check shall inform the UAS4STEM committee of necessary data for logistics and safety during the competition. The Fact Sheet submitted must follow the format provided in Appendix B: FACT SHEET and PROGRESS CHECK

4.2.2   The Fact Sheet shall be typed and shall be electronically submitted in PDF file format.

4.2.3   The Fact Sheet's filename shall include the school and team name, abbreviated as needed, and have the prefix "FS". (For example: FS_SchoolName_TeamName.pdf)

4.3 PROOF-OF-FLIGHT

4.3.1   Prior to the competition, a proof-of-flight video shall be submitted as proof that the team's aircraft can attain, sustain, and land in a safe manner.

4.3.2   The proof-of-flight video does not need to have the craft in full autonomous configuration. It is acceptable to demonstrate a Radio Controlled (RC) flight.

4.3.3   The proof-of-flight video shall identify the school and the team name. The video shall show the vehicle demonstrating safe Takeoff, Flight, and Landing.

4.3.4   A text file containing a link to the team's video posted on the internet (www.youtube.com is preferred).

4.4 SAFETY INSPECTIONS

4.4.1   Safety inspections shall include a physical inspection, fail-safe check, and flight termination check.

4.4.2   Safety inspections shall be performed on all aircraft by designated competition safety inspectors prior to being allowed to make any competition flight.

4.4.3   The safety inspections are not a scored element. All decisions of the safety inspector(s) shall be final.

4.4.4   Physical inspection of the aircraft shall include:

   4.4.4.1   Verify all components adequately secured to vehicle.

   4.4.4.2   Verify rotor structural attachment integrity.

   4.4.4.3   Visual inspection of all electronic wiring.

   4.4.4.4   Radio Range checks, motor off and motor on.

   4.4.4.5   Verify all controls move in the proper sense.

   4.4.4.6   Check general integrity of any payload system

   4.4.4.7   Verification of fail-safe mode operation covered by manual override and pilot-commanded flight termination.

4.5   FLIGHT READINESS REVIEW (FRR) BRIEFING

4.5.1   The FRR shall be an oral briefing presented to a team of judges during which the teams substantiate, with data, their plans to safely accomplish the mission.

4.5.2   The intention is to demonstrate to the judges that the team is ready to compete safely, with low risk, in the flight mission phase of the competition. The FRR shall address the mission tasks the team plans to achieve during flight.

4.5.3   Following the FRR briefing, there will be a question and answer period, followed by an inspection of the team's UAS, including aircraft, ground station, test data, safety checklists, and other supporting evidence.

4.5.4   All team members present are encouraged to participate.

4.5.5   The FRR Briefing will be held at the flying location and will be oral only. Teams may use their aircraft or ground control station to demonstrate various aspects of the briefing. TEAMS MAY NOT POWER UP THE AIRCRAFT.

4.5.6   The FRR Briefing is a scored element worth TEN Points. The FRR briefing will be assessed on the team's ability to effectively articulate the scope and depth of the developmental testing performed, the ability of the system design to perform the planned flight tasks, and the preparations made to improve the chances of a successful Flight Mission.

4.5.6.1   The FRR briefing shall not exceed 15 minutes in duration, followed by a maximum period of 5 minutes where the judges will ask questions and the team shall answer. A judge will time the presentation, provide a 2 minute warning, and cut off extended presentations as needed.

4.5.6.2   The breadth of the presentation will be scored based upon inclusion of the following elements with relative worth in percent:

4.5.6.2.1   Team member introductions including flight mission roles and experience. (10 %)

4.5.6.2.2   A brief system overview relating to flight tasks planned, expected performance, and any risk evaluation. (10%)

4.5.6.2.3   System Safety with identified design and operational strategies. (10%)

4.5.6.2.4   Developmental Test Results including: test plan schedule (through ground testing to flight testing to mission performance testing), results of testing, and any corrective action taken to improve the effectiveness on mission. (30%) completion.

4.5.6.2.5   Evidence of Mission Accomplishments. (10%)

4.5.6.2.6   Pre-Mission Briefing, including personnel resourcing for the flight, communication procedures, Go/No-Go criteria and fallback plans should a technical issue arise during flight mission. (20%)

4.5.6.2.7   Team member participation and communication skills (clarity, accuracy, logic, precision, relevance, depth, and suitability). (10%)

4.6   FLIGHT MISSION REQUIREMENTS

4.6.1   The flight Mission evaluates the teams' ability to conduct a mission operation with their vehicle. This is the culminating event and a scored element of the competition.

