ASME Student Design Competition – 2021 Rules
Harvesting the Sun and Wind

ATTENTION E-FESTERS! Please read this important announcement about ASME E-Fests® in 2021

ASME is excited to host a second E-Fest Digital on April 24, 2021. E-Fest Digital will include career and professional development content, digital competitions (including the Human Powered Vehicle Challenge, the Student Design Competition, the Innovative Additive Manufacturing 3D Competition, the Oral Competition, the Environmental Systems Division Oral Competition and the Elevator Pitch Competition) and much more! Questions may be directed to efests@asme.org.

We encourage students, competitors, and faculty members to take advantage of the learning experiences provided by both our competitions and other digital offerings throughout the year. Questions may be directed to efests@asme.org and a digital calendar is posted on https://www.asme.org/conferences-events/events (sort by audience type students/early career engineer) with lots of information.

All ASME conferences, meetings and events scheduled through December 2021 are being planned as virtual only, enabling everyone to enjoy the full benefits of participation via our virtual event solutions with no physical presence required. ASME will not have any physical or in-person events during this time but will continue to deliver the insights and expertise that our community depends upon. For more information about ASME's virtual approach to events and meetings, visit https://www.asme.org/anywhere.

Students are encouraged to download E-Fest competitions rules at https://efests.asme.org/competitions for our 2021 Digital events.

Additionally, ASME will be hosting a series of year-long digital events including a Student & Early Career Town Hall (Feb. 4, 12:00 pm – 1:15 pm EST), webinars and other competitions. Please visit http://efests.asme.org for more details.

ASME Student Design Competition – 2021 Rules
Harvesting the Sun and Wind

Nearly twenty percent of the energy consumed around the world to heat, power, or transport comes from renewable sources including biomass, geothermal, solar, hydropower, wind, and biofuels. Renewable sources now generate a quarter of global electricity, possibly rising to 45 percent by 2040. Much of the increase will likely come from solar, wind, and hydropower. The ability to generate these advances in technology will require the efforts of skilled engineers who need to appreciate the challenges involved in both collecting and using renewable energy.
In addition, designing, building and operating "co-robots" -- robots that can assist other robots or people in accomplishing some goal – is an important skill to possess. This year's competition requires teams to design and build a vehicle capable of collecting solar and wind energy to extend the duration of operation of a remotely controlled vehicle that navigates a course and transports weights to earn points. *The validation of your design is scheduled to take place only as a virtual event prior to the E-Fest Digital on April 24, 2021.* *See below for the details.*

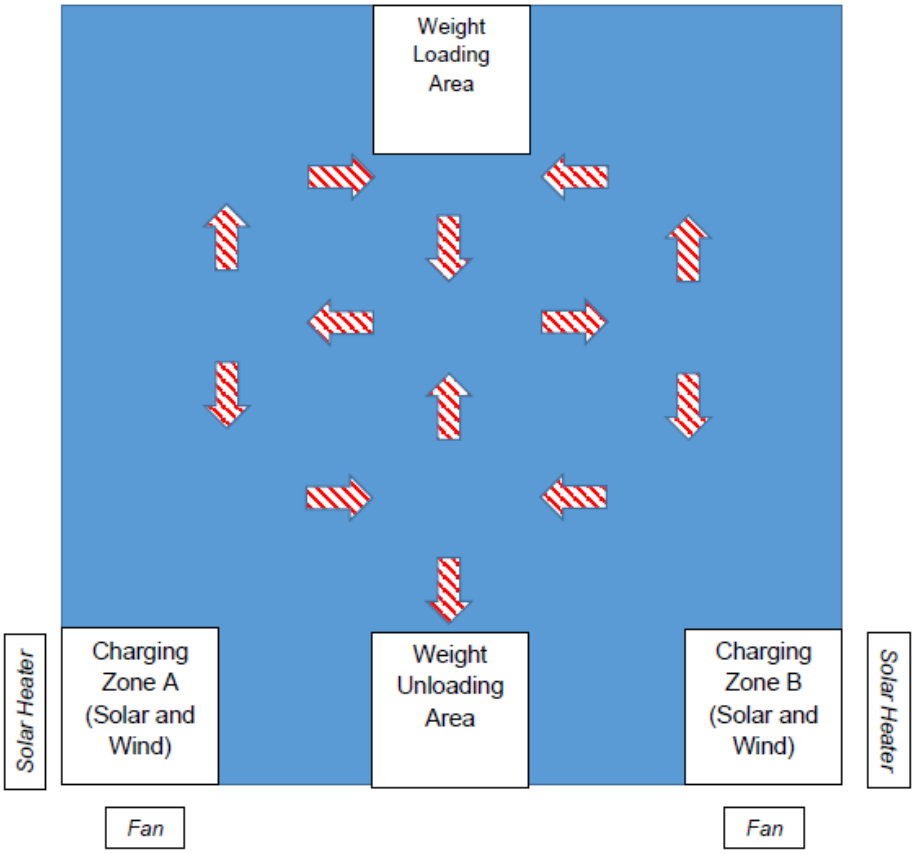
General Rules: team eligibility, overall design setup and constraints:

