

2020 ASME IAM3D Competition Rules

U.A.R.C.V.

Do you have the need for speed? The 2020 ASME IAM3D Unmanned Aerial Racing Cargo Vehicle (U.A.R.C.V.) competition tasks university students to use additive manufacturing and an iterative design process to create an unmanned aerial racing vehicle capable of picking up and dropping off a payload on each lap. One document submittal, a design report showing your team's design process and detailed drawing will be required prior to participating in the physical obstacle course. ****Be sure to pay special attention to the Competition Safety Requirements & Safety Equipment portion of the rules. All teams must be in compliance with safety in order to compete.**

Objective

The objective is to design and manufacture a U.A.R.V. using additive manufacturing and an iterative design process that will race in five team flights for five laps through an obstacle course picking up and delivering one payload per lap.

Registration

Teams will be required to register their team's vehicle AND as individuals through the E-Fest website. To ensure proper registration please register through the E-Fest website at least 2 months before your applicable E-Fest. Teams that have not registered two months prior to the competition date and do not reply to registration inquiries may lose their spot if another team on the waiting list is registered. One month prior to the applicable ASME E-Fest start date where your team will be competing IAM3D registration will be closed and IAM3D staff will be unable to accept any further registrations. E-Fest 2020 location dates can be found at <https://efests.asme.org/>.

Example: If the E-Fest you are attending occurs February 3rd-5th vehicle registrations should be completed by December 3rd. IAM3D registration will close January 3rd.

Eligibility

Every participant must be a student member of ASME who is enrolled as an undergraduate in a baccalaureate or associate engineering/engineering technology degree program or was enrolled in one of those programs within one year of the competition date (must still be a dues paying member). All competitors agree to abide by the [ASME Engineering Code of Ethics](#).

Competition Safety Requirements & Safety Equipment

All teams/team members must wear safety glasses while assembling and working on vehicles and while on the course. Teams will not be allowed to compete without safety glasses. Teams are required to provide their own safety glasses. It is suggested to bring comfortable safety glasses as you will be wearing them all day. Additional personal protection equipment (PPE) is recommended.

Design Report

The design report should address at a minimum the following points:

- Individual CAD drawings for every part created using additive manufacturing
- Exploded CAD assembly drawing of all parts created using additive manufacturing
- Analyses: Expected vehicle performance, part specifications, and structural simulations
- Design for manufacture and assembly analysis (DFMA) <https://en.wikipedia.org/wiki/DFMA>
- Design for additive manufacturing analysis (DFAM) https://en.wikipedia.org/wiki/Design_for_additive_manufacturing
- Design Iterations and physical testing information

There is no paper length or format requirements but design reports should be professional and contain sufficient detail to describe the design and function of the vehicle. The design report will be due two months before the start of your applicable E-Fest. Date examples can be found in the registration section. Design report scores will be provided publicly at the start of the competition. Late report submissions will be accepted but a 6 point per day penalty will be incurred based on the number of days after the target submission date that the report email is received. Due to time constraints scoring of late submissions will be attempted but are not guaranteed.

Submission of Design Report

To officially submit your design report, email your document in PDF format along with team information to IAM3D@asme.org. In the email body include the following team information:

- University /Project name / Vehicle name
- Chapter advisor name and contact information
- Chapter president's name and contact information
- Team captain contact information (Email address, phone number, physical location)
- Number of students on the competition team
- Number of students that intend to participate at E-Fest with your team

Use of Additive Manufactured Parts

This competition strives to provide experience in additive manufacturing and an iterative design process. To ensure the spirit of the competition, scoring will be heavily weighted on what percentage of parts on your team's vehicle were produced using additive manufacturing. Teams will be required to design and construct their vehicle's airframe using additive manufacturing. All designs of additive manufactured parts must be original, designed, and created by the competing team. The use of preexisting designs will be grounds for disqualification.

Score weighting equation:

$$\left(\frac{\text{Number of parts created using additive manufacturing}}{\text{Total number of parts (minus exceptions)}} \right) \times (\text{Total Final Score})$$

Example:

$$\left(\frac{30 \text{ parts created using additive manufacturing}}{50 \text{ Total number of parts (minus 10 exceptions)}} \right) \times (\text{Total Final Score of 500}) = 375 \text{ points}$$

Additive manufacturing through any traditional form of line fed or powder-based process will be allowed. Any form of commercially available additive manufacturing material/process will be allowed. Alternative forms of additive production that are found to reduce structural integrity enough to be considered unsafe may be disqualified and will be left to the judge's discretion.

