2nd Annual MAV Student Challenge

AHS International

70th Annual Forum and Technology Display

May 19-22, 2014, Montréal, Quebec, Canada

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Overview

The American Helicopter Society (AHS) International invites student teams to participate in the 2nd Annual Micro Air Vehicle (MAV) Student Challenge. This electric-powered vertical take-off and landing (VTOL) MAV competition is designed to award prizes for both "form" and "function" of the MAV. With respect to "form", teams with unique, innovative and robust VTOL MAV air-vehicle design would be awarded points. With respect to "function", teams that demonstrate the best flight and autonomy capabilities would be awarded. Overall, teams showing superior system integration of vehicle flight systems, sensors and remote-operation-station would be considered for final awards. Teams can receive multiple awards based on these aspects.

Criteria: A panel of judges would select awardees based on the following tasks:

A. **Design Presentation and Flight Demo:** The team shall make a presentation showcasing various aspects of their design, including innovation or uniqueness of a) air vehicle design, b) system integration, and c) ground control capabilities. The team shall perform a short flight demonstration (free-style) of relevant capabilities.

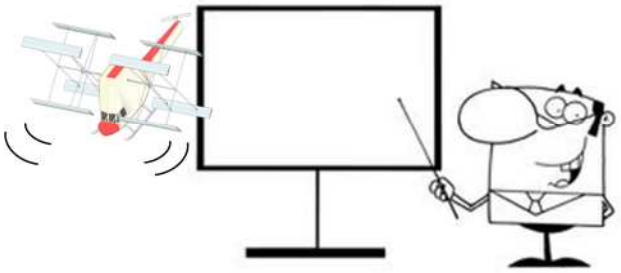

Figure 1. Task A - Poster Presentation and Free Flight Demo

B. **Indoor Target Search Mission:** As shown (see Figure 2 at right), the flight-demo consists of a sequence of phases that involve demonstrating state hover, target-search and acquisition, and return to base. Teams can conduct a fully autonomous mission or remotely piloted mission (manual flight) using onboard vision system. Specifically, for manual flight, teams will switch to camera-based flight after crossing a line-of-sight (LOS) boundary.

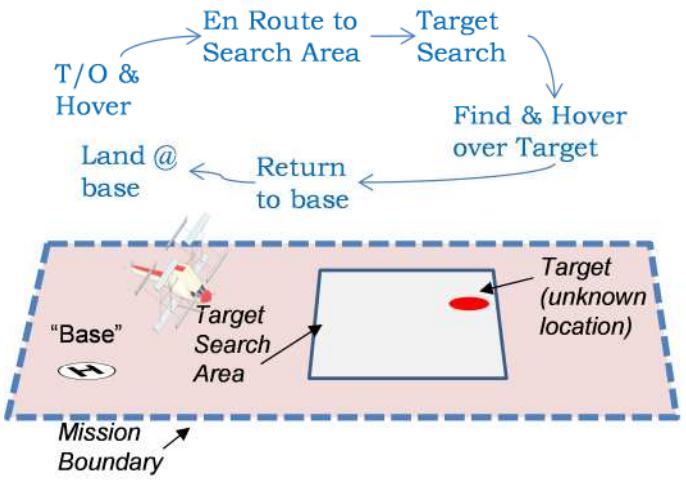

Figure 2. Task B - Target Search Mission

Prizes – The judges will select teams for the following three prizes:

- **Best Autonomous Target Search**
- **Best Manual Target Search**
- **Most Innovative Vehicle Design**
- Several Small Participant Awards

Overall, total prize money is more than $5,000. The final amount will be based on the contributions received from various event sponsors. Final competition details and award amounts will be announced on or before **January 30, 2014**.

Who can Apply

Team Restrictions

Competition is restricted to teams with full-time university and/or high-school students. At least one member of the team must be a current AHS Student Member at the time of entry. High-school teams are encouraged to find a university or industry mentor to help guide progress through various competition milestones. A list of AHS volunteer mentors, including contact information, will be made available for participating high school teams via the AHS website by December 31, 2013. Teams must have at least one member registered for the AHS Forum. A limited number of students may be provided with complimentary registrations for serving as Audio-Visual (AV) Volunteers. If there more than 2 teams per university, the selectors reserve the right to disallow participation to limit number of teams.

Vehicle restrictions

The competition is restricted to platforms with the following properties:

Configuration:

- Must have VTOL capability
- Single/multiple rotors/propellers
- Onboard flight-stabilization
- Onboard camera(s) needed for mission – Multiple cameras are allowed.
- Standard communication (preferred 2.4 GHz)

Space, Weight And Power (SWAP):

- Electric-powered vehicles only (no gas powered vehicles)
- Weight < 500g (17.6 oz) including batteries
- Size <450 mm (17.7 in) in any dimension

Safety:

- "Kill Switch": Dedicated hardware RC kill switch or remote-operation button command, Vehicle equipped to instantly cut power upon receiving "kill" command.