4.6.2   A lead judge will be assigned to each team at the flight line. It is important that all team members follow the instructions of the judges. There will be additional judges assigned who are focused on different aspects of the competition (imagery, autonomy, safety, teamwork, etc.) depending on which tasks the team is planning to accomplish.

4.6.3   Only systems presented in the FRR, inspected by safety inspectors, and included in the preflight brief will be permitted to fly.

4.6.4   OPERATIONAL TIMELINE

4.6.4.1   Setup Time = 15 minutes maximum. Setup time begins when the team arrives at the flight line. A lead judge will be assigned to each time and will start a dedicated stopwatch after communicating with the team Captain. After the maximum time, the judge may declare mission start, regardless of the team's readiness to launch the mission.

4.6.4.2   Flying Time = 30 minutes maximum.

4.6.4.2.1   Flying Time shall start at the declaration by the Lead Judge who will have a dedicated Mission Clock Stopwatch.

4.6.4.2.2   A team may elect to cycle through the takeoff and landing sequence during the flying time more than once for a variety of valid reasons (change batteries, load payload, etc). No points will be lost, but flying time continues to be used.

4.6.4.2.3   Flying time stops when the vehicle has completed flight (landed, crashed, or terminated) and the team has turned off transmitters. The lead judge will confirm with the team captain that the flying time period has stopped and the post processing time period starts.

4.6.4.2.4   Teams that are still flying after 30 minutes will be assessed a penalty of one point for each part of a minute over the 30 minute time limit.

4.6.4.2.5   Teams that are still flying after 40 minutes will be disqualified.

4.6.4.3   Post Processing Time = 20 minutes maximum.

4.6.4.3.1   Post Processing Time begins immediately after the flying time stops. This time is for data processing. No RF transmission shall be performed during Post Processing Time.

4.6.4.3.2   The system shall be disassembled and transported off of the flight line immediately at the beginning of the post processind time.

4.6.4.3.3   Post Processing time stops when the team captain hands in the scoring sheets, or when the maximum post processing time is exceeded.

4.6.4.3.4   Teams that complete Post Processing and turn in a scoring sheet with at least one correct ID in less than 10 minutes will be awarded a two point bonus.

4.6.4.3.5   Teams that complete Post Processing in less than 20 minutes but more than 10 minutes with at least one correct ID will be awarded a one point bonus.

4.6.5   MISSION LIMITATIONS

4.6.5.1   Mission Boundaries

4.6.5.1.1   During the entire mission, aircraft shall remain in controlled flight and within the no-fly-zone boundary. A specific no-fly-zone boundary definition will be provided to teams following their FRR. Any vehicle appearing uncontrolled or moving beyond the no-fly-zone boundary during autonomous flight will be subject to immediate manual override. Failure of manual override will result in flight termination.

Map of Competition Area (example)

MAP KEY	
Red outline:	No-fly-zone boundary
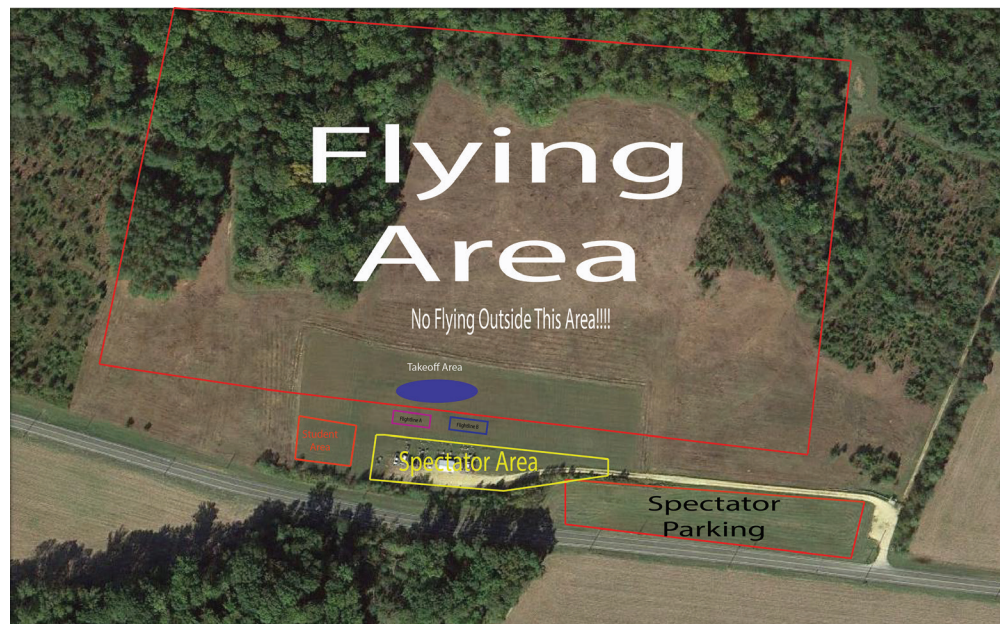
4.6.5.1.2   Teams must be aware of the no-fly-zone prior to flight. This can be as simple as moving a mouse over the defined points to ensure they are aware of the boundry.