Required Commercially Purchased Parts

Safety is a criterion that nearly every engineering design considers. For this reason, some parts of this competition will require commercially purchased parts and are considered to be exceptions to the used of additive manufacturing parts score.

All Electronics (example: flight controllers, cameras, FPV...)

Wire

Electric Motors

Propellers

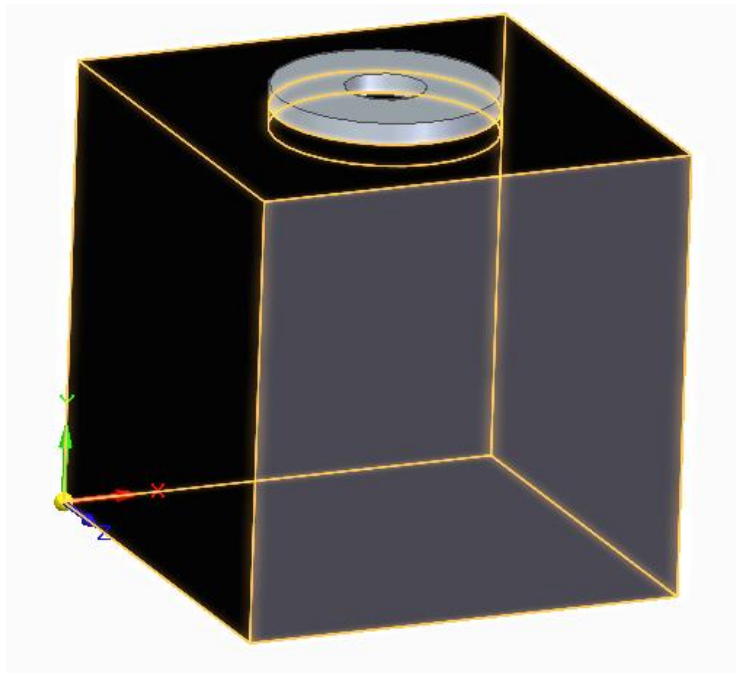
Batteries

Fasteners/Bolts/Nuts

Other parts may be deemed exceptions to the use of additive manufacturing parts score and will be left to the judge's discretion.

Payload

The payload will be a 3D printed (PLA) one-inch cube with 30% infill and four outer shells. A ferromagnetic metal (steel) washer smaller than one inch and larger than one half inch diameter will be attached to the top of each payload. All competition payloads are identical and will be provided by ASME.



Vehicle & Vehicle Size Constraints

The vehicle size constraints are as follows:

- 33 cm measured diagonally from motor center to motor center
- 25 cm height

A judge will measure dimensions to ensure that your vehicle dimensions are compliant. This does not include the device controller, FPV goggles, or payload. Vehicles are allowed to transform to any dimensions as long as it does so while on the course and only by doing so on its own and under its own power. Keep in mind the course and obstacle dimensions!

Vehicle Safety Provisions

- A safety briefing will be held during the first day of the competition. All team members are required to attend.
- Vehicles must pass an airworthiness/wiring inspection. Once vehicles are inspected, they may not be altered without re-inspection.
- No one will be allowed on the course during the race.
- Race viewing will only be allowed from outside the netted course area and will require the use of safety glasses.
- All pilots must have an arming switch feature on their controller.
- Vehicles must have a physical kill switch located on the vehicle and controller.
- Pilots will not power up video transmitters or vehicles unless instructed to do so by a Judge or race official.
- Pilots must use FPV to pilot the vehicle. Goggles and ground stations are allowed.
- Pilots will not be allowed to fly outside of the designated competition area. Flying outside of the designated competition area is STRICTLY prohibited and will result in immediate disqualification.
- All batteries must be stored in a LiPo safe bag or an approved fire-resistant container.
- Vehicles may not fly higher than 10'. Any breach of this will result in immediate disqualification.

Failure to adhere to the above provisions constitutes a possible disqualification. Disqualifications will be at the discretion of the Judging team.

Energy Sources

All electrical energy for the device must be provided by commercially produced rechargeable batteries. Student designed and manufactured energy sources will not be allowed.

