

# **OFFICIAL COMPETITION RULES**

## **for the 1995 International Aerial Robotics Competition**

### **General Rules Governing Entries**

1. Vehicles must be unmanned and autonomous. They must compete based on their ability to sense the structured environment of the Competition Arena. They may be intelligent or preprogrammed, but they must not be flown by a remote human operator.
2. Computational power need not be carried by the air vehicle. Computers operating from standard commercial power may be set up outside the Competition Arena foul-line boundary and uni- or bidirectional data may be transmitted to/from the air vehicle.
3. Data links will be by radio, infrared, acoustic, or other means so long as no tethers are employed. The air vehicles must be free-flying with no entangling encumbrances, however, tethered subvehicles are allowed. Subvehicle(s) must be attached permanently to the autonomous air vehicle at all times. Subvehicles must themselves be autonomous. They may be deployed within the rings to search for, and/or acquire the disks. Subvehicles may not operate outside of the rings.
4. Any form of propulsion is acceptable if deemed safe in preliminary AUVS review.
5. Air vehicles may be no larger than a 10-foot (side) cube when

operational.

6. Intention to compete must be received no later than September 30, 1994. To avoid unnecessary delay due to the mail (particularly for international entries), a letter of intention to compete can be transmitted by FAX to Robert C. Michelson, AUVS Technical Chairman at (404) 528-3271. The completed original application form can follow by mail, but must be received no later than October 31, 1994. A brief concept outline describing the air vehicle must be submitted at that time for safety review by AUVS (the application form provides space for this). AUVS will either confirm that the submitting team is a qualified competitor, or will suggest safety improvements that must be made in order to qualify. A VHS video tape of your vehicle flying under either autonomously or under remote human pilot control must be supplied by March 1, 1995 to continue to be considered as a serious entry.

A research paper describing your entry will be due by June 1, 1995 (see rule No. 6-9).

The competition will be held in Atlanta Georgia on the campus of the Georgia Institute of Technology on Thursday, July 6, 1995 (with Friday, July 7 as an alternate). Prize money will be distributed during the Awards Banquet at the AUVS national symposium being held July 10 through 12 in Washington, D.C.

7. Teams may be comprised of a combination of students, faculty, industrial partners, or government partners. Students may be undergraduate and/or graduate students. Interdisciplinary teams are encouraged (EE, AE, ME, etc.). Members from industry, government agencies (or universities, in the case of faculty) may participate, however full-time students must be associated with each team. Participants must be enrolled at their schools for at least 12 credit hours or more per quarter/semester during winter and spring 1995 to be considered "students." The student members of a joint team must make significant contributions to the development of their entry. Only the student component of each team will be eligible for the cash awards.

# Competition Rules

1. Air vehicles must transfer six randomly placed disks from the pick-up ring to the drop-off ring on the other side of the three-foot high central barrier. The disks must be transported one at a time. Though randomly placed, the disks will initially be at least three inches from the edge of the pick-up ring.

2. All air vehicles must start from the designated starting area. Only two members from the team may be within the boundaries of the Competition Arena once attempts to start the vehicle begin. From lift-off until the end of the round, all team members must remain outside the Competition Arena.

3. Teams will be allotted 60 minutes to complete the task. Each team will be assigned a specific 60-minute time slot in which they must set up and perform as many attempts as they wish. Judges will score each valid attempt, with the highest score being used to determine the winner.

To accommodate the number of competing teams within a reasonable time, three arenas will be constructed side-by side as shown at the top of the next page. A team will be assigned to one of the three arenas. Non-flight activities such as set-up, calibration, and take-down will be performed simultaneously by the three teams occupying the arenas.

Upon notice that a team is ready to fly, the clocks will be stopped for the other two teams and the field will be cleared except for designated officials and two members of the currently flying team. Once that run is complete, the other teams may return to their on-field activities and the clocks will be allowed to continue. After 60 minutes of arena time, a new team will be allowed to take control of the arena and the clock for that arena will be reset.

4. Teams may have more than one entry. Each entry must be based on a different air vehicle technology or navigation scheme and

must be documented by a separate application form, submitted in accordance with all deadlines. A round will be declared a valid try if the vehicle leaves the starting area.

5. Subvehicle tethers may only touch the three-inch high edge of either ring, the six-foot diameter base of either ring, or the region designated as the starting area. A run will be terminated if any part of an air vehicle, subvehicle, or subvehicle tether touches the ground outside of the starting area or the pick-up and drop-off rings.

6. The score will be based on a number of factors as follows:

**Effectiveness Measures:**

1. The number of disks (c) successfully transferred from the pick-up ring to the drop-off ring (50 points per disk).

2. The elapsed time (d) between take-off (leaving starting area) and the first valid disk acquisition measured in seconds divided by 10, and subtracted from the total score during a given round.

3. Successfully leaving the starting area and "operating autonomously and intelligently" for not less than 30 seconds (e) is worth 99 points.

4. The number of successful disk acquisitions from pick-up ring (200 points each). Disks dropped within 25 feet of the center of the pick-up ring do not count as successful acquisitions.

5. Successful autonomous landing at the end of a round (g) is worth 30 points.

**Subjective Measures:**

6. Elegance of design and craftsmanship (h) on a scale of zero to

30 (highest).