Selection and Competition Schedule

The team applications will undergo a gated review process involving paper submission of design approach, a video submission of capabilities, followed by the final competition at AHS Forum. These stages are described below.

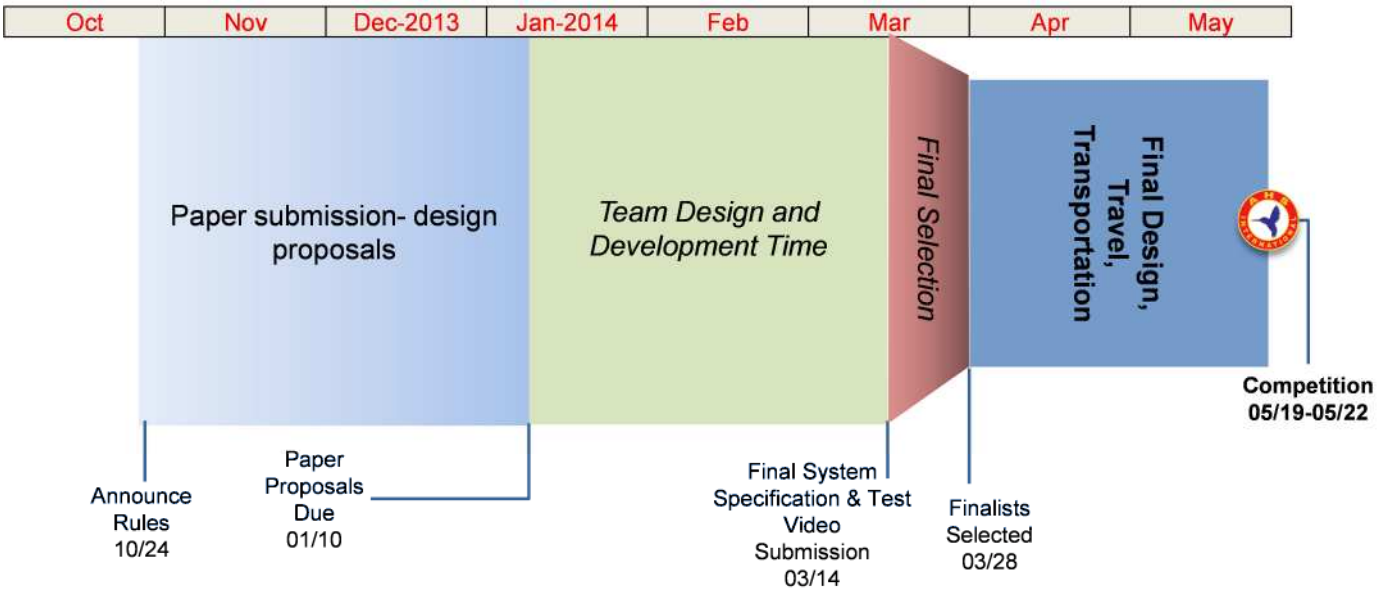

Figure 3. Schedule of Events and Selection Timeline

Gate 1: Paper Submission (Due January 10, 2014)

Each participant team shall submit a completed **team information form**, and an abstract with the following information: Team description with key student and faculty members (1 page), Vehicle specification and capabilities (1 page), Onboard-System & Remote-Operation development proposal (2 pages), Preliminary plan to final demo (1page). This information will used to judge relative progress of the teams and a preliminary ranking of teams. Preliminary ranking results will not be disclosed, but will be incorporated into final selection.

Gate 2: Video Evidence of Competition Readiness (Due March 14, 2014)

Each participant team shall submit a system design document with the following information: Final vehicle & system configuration description (2 pages), Vehicle Autonomy and Remote operation capabilities including target tracking results (2 pages), Gaps to address before final demo (1page).

Additionally, teams will **submit a video** showing a) measurement of vehicle dimensions and weight, and b) vehicle acquiring a stable hover over a known target using onboard vision. If remotely operated, the video shall clearly show takeoff from a nearby base location, and the operator transitioning from line-of-sight operation to using only onboard cameras as visual cues to hold target hover. If autonomous, the video should show the real-time ground-station or recorded target-feedback information relevant to the tracking performance. These results should be included in the paper submission as well for Gate 2.