Maximum battery specs:

- 4S
- 4.2 Volts per cell

Springs may be used with the following static size constraints.

- ½ Inch diameter maximum.
- 2-inch length maximum.

Controls

Devices may be controlled via remote control through a transmitter/receiver radio link. As an exception to the rechargeable battery rule, a radio transmitter may have its own batteries and these

batteries do not have to be rechargeable. The transmitter/receiver radio link may be any commercially available model controller. All radio controllers will be impounded and shut off during the competition, except during the team's race. Umbilical controls may not be used.

First Person Visual (FPV)

No one will be allowed on the physical course while vehicles are in flight. Due to this requirement, FPV is required for all vehicles/pilots. Please be prepared to record your flights and provide your flight videos to the judging staff. FPV video may be used to settle race disputes. Providing your video to the judging staff will signify your permission for ASME and IAM3D to use all provided videos for advertisement purposes. If you do not wish to have your videos used please inform the judges at the competition before submitting your videos.

Course

Each team will be given 5 minutes to ready their vehicle. Vehicles will fly 5 laps. On the first lap, the vehicle will be staged on the ground in their respective lane. The vehicle will be required to pick up a payload from a section of the same lane before entering the obstacle course. After clearing the last obstacle, the vehicle must deposit the payload in the staging lane. The remaining four laps will start with payload pickup, obstacle course and payload drop off in the same fashion as the first lap but will not be required to land. The final lap will stop when the vehicle comes to rest on the empty payload lane. Any race that results in a tie for first place will be settled in a two lap face off. Payload deposit is required for the lap to count in face offs. If a race results in a tie for second place both teams will receive a score for second place and third place will not be awarded. On the final race day, a maximum of 20 teams with the highest scores will participate in an additional semi-final race. The top 5 team scores after the semi-finals will participate in a final race.

Day 1: Practice laps and lane selection races – No race scoring

Day 2: Initial race round for score and vehicle reduction rounds

Day 3: Semi-final races and final race.

There will be many races involved. It is suggested to make your vehicle modular and bring backups to everything. Crashes are inevitable and rebuilt/backup vehicles will be permitted to race.

Course dimensions and obstacle descriptions can be found in Appendix 1.

Scoring

Practice runs will be organized on the first day of competitions.

There will be three ways to score points.

- Design Report - 2500 Points possible
- Use of Additive Manufacture Parts - 5000 Points possible
- Obstacle course - 2000 points possible
- Payload Score: 200 points per successfully deposited payload
 - 1st place - 1000 points
 - 2nd place - 500 points
 - 3rd place - 250 points

Pilots that prematurely start, or miss going through an obstacle will be required to run one additional lap per occurrence. Missed obstacles will only be penalized if the vehicle completes a lap without going back to complete the missed obstacle.

In the event that a payload is dropped, the penalty will be not receiving the payload score for that individual payload. Payloads may not be recovered if it falls outside of the designated pickup area.