1. Students participating in the competition must be undergraduate engineering students (any engineering discipline is allowed) and must be ASME student members. There is no limit on the number of students on a team or the number of teams from a school. Each student may only participate on one team (contribute to one device) – participants from schools fielding more than one team will be asked to affirm this at the competition.
2. Teams **must provide a rigid sizing box with a top** for the device and tools the team would use to make minor repairs during the competition. This box must be less than 50 cm x 50 cm x 50 cm (internal dimensions). Teams will be required to verify box dimensions and that their device fits within the storage box in a submission video prior to the virtual competition.
3. The competition will take place in two stages. A preliminary round will be submitted prior to the virtual competition and teams will record and submit video(s) of their device on the day of the virtual event. Design modifications are allowed between these two stages.
4. Teams must construct their own demonstration field which must be a 5-meter by 5-meter space marked on the floor by tape (see Figure 1). Devices must stay within the tape during demonstration. The field will have four 1-meter x 1-meter areas: two Charging Zones that are specific to teams, a Weight Loading Area and a Weight Unloading Area that are used by all teams. Thirteen target arrows (at least 10 cm long, 2 cm wide at the back, and 4 cm wide at the arrow head) should be taped to the floor in the pattern shown in Figure 1. Exact location dimensions are not specified, but the symmetry given in the figure must be maintained.
5. Teams must build a device propelled completely by ***one rechargeable AAA battery*** that is located on the device. Teams must use AmazonBasics AAA Rechargeable Batteries rated at 800 mA-hrs that are unaltered. Each competition round will start with the AAA battery fully charged; during the competition energy can be collected within the team's Charging Zone to replenish the battery energy – teams will be assigned Zone A or B for

each demonstration. The use of mechanical energy is allowed if it is generated by the energy collected, teams may not use pre-loaded springs or weights or initially compressed gas.

6. Devices must use the same AAA battery that propels the device to also power all device *control* functions: steering, braking, deploying energy collection systems, engaging the drive system, etc. An RC remote controller must be used by one team member to control the movement of the device. The remote controller may have its own battery, and this does not have to be rechargeable.
7. Teams will provide their own solar energy and wind energy sources:
    - The solar energy will be simulated by a *500W Utilitech Portable Halogen Work Light with Floor Stand* as the source of solar energy for each Charging Zone at the competition. Teams may acquire this from a variety of online sources, such as Amazon.com. *Comparable alternative light sources may be used.* During the competition rounds, teams will be allowed to position the solar energy source near the edge of the Charging Zone. Once the round begins the light may not be moved.
    - The wind energy will be simulated by a Lasko model 3300 20″ Wind Machine Fan with 3 speed settings as the source of wind energy for each Charging Zone at the competition. Teams may acquire this fan from Amazon or other online sources. *Comparable alternative wind sources may be used.* During the competition rounds, teams will be allowed to position the wind energy source near the edge of the Charging Zone. Once the round begins the fan may not be moved.
    - During the demonstrations, a team member will be permitted to turn on both or either of the two energy sources while the device is in the Charging Zone, and then turn off all energy sources when the device leaves the Charging Zone.
8. All devices ***must be capable of recharging*** the AAA battery using either the solar or wind energy sources. Before the virtual competition teams will be asked to submit a video demonstrating this capability to the judges – teams must prove that power is being provided to the AAA battery due to the solar or wind sources.
9. Each demonstration will begin with the device in the Weight Loading Area. A team member may manually load weights in ½ kg increments onto the device for transport to the Weight Unloading Area. Teams must create their own uniform ½ kg steel plates that are roughly 8 cm x 8 cm x 1 cm in dimension. Teams will load between one and ten plates (total load from ½ to 5 kg) for each trip to the Unloading Area. A team member must properly secure plates to the device during the trip – if any weight(s) falls off the device before reaching the Unloading Area the entire trip score is forfeited.