Finalists Teams Selection (Due March 28, 2014)

The AHS competition finalists will be selected by a panel of judges using the following criteria a) Prior experience, b) Team diversity, c) Proof of vehicle readiness, d) Vehicle weight/size and constraints, and e) Plan realism. Additionally, the video evidence submitted at Gate 2 will be used to assess vehicle readiness and performance and ascertain vehicle weight/size and constraints. The panel will select **SIX FINALISTS** on March 28th, 2014 for participation in AHS Forum competition.

Final Competition

The Final Competition will be held in Montréal, Quebéc during the AHS Annual Forum on May 19-22, 2014. During the final competition, the teams will conduct Task A and Task B discussed above. Teams will be rated according to the following metrics by an independent panel of judges.

Task A Ratings

For Task A, poster presentation and free-flight demo, the metrics are provided in table below. The rating IDs A1-A5 will be combined in a specific weighted formula (to be disclosed later) in order to construct an overall score.

Task A	**Design and Innovation Metrics**	**Rating ID (0-5)**
Originality	Not off-the-shelf, involves innovative engineering, solved challenging integration issues, unique capabilities	A1
Flight Performance	physical design, , stabilization approach, aerodynamics and flight-stability, agility	A2
System Engineering	sensor-integration, remote pilot & GCS capabilities; antenna/wiring/sensor installation, craftsmanship.	A3
Maturity	Ruggedness, Field readiness, completeness of design, autonomy-readiness, potential for sensors.	A4
Teamwork	Inter-disciplinary teams, team “intangibles”, leadership shown.	A5

Task B Ratings

As mentioned earlier (Figure 2), Task B consists of executing a target “search & acquire” and return to base mission using only an onboard set of cameras. Specifically, the base, target and boundary details are depicted in the figures below. Figure 4 shows the “Line of Sight” (LOS) boundary that stipulates the threshold beyond which an operator

located near the base switches to onboard-camera-based control of platform as the vehicle moves into the right. Although the target location area is roughly known, the exact location of the target is unknown and may move from team to team. Figure 5 shows the details of the target and Figure 6 shows the details of the home base. In case of autonomous operation, these "images" can be used by video-processing algorithms for target and home-base search and hover-hold operations. Figure 7 shows the tape that will mark the perimeter of Task B operation. Under no circumstance shall a vehicle overshoot this boundary by more than 3 ft (1 m). Vehicle altitude is limited to 15 ft AGL (4.5 m).

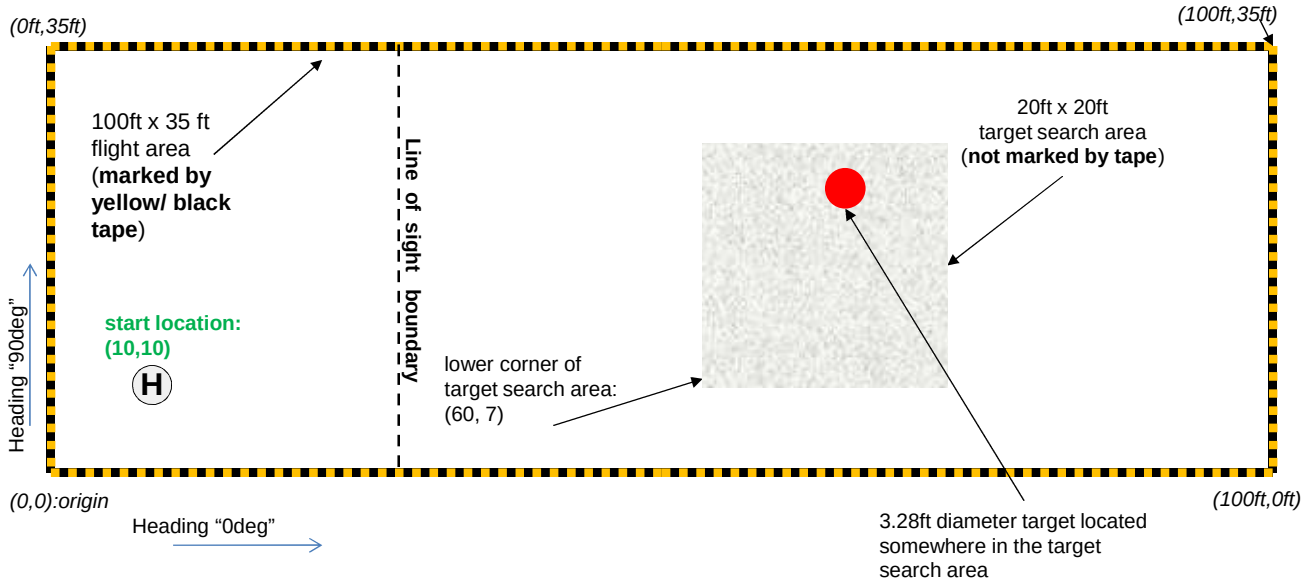

Figure 4: Approximate Layout of the Competition Area (total area subject to change) showing the key target-search mission parameters.