4.6.5.1.3

After takeoff and before landing, aircraft shall sustain flight at an altitude below 350 feet AGL (above ground level) for the duration of the mission. Flight above 350 feet during autonomous flight shall require manual override. Failure of manual override will result in flight termination.

4.6.5.2   Takeoff

4.6.5.2.1   Takeoff shall take place within the designated takeoff/landing area shown on the competition map.

4.6.5.2.2   Manual takeoff and then transitioning to autonomous flight will be permitted but does not count as an autonomous take off.

4.6.5.2.3

The first takeoff will be scored, regardless if it is manual or autonomous. Only autonomous takeoff attempts on the first takeoff will earn points. Landing shall take place within the designated takeoff/landing area shown on the competition map. Any of a team's landings will be scored if autonomous. Only a successful autonomous landing will earn points.

4.6.5.3   Landing

4.6.5.3.1

4.6.5.3.2   Landing under manual control is permitted.

5.   SYSTEM REQUIREMENTS

5.1   Registered teams will be provided with materials needed to create a Quadzilla UAS. Teams may only use parts provided. If parts are damaged or destroyed they may only be replaced with parts with the same specifications. TEAMS WILL NEED TO PROVIDE THEIR OWN LAPTOP. Only a single laptop will be allowed on the flight line with a team.

5.2   **Step-by-step PDF documentation and a video guide to build the Quadzilla UAS can be found at http://www.quadzillacopter.com/build/**

In the pits and the airfield, the UAS4STEM Competition will ensure that teams are provided shade, a folding table, chairs and a single electrical power extension cord.

## 6.	DESCRIPTION OF MISSION TASKS

The Flight Mission has been divided into a series of tasks. Teams do not need to complete every task. The available tasks are listed in this section with the associated scoring associated with each task.

### 6.1	Autonomous Flight Tasks

PARAMETER	OBJECTIVE	POINTS
GCS Display Items	Accurately display "no-fly-zone boundaries" and shall accurately display current aircraft position with respect to the "no-fly-zone" boundary, display airspeed and altitude to operators and judges This is a minimum requirement for flight approval.	N/A
Takeoff	Achieve controlled autonomous takeoff. Scored on first takeoff attempt. Pilot or ground station operator may activate button or switch to initiate the takeoff. Takeoff is complete when aircraft reaches an altitude > or = 100 ft and hovers for a minimum of 5 seconds.	Four points
Waypoint navigation	Capture waypoints in sequence. Waypoints will be chosen no less than 50 ft from the "no-fly-zone" boundaries and will be provided to teams following completion of their FRR. Waypoints will be provided to the teams the morning of the competition. Waypoints will include changes in altitude. Capture waypoints in sequence while in autopilot control with + 50 ft accuracy, and maintain navigation + 50 ft. along the planned flight path. Aircraft must hover at each waypoint for a minimum of 3 seconds.	One Point for each of five waypoints achieved
Landing	Achieve controlled autonomous landing. Scored on any landing attempt. Pilot or ground station operator may activate button or switch to initiate the landing.	Four Points

### 6.2	Search

PARAMETER	OBJECTIVE	POINTS
Localization	Determine item location within 50 ft.	One point each
Classification	Identify item characteristics.	One point each
Mystery Target	Identify a mystery target proved by judges prior to flight.	Two points
Complete Solution	Locate, Classify, and provide clear descriptions of all five items of interest.	Five points

6.2.1	The search area is defined as the area 50ft within the "no-fly-zone" boundaries. Note that it is not required that your aircraft fly autonomously during search activities, but it may be more efficient if it does.