Figure 1: Playing Field (for face-to-face competition)
(5m x 5m overall size)



10. After the team has loaded their device with as many ½ kg plates as the team chooses, points are earned by traversing the Playing Field to the Unloading Area and driving over Arrows on the ground. Devices must be approximately centered over the Arrow when crossing it and must travel in the direction of the arrow. After a device has left the Loading Zone it may cross as many or few arrows as the team wishes before unloading the weights. Teams earn points for each arrow crossed as the device moves to the Unloading Zone; points are only awarded once per arrow during each round trip from Loading to the Unloading Zone. Points are awarded as follows:

Arrow Scoring Factor = (Number of arrows properly crossed)/10

11. A team's points for each trip carrying weights from the Weight Loading Area to the Dropoff Area will be calculated:

*Trip Score = Arrow Scoring Factor *Total Weight Delivered to Dropoff Area (0.5 to 5.0 kg)*

12. A team's total points for each round will be the sum of all Trip Scores within the time limit.
13. When the AAA battery on the device requires recharging, teams must drive their device to the team's assigned Charging Zone without any manual assistance, the Solar or Wind power source will be turned on, and the device recharged. If a device becomes stranded without power on the Playing Field, a team member will be allowed to manually place the device in the Charging Zone, however a time penalty will be assessed before the power sources can be activated – these time penalties are described below.
14. Teams may replace the AAA battery between any rounds, however all batteries used must be unaltered AmazonBasics AAA Rechargeable Batteries rated at 800 mA-hrs.

Demonstration Setup Rules: preparing for testing, operator/device operation

15. By March 26, registered teams must submit a video that validates the requirements of the competition and their device: Playing Field and Sizing Box dimensions, proper Loading Weights, Solar and Wind power sources, AmazonBasics AAA Batteries, ability of device to recharge. Teams are also required to have their university faculty advisor submit an email from their university account affirming that the team is making no intentional efforts to break competition rules and all team submittals follow ASME ethical practices.
16. For each round only one person from the team will remove the device from the sizing box and prepare the device to operate. Other than connecting power to the device and setting up to operate, no modifications are permitted during this setup time. There is no specific time limit on this setup, but **it must be done by only one person**.
17. The testing area surface should be reasonably level and a relatively smooth surface of the team's preference (e.g. hard surfaces, carpet, or other flooring typically found in public areas). **It must be set up indoors.**
18. Only one team member will be allowed to control the device when time is started. This person would also retrieve and place the device in the Charging Zone if it becomes stranded. At the start of the performance videos the device controller should be clearly identified.
19. Teams are allowed to control their device with one remote control, operated by one team member. A second team member may load and unload weights, and control the energy sources in the Charging Area. This person also must be identified at the start of all videos. All other team members must remain appropriately distanced from each other around the playing surface and not interact with the device during rounds.
20. The time limits provided for each device test is given in the following sections; if the device becomes unable to continue, the testing round will be stopped.

Preliminary Device Performance Rules: initial performance measurement

21. By April 2, registered teams that have submitted an approved Competition Compliance video will create and submit a video of their device being tested once on their Playing Field.
22. ~~Multiple teams may operate their devices at the same time on several Playing Fields to expedite the competition. The number of simultaneously operating devices will be determined by the lead judge(s) at each EFest.~~ *This section is no longer applicable.*
23. For the ***Preliminary Device*** testing round, each team will have 5 minutes to earn points after setup. If a device becomes stranded and must be manually placed in the Charging Zone, this will incur a 15 second time penalty each time. ASME SDC judges will time the events in the video to verify compliance and scoring. Teams should clearly show a stopwatch starting on their video when their device begins, and end the video showing the final elapsed five-minute time.
24. ~~For the ***Competitive*** testing round, two teams will compete on the Playing Field and will have 10 minutes to earn points after setup. The A and B teams will be randomly drawn. A team device may not enter the Charging Zone of the other team. If a device becomes stranded and must be manually placed on the starting ramp, this will incur a 15 second time penalty for the first manual intervention, with the penalty increasing by 15 seconds each subsequent time (15, 30, 45, etc. seconds).~~ *This section is no longer applicable.*
25. The final team score for the ***Preliminary Device*** qualifying will be the sum of the points scored during the initial test video. The 16 highest teams submitting an approved Competition Compliance video (rule #15) and a valid Preliminary Device Testing video will advance to the Elimination Round Testing. A 16-team bracket is shown below. For the initial seeding, any ties will be broken using the total number of ½ kg weights moved in the five-minute test videos.