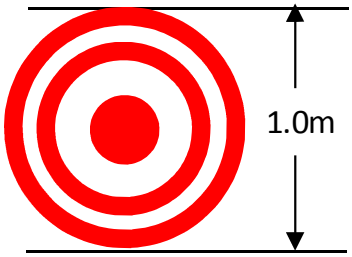

Figure 5: Floor-Painted Target (1m dia)

Figure 6: Floor-Painted Home Base (1m dia)

Figure 7. Mission Boundary Marking Tape (3" wide)

For Task B, the panel of judges will use the following ratings (rating ID B1-B6) to record Task B demonstration performance. The rating IDs B1-B6 will be combined in a specific weighted formula (to be disclosed later) in order to construct an overall score.

Task B/ Mission Phase	**Criteria**	**Rating ID (0-5)**
Take off & Hover	6ft hover height above base. Metric: Time to Stable Hover, Hover Performance above base.	B1
En Route to Search Area	Transition to this phase with clearly announced user signal. Metric: Qualitative smoothness of transitions. Metric (B2): Time to Search Area.	B2
Target Search	Remote operator or Autonomous system will use only onboard camera to find and track target. Establish stable target tracking for 30 seconds. Metric (B5): Time to find target, Operator involvement. Metric (B6): Lateral target tracking error. Stable roll/pitch performance.	B3
Target Track		B4

En Route Return to Base	Transition to this phase with user signal. Remote operator can use LOS.“Base” can use homing beacons for autonomous RTB. Metric: Qualitative smoothness of transitions, Time to acquire stable hover over Base	B5
Hover and Landing	Acquire stable hover <6ft above base before landing. Metric: Hover and Landing Performance. Distance from center.	B6

The disqualification rating will be given in case the vehicle violates the vehicle and demonstration limits. Specifically, the following criteria will disqualify a team during final competition. A “DNQ” rating will nullify all B1-B6 ratings for the team.

Criteria	**Rating ID**
Vehicle weight or size within stipulated limits.	DNQ if fail
Vehicles remains mostly within the mission boundary under 15 ft AGL, maintains speeds below 5ft/sec at all times. Overshooting this boundary SHALL NOT exceed 3 ft.	DNQ if fail
Remote operator MUST use only onboard camera to stay within bounds. Operator switches to onboard camera beyond the LOS boundary.	DNQ if fail

The ratings A1-A5, B1-B6 will be combined in a specific weighted formula to decide the three prize winners for the AHS competition. Runners-up will receive participation awards. All prize awards are subject to availability of competition sponsors and award funds.

Travel

AHS will not provide any travel or accommodation support for finalist teams. Teams are responsible to raise funds for travel, accommodation, equipment transportation, customs and storage if necessary. AHS will provide onsite storage, power-supplies and desk-space for equipment checks and repair. Additionally, AHS will provide easels or other poster-mounting means for displaying team presentation artifacts. Teams can contact AHS to consider a waiver or discount for AHS Forum registration fees for student participants. It is recommended that three team members attend the final demonstration in order to provide necessary support and safety operations.

Disclaimers

AHS assumes no responsibility for any actions caused by any participants of the MAV Student Challenge. These rules are subject to changes. Final rules will be published on or before January 30, 2014.

2nd Annual MAV Student Challenge
Team Information Form

Team Name: _____

School/Department Name: _____

(Limit of 2 teams per university. If more, Selectors *may* disallow to limit number of teams.)

Point of Contact (Faculty, Email, Phone No.): _____

_____

AHS Session Reference (if any): _____

Electric MAV Details

MAV Type (Quadrotor, Helicopter, etc).: _____

MAV Weight (without batteries): _____

MAV Weight (with batteries): _____

MAV Dimensions (all inclusive): _____

MAV GCS Interface (data-link, RC, etc.):_____

MAV Sensor Payload: _____

MAV Max Speed (if known): _____

Will this MAV have a remote-control operated power-kill switch? Describe implementation.

Current Autonomous/Control Capabilities:

Submission: Please send completed form along with your paper proposal (see Gate 1 details in announcement) to Harshad Sane (Harshad.sane@sikorsky.com) by January 10, 2014, with subject "AHS MAV competition". Teams will have to submit a follow-up Gate-2 "paper & video" proposal on March 14, 2014. Teams will be notified of final acceptance by March 28, 2014.