6.2.2	The vehicle shall search for items of interest related to the CONOPS. Five items of interest will be located within the search area. The exact nature of these items will not be provided to teams. However, the minimum dimensions of the items will be 3 feet by 3 feet.

6.2.3	Teams shall record the item characteristics and GPS locations on the item report sheet located in Appendix C. Classification points are earned if you identify the item of interest, for example, - "body" or "red shirt", or "person".

. 6.2.4 Descriptions of items of interest will be submitted with the item report sheet on a flash drive provided by the competition. An Excel file will be included for teams to list target locations. If Excel is not available on the team laptop, a freeware version is available at OpenOffice.org

7. SAFETY REGULATIONS

7.1 Flight Operations

7.1.1 Flight operations of any type involve some level of risk to personnel and property. It is the responsibility of all personnel involved in and around flight operations to identify, evaluate, and mitigate risks to the maximum extent possible.

7.1.2 When teams are conducting flight tests, extra precautions must be in place to protect team members and others.

7.1.3 It is required that teams use an experienced RC Pilot to act as Safety Pilot for any test flights. T

7.2 The System

7.2.1 The system shall provide sufficient information to operators on a continuous basis to ensure that it is operating within no-fly/altitude boundaries.

7.2.2 The aircraft shall be capable of manual override by the safety pilot during any phase of autonomous flight.

7.2.3 The flight termination system, activated by a single switch, shall be capable of overriding all flight modes and executing the Return-To-Land command.

7.2.4 The aircraft shall automatically Return-to-Land (takeoff location) after loss of primary communications link signal within 5 seconds.

7.2.5 The fail-safe check will demonstrate flight termination on the ground by switching off the transmit radio for 20 seconds and observing activation of flight termination.

7.3 Other

7.3.1 No more than eight (8) team members will be allowed in the mission area.

7.3.2 Open toed shoes/flip flops should not be worn during safety inspections, flight line operations, or when rotors are powered.

7.3.3 Judges may deduct points as penalty for procedural safety errors (even accidental).

7.3.4 Officials have the right to disqualify an entry or a team that they deem to be a hazard.

APPENDIX B: FACT SHEET AND PROGRESS CHECK

No Hand-Written Entries Accepted

1.   School/Team Name: _____

2.   Team Captain (Name and email address):_____

       _____

3.   Team Advisor (Name and email address):_____

       _____

4.   Team Mentor (Name and email address): _____

       _____

5.   Progress (check all that apply)

       ☐ All team members have registered as student member of AMA

       ☐ All team members have completed on line Safety Course

       ☐ School has completed registration to be an AMA MASC club

       ☐ Quadzilla Build

              ☐ Motor Assembly complete

              ☐ Power System wiring complete

              ☐ Body Plate Assembly complete

              ☐ APM 2.8 Assembly complete

              ☐ Leg Assembly complete

              ☐ Calibration complete

              ☐ Propeller Assembly complete

       ☐ Ground Control Station (http://copter.ardupilot.com/wiki/table-of-contents/)

              ☐ Mission Planner Installed

              ☐ Firmware loaded on APM 2.8

              ☐ Hardware configuration complete

              ☐ Caibration complete

              ☐ Motor Set Up

       ☐ First Flight

       ☐ Waypoint Navigation

       ☐ Autonomous Take-Off

       ☐ Autonomous Landing

APPENDIX C: ITEM REPORT SHEET

Use this sheet for submitting search results.

School Name: _____

Team Name: _____

ITEM NUMBER	ITEM DESCRIPTION	LATITUDE*	LONGITUDE**
1			
2			
3			
4			
5			

*Latitude in the following format: Degrees to the 6th decimal place with positive indicating North Latitude and negative indicating South Latitude

      Example: 38.365458

**Longitude in the following format: Degree to the 6th decimal place with positive indicating East Longitude and negative indicating West Longitude

      Example: -76.539108

APPENDIX D: MENTOR GUIDELINES AND EXPECTATIONS

- Complete necessary site specific requirements to be an approved volunteer
- Agree to exchange contact info with sponsor teachers at your designated site
- Aid students in completing AMA registration
- Aid schools in registering with AMA as a MASC club
- Agree to meet with teams at a minimum of two times a month
- Photo documentation

UAS4STEM SPONSORSHIP INFORMATION

Please make your check payable to Academy of Model Aeronautics and return with this form.