Elimination Competition Bracket (seeding based on Preliminary Device video results)

Elimination Testing Rules: "*head-to-head*" knockout rounds

26. Elimination testing rounds will each last 15 minutes. Starting on April 8, the top 16 scoring teams be informed that they have qualified to compete in the elimination bracket shown above. The seeding for the final 16 competitors will be based on the April 2 videos submitted to ASME. All teams will be informed at the same time on April 8 and given a unique code that they must show at the start of their performance video; teams and must operate, record and upload their video by midnight April 9, 2021 (US EDT).
27. ~~A team device may not enter the Charging Zone of the other team.~~ If a device becomes stranded and must be manually placed in the Charging Zone, this will incur a 30 second time penalty for the first manual intervention, with the penalty increasing by 30 seconds each subsequent time (30, 60, 90 etc. seconds).
28. If two teams are tied in any of the head-to-head competitions, the higher seeded team will be declared the winner.
29. Winning teams from the April 9 videos will advance and continue competing against each other until an overall winner is determined. Advancing teams will be informed and then given instructions for identifying their device for the next round. Teams will have ~30 minutes to operate, record and upload their video. When the semi-final round has been reached the four teams will compete one final time on April 10. The final videos to determine all four final places will be recorded by teams on April 23, and the results announced at the E-Fest Digital on April 24.

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Activity Timing for 2021 SDC E-Fest Digital Competition

The following list shows the delivery dates for the activities associated with the 2021 virtual Student Design Competition. Specific requirements and details of submittal procedures will be provided closer to the activity delivery dates

- (*Optional*) Preliminary Design Review March 26, 2021 (midnight US EDT)
    - Teams may submit a 10-minute video or PowerPoint presentation with voice over detailing: 1) their design process and decision making, 2) the description of their final device and its unique qualities, and 3) the procedures taken by the team to test during the fabrication of the device and the validation and refinements made during final operation before the competition.

- (Required) Compliance with Competition requirements March 26, 2021 (midnight US EDT)
    - Teams must submit a video as detailed in above competition rules, specifically Rule #15.

To be eligible to submit performance videos, teams must have registered for the E-Fest Digital and received confirmation from ASME SDC that their Competition Compliance video was approved.

- (Required) Preliminary Device Performance April 2, 2021 (midnight US EDT)
    - Teams must submit a video as detailed in above Preliminary Device Performance Rules.

*The performance videos submitted by April 2 will be used to select the **top 16 teams** (teams advancing will be notified by April 8) that will compete in the elimination rounds. This will also enable all competitors and judges to become comfortable with the video submission process.*

- (Required for all qualifying teams) Initial Elimination round April 9, 2021 (midnight US EDT)
    - Each of the top 16 scoring teams based on scores from the April 2 videos must operate their devices as detailed in above Elimination Testing Rules section.
    - All teams advancing to the round of 16 will be informed at the same time by 9 p.m. US EDT on April 8. Advancing teams will be given instructions for identifying their device and must operate, record and upload their video by midnight April 9, 2021 (US EDT)
    - All teams will be scored by ASME SDC judges and the 8 winners will advance to the next rounds that will take place on April 10.

- (Required for all advancing teams) "Live" Elimination Competition April 10, 2021 (9 a.m. US EDT until all elimination rounds are completed)
    - Each of the top 8 teams must be available to start the competition by 9 a.m. US EDT.
    - All teams will be given instructions for identifying their device and must operate their devices as detailed in above Elimination Testing Rules.
    - Teams will have ~30 minutes to operate, record and upload their video.
    - All 8 teams will be scored by ASME SDC judges and the winners advance to the semi-final round.

- Semi-final teams will be given instructions for identifying their device, and will have ~30 minutes to operate, record and upload their video as detailed in above Elimination Testing Rules.
- All 4 teams will be scored by ASME SDC judges. The two winning teams advance to the finals, the two non-winning teams will compete in a 3rd place round.

The semi-final videos submitted on April 10 will be scored by ASME SDC judges to determine the finals and the 3rd place teams. These four teams will all submit their final performance videos on April 23.

- (Required for the final four teams) 1st through 4th Place Competition April 23, 2021 (midnight US EDT)
  - Each of the top 4 teams based on scores from the April 10 semi-final videos must operate their devices as detailed in above Elimination Testing Rules section.
  - All four teams will be informed of their placement at the same time on April 22 by 9 p.m. US EDT, and given instructions for identifying their device and must operate, record and upload their video by midnight April 23, 2021 (US EDT)
  - All four teams will be scored by ASME SDC judges and the results of 1st, 2nd and 3rd place will be announced at the E-Fest Digital on April 24.