6.1 Component integration (0 - 10).

6.2 Craftsmanship (0 - 10).

6.3 Durability (0 - 10).

7. Innovation in air vehicle design (i) on a scale of zero to 50 (highest).

7.1 Primary propulsion mechanism {lift} (0 - 10).

7.2 Attitude adjustment scheme {yaw/pitch/roll/lateral} (0 - 10).

7.3 Disk retrieval mechanism/scheme (0-30).

8. Safety of design to bystanders (j) on a scale of zero to 40 (highest).

8.1 Isolation/shielding of propulsors (0 - 10).

8.2 Containment of fuel and exhaust by-products (0 - 10).

8.3 Crashworthiness (0 - 10).

8.4 Emergency flight termination mechanisms (0 - 10).

9. Each team is required to submit a journal-quality paper (written in English) documenting its project. This paper (m) is worth 50 - 100 points depending on technical quality. Papers are limited to 10 pages (including figures and references, if any). The format shall be single-sided with text occupying a space no greater than 9 inches tall by 6.5 inches wide on each page. Font size shall be 12 point (serif font) with 14 point leading. The example format is provided on [page 12](#) of these rules. Topics to be covered include: competitive strategy, how your vehicle design achieves your strategy, propulsion, stability augmentation schemes, navigation schemes, and disk retrieval mechanism. Five copies of your paper are due to the application submission address by June 1, 1995.

10. Best team Tee Shirt (l) (one point to the best).

The points for a given round will be totalled according to the following formula:

$$SCORE = (c * 50) + e + (f * 200) + g + h + i + j + l - (d/10) + m$$

The highest score accumulated by any entry after all rounds have been completed will be declared the winner.

7. Up to \$10,000 will be awarded to the team having the highest score achieved during any fully autonomous round in which a disk is successfully moved. In the event that no air vehicle is capable of successfully moving even a single disk during any round, the method of prize money distribution will be at the discretion of the judges- however any partial awards resulting shall not exceed \$1,000 per award with the total allocated to such partial awards not to exceed \$5,000.

8. Air vehicles may only land within one of the two rings or within the starting area. The air vehicle must be airborne at all other times. "Air vehicles" are considered to be those capable of sustained flight out of ground effect while requiring the earth's atmosphere as a medium of interaction to achieve lift (as such, pogo sticks and similar momentary ground-contact vehicles are not considered to be flying air vehicles). The scoring formula and arena have been carefully designed to normalize advantages inherent to a given class of air vehicles such that all may compete fairly to perform the same task. Prospective teams must decide how best to allocate resources to maximize their potential score in light of the constraints imposed by the arena, the task, and the scoring algorithm.

9. Air vehicles may not latch onto, or use, the central barrier for locomotion or stability. Vehicles crossing over the foul line will be disqualified for that run and must be returned to the starting area.

10. Disks placed within the drop-off ring, but which are later knocked out by other disks or the air vehicle itself, still count

toward the total. Disks which bounce or roll out of the drop-off ring during initial placement do not count.

11. Each air vehicle must be equipped with an independently-powered, independently-controlled, non-pyrotechnic termination mechanism that can render the vehicle ballistic upon command of the judges (e.g., if using R/C radio equipment, a separate battery and receiver must serve as the independent relay for the onboard flight termination signal). This termination mechanism must be demonstrated to the judges prior to the first round. Air vehicles may be landed under manual control if desired, but the points that could be awarded for an autonomous landing will be forfeited. Both autonomous and manually-assisted landings must occur within the foul lines of the Competition Arena. Fully autonomous flights which successfully move a disk but have manually-assisted landings are still considered "fully autonomous runs" and are eligible to receive the \$10,000 award.

## **HOW COMPETITORS WILL BE JUDGED**

1. A team of three judges will determine compliance with all rules. Official times and measures will be determined by the judges. Subjective measures (6 - 10) will be judged the day prior to the competition at a location near the arenas and in accordance with a schedule to be announced a week prior to the competition. Team papers will be ranked and scores assigned to them at this time.

## **GROUNDNS FOR DISQUALIFICATION**

1. Vehicles crossing over the foul line will be disqualified for that run only.
2. Judges will disqualify any vehicle which appears to be a safety hazard.

3. Intentional interference with a competitor's run will result in disqualification of the offending contestant's entry.
4. Damaging the Competition Arena, disks, or navigation aids may result in disqualification.
5. Actions designed to damage or destroy an opponent's vehicle are not in the spirit of the competition and will result in disqualification of the offending contestant's entry.

## **AWARDS**

1. Up to \$10,000 Cash tuition award to winning student team members.
2. National recognition for the winning student's university.
3. National recognition through AUVS for the winning industrial/government/faculty organization.
4. Free full-page advertisement for the winning company, governmental agency, or university faculty department in Unmanned Systems magazine. If more than one industrial/government/academic entity is supporting the team, then the student component shall designate which partner has supplied the greatest assistance (in whatever form), and that partner shall receive the free full-page advertisement.
5. Special recognition to the winning team at AUVS '95 to be held in Washington, D.C. including free attendance to the symposium and awards banquet for up to 10 team members, an invitation to display the winning air vehicle in the exhibit hall, and the opportunity to present a paper to the unmanned vehicle community detailing winning design and construction strategies. Other competing teams will receive two complementary registrations to the symposium.

All teams are invited to submit papers describing their designs and strategies by submitting them for presentation in one of the air vehicle sessions by the regular submission deadline. Also, exhibit

space can be made available to all teams wishing to showcase their technology at the symposium by contacting AUVS headquarters. (Teams having their entries on display in the exhibit hall have found this to be a good way to make further contacts for their universities and for themselves as graduates).

**REMEMBER THESE IMPORTANT DATES:**

- Notification of intention to compete September 30, 1994
- Application Deadline October 31, 1994
- VHS Video of air vehicle flying March 1, 1995
- Journal quality paper June 1, 1995
- Static Judging the day prior to the competition July 5, 1995
- Performance judging (i.e. "the competition") July 6, 1995
- Rain-day for performance judging July 7, 1995
- AUVS Symposium in Washington, D.C. July 10 through 12, 1995