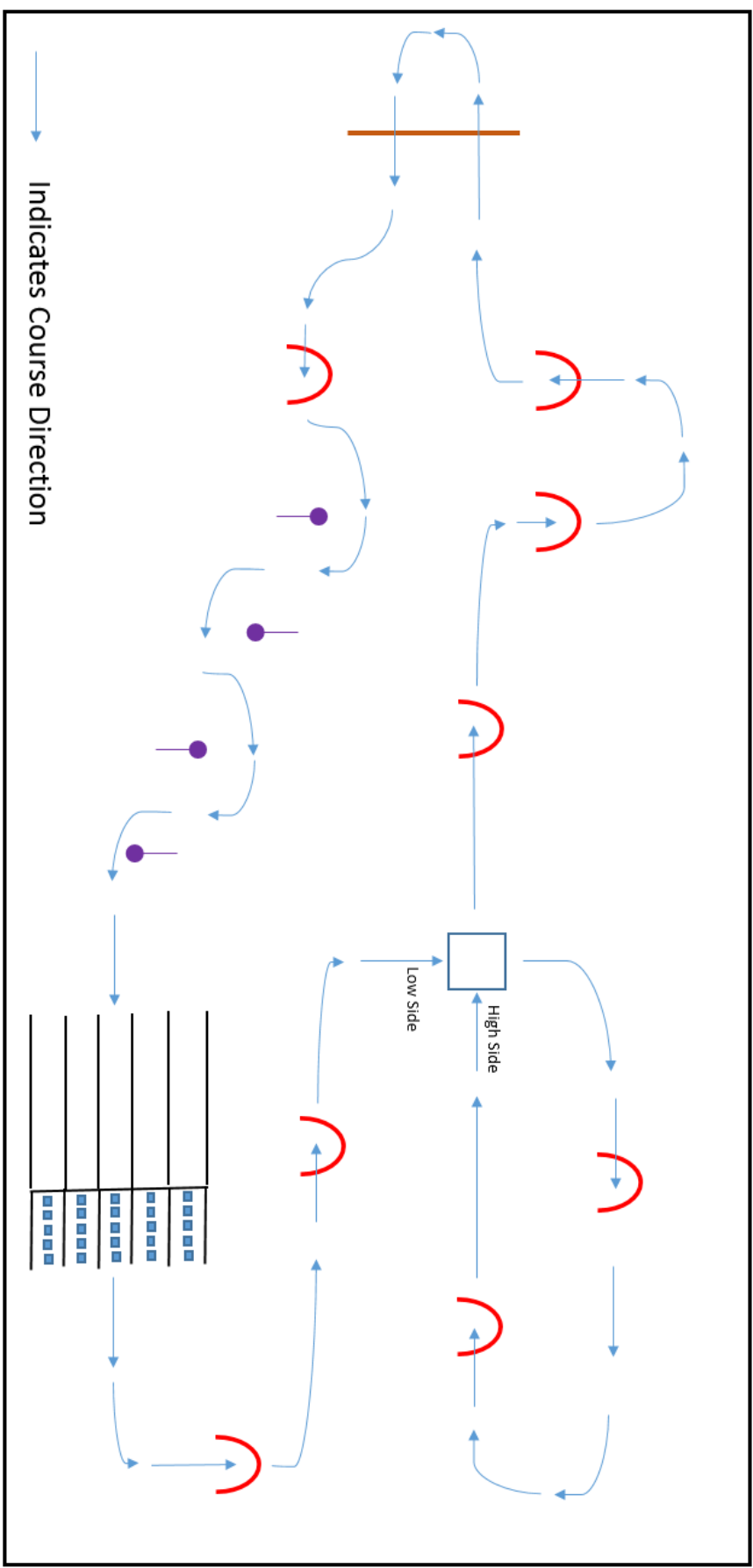
Teams that fail to meet the following requirements will receive an obstacle course score of zero but will keep design report and use of additive manufacture parts scores.

- Teams must be physically present at the time of their scheduled race.
- Finish all 5 laps in under 15 minutes.
- Vehicles must stay within the outer course boundary and under an altitude of 10 feet.
- Intentional vehicle collisions are prohibited. Pilots can resume the race if they are able to fly without intervention. The pilot not at fault may be granted a makeup run. Make-up runs should not be expected and are at the discretion of the Judging team.

Additional questions may be emailed to IAM3D@asme.org

Appendix 1: Competition Course and Obstacle Dimensions

IAM3D 2020 Course



*Course outer dimension is 100 X 50 feet. Obstacles are not shown to scale. Obstacle placement may vary and is not to scale. Course Legend is on Following Pages. Obstacles may be lit with LED lighting.

Course Legend



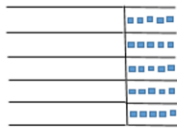
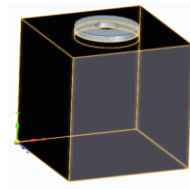
Race Gate



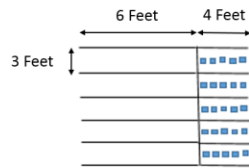
Turn Flag



1 Inch Cubed
Competition
Payload



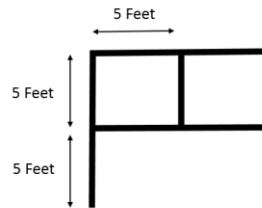
Payload
Pickup/Drop off
Lane



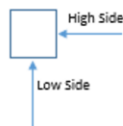
All Dimensions are approximate



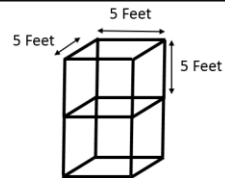
Field Goal
Obstacle



Constructed of PVC Pipe



High/Low
Cube



Constructed of PVC Pipe