Business Name:

Contact Name:

Address:

City	State:	Zip:

Phone	Email:

SUPER STEM SPONSOR
$10,000

1. Logo listed on all promotional advertising for UAS4Stem- including ad in Model Aviation magazine
2. Name and logo listed on all national contest materials
   a. Programs
   b. Shirts
   c. Team tent cards
   d. Awards Podium
3. Logo listed on UAS4Stem website
4. Recognition in all AMA newsletters
5. Social Media postings on Facebook & Twitter by the Academy of Model Aeronautics
6. Insert/ Advertisement (provided by company) in grab bags provided to each national contestant
7. Banner recognition at national contest
8. Ability to have a booth at the national contest
9. Logo listed on regional and national contest certificates
10. Full page advertisement included in the national contest program
11. Name & logo listed in the UAS4Stem rules manual

STEM SPONSOR
$7,500

1. Logo listed on all promotional advertising for UAS4Stem- including ad in Model Aviation magazine
2. Name and logo listed on all national contest materials
   a. Programs
   b. Shirts
   c. Team tent cards
3. Logo listed on UAS4Stem website
4. Recognition in all AMA newsletters
5. Social Media postings on Facebook & Twitter by the Academy of Model Aeronautics
6. Insert/ Advertisement (provided by company) in grab bags provided to each national contestant
7. Banner recognition at national contest
8. Logo listed on regional and national contest certificates
9. Quarter page advertisement included in the national contest program
10. Name & logo listed in the UAS4Stem rules manual

QUADZILLA SPONSOR
$5,000

1. Logo listed on all promotional advertising for UAS4Stem- including ad in Model Aviation magazine
2. Name and logo listed on all national contest materials
   a. Programs
   b. Shirts
3. Logo listed on UAS4Stem website
4. Recognition in all AMA newsletters
5. Social Media postings on Facebook & Twitter by the Academy of Model Aeronautics
6. Banner recognition at national contest
7. Logo listed on regional and national contest certificates
8. Name & logo listed in the UAS4Stem rules manual

UAS4STEM SUPPORT SPONSOR
$2,000

1. Name listed on all promotional advertising for UAS4Stem- including ad in Model Aviation magazine
2. Logo listed on UAS4Stem website
3. Recognition in all AMA newsletters
4. Social Media postings on Facebook & Twitter by the Academy of Model Aeronautics

UAS4STEM SUPPORT TEAM SPONSOR
$1,995

AMA
ACADEMY OF MODEL AERONAUTICS
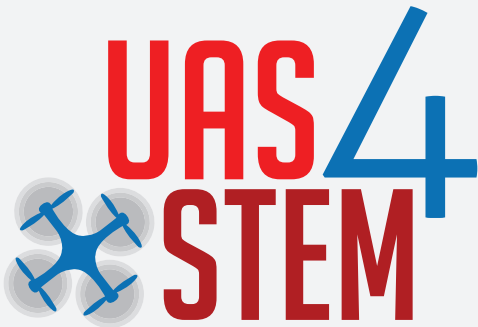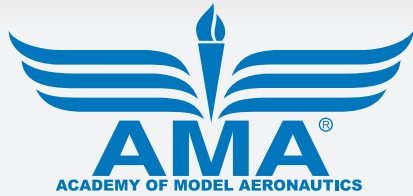
UAS4 STEM

Introducing a new STEM program from the Academy of Model Aeronautics!

UAS4STEM is designed to encourage students to explore the sUAS (drone) phenomenon, teamwork, competition, and success through STEM.

SEARCH AND RESCUE
CHALLENGE

THE MISSION:
A small group of hikers has gone missing in a remote area. Your team has been called upon to provide rapid response using a small Unmanned Aircraft System (sUAS) that can support the search-and-rescue mission.

ELIGIBILITY:
Teams consist of between four and eight members. All team members must be between 11 and 19 years old. All competitors are required to complete the sUAS ground school curriculum before kit shipment.

COST PER TEAM:
$1,995

Price Includes:
• Eight sUAS Ground School licenses
• Quadzilla quadcopter
• AMA membership
• Regional and national competition entrance
• No additional regional or national event entry fees

For additional details and information, visit:

WWW.UAS4STEM.ORG

AMA FLIGHT SCHOOL

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