MARYLAND

MESA CHALLENGE

LEVEL: Secondary

2023—2024

COMMUNITY CLEAN-UP

JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

23-03929

Community Clean-up Challenge

Level: Secondary School

Type of Contest: Team

Composition of Team: Two to four students per team (four team members is strongly encouraged)

Number of Entries: One entry per school

Next-Generation Science Standards:

- MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4, MS-LS2-5
- HS-ETS1-2, HS-ETS1-3, HS-LS2-7

United Nations Goal: Goal 6—Ensure availability and sustainable management of water and sanitation for all (https://sdgs.un.org/goals)

Overview: The Adventures of Super Clean Machine, the Trash-Gobbling Superhero!

Engineers tackle all kinds of challenges, from health concerns, to flying into space, to helping the environment. During this challenge, you are going to become engineers and design the newest environmental superhero, Super Clean Machine!

Super Clean Machine has some hard-working cousins in Maryland. Let's first meet the family of Super Clean Machine. The cousins are Mr. Trash Wheel, Professor Trash Wheel, Captain Trash Wheel, and Gwynnda, the Good Wheel of the West. They live all around the Baltimore, Maryland, area working hard to clean the water that flows into the Chesapeake Bay. As of April 2023, the Trash Wheel family has collected 2,362.23 tons of trash from Maryland's rivers and streams! Now we need one in your community! Super Clean Machine could clean water, land, or both, since we know trash on land often ends up in the water.

Super Clean Machine defends your community against trash. It has to fight off the trash villains, such as winds that toss trash into the environment and those pesky humans who use the environment as their trashcan (litter) by not putting their trash in an actual trashcan. For Super Clean Machine to help defend your community, it must be automated and generate its power from the environment, like the sun, wind, or water. It must have a movable conveyor belt to carry trash to the collection container. Super Clean Machine can collect trash from land, water, or both.

Super Clean Machine will need to collect three types of trash: plastic (one ping-pong ball), "metal" (one aluminum foil ball), and an item of your choice (you choose shape and material).

To learn about the technology behind the original Trash Wheel family, visit here. Super Clean Machine does not need to be designed the same way, but this gives you a starting point.

Helpful Links

- https://youtu.be/Zzjw-Pw5jwQ

- https://youtu.be/v5l7s6wC50g
- Waste360 *Nothing Wasted* Podcast – Meet Mr. Trash Wheel Podcast transcript from April 2020

Objective

The goal of this challenge is to create a garbage-gobbling, litter-loving, trash-collecting superhero to help clean up your community. Your trash-collecting device can be created for land or water. You are required to have an automated conveyor belt to move the collected trash to a collection bin. You are required to incorporate an alternative energy source and programming element. The original Trash Wheel family was created for water, so they have a waterwheel helping power the device. Because you have a choice of cleaning up land or water in your community, you may or may not require a waterwheel component. Perhaps your Super Clean Machine has feet to chase down the land litter.

Judging Guidelines

The competition will be scored based on the following components: design and construction, presentation/performance demonstration, and electronic poster. The Scoring Sheets at the end of this document provide details about the scoring of each component with the following points for each category (100 points total):

Design and Construction	20 points
Video-Recorded Presentation with Demonstration	60 points
Electronic Poster	20 points
Total Score	100 points

Continuing Projects

MD MESA recognizes that there is both an interest in and benefit for student teams to continue work on a project started in previous years. However, all projects must be new and original. Teams cannot continue working on a project previously submitted.

Plagiarism Policy

Academic honesty and personal integrity are essential to ensure future success as college students and STEM professionals. As such, the APL STEM Program Management Office expects that the work presented for this challenge will be solely the work of the students. If the work or ideas of another are used to further students' work, proper credit must be given to the owner. Failure to do so will be interpreted as an act of plagiarism. If it is determined that a student committed plagiarism, they will be disqualified from the competition and will be ineligible to receive any awards. They may also risk further sanctions from the APL STEM Program Management Office.

MESA USA Code of Sportsmanship

At all times during the course of the competition, MESA students, staff, advisers, and supporting family members should act in a professional and courteous manner. All judges' decisions are final.

Design and Construction (20 Points)

The overall design and construction of the functional model of Super Clean Machine will be judged on the following characteristics:

1. **Size**—The complete functional model/device must be relevant to the theme and constructed on a base no larger than 36 × 36 inches (8.36×10^3 cm^2) and be no taller than 36 inches (91.44 cm) before and during operation.

2. **Trash Collection**—Super Clean Machine must be designed to effectively collect the three "trash" items and dispose of them in a trash container, during two tests. Super Clean Machine and "trash" items may be decorated, but the "trash" must remain clearly visible throughout the demonstration until deposited into the final trash container. The "trash" must not be fastened to the device with any type of adhesive, and it cannot be fully enclosed within the device.

   Note: The "trash" must be one ping-pong ball, one aluminum foil ball (about the size of the ping-pong ball, which is 4 cm in diameter), and an item of your choice (you choose the shape and material).

3. **Automated Device**— Your device is required to have a movable conveyer belt to transport the "trash" from pick-up to the collection bin. It must be able to remain activated without continual physical contact from the team member(s). In other words, the device (once set up) should fully function after activation without a continual push or pull (i.e., force) from the team member(s), except when removing the final trash container to show collection.

   A switch, lever, trigger, programmed start button, etc., must be part of the design to initiate launch of the device, which may be activated only by brief physical contact from the team member. However, at no time should any physical action from a team member generate a force that directly contributes to the conveyor belt or device moving. The launch operation is scored during the performance demonstration.

4. **Original Materials and Cost**—Any suitable materials or tools may be used in the construction/assembly of the device. Scoring emphasis will largely be placed on the device being made primarily (more than 50%) of recycled/repurposed component materials (besides the provided starter materials from MD MESA), with the finished device costing less than 50 U.S. dollars. Materials provided by MD MESA are not included in your budget. Donated items must be assigned a retail value. It is not mandatory to use the provided materials.

   MD MESA will be providing a Circuit Playground Express, a servo, a motor, a solar panel, wires, a breadboard, a switch, basswood, popsicle sticks, a ping-pong ball (plastic trash), and aluminum foil for a ball (metal trash).

5. **Alternative Energy and Programming Element**—Your device must be powered by an alternative energy source. The energy source can be a direct power supply or used to recharge a battery source. A coding element is also required for your project. You can choose how to incorporate your coding element. At a minimum, at least one of your movable parts should be programmed. You will be provided a solar panel, Circuit Playground Express, and adapters. You are not required to use these materials, but you are required to have the required elements.

6. **Creativity**—We encourage creativity! Feel free to add your own creative ideas, as long as they don't interfere with the running of the device. Perhaps your Super Clean Machine wears a cap or has a special flag. Feel free to look at what makes each Trash Wheel unique to help you generate ideas of your own https://www.mrtrashwheel.com/meet-the-trash-wheels/.

7. **Testing**—The judges will need to see your device in action. Your team will need to show the "trash" being collected from the environment you choose, either land or water. If your device works on both land and water, please show it collecting the "trash" in both environments.

> **Note:** Water movement or wind may be needed to help collect your trash, if the device does not move itself. Using a fan or blow-dryer to create "wind" is acceptable. This is for demonstration purposes and does not count in your budget.

Electronic Poster Requirements (20 Points)

Each team must create an electronic display board. Microsoft PowerPoint is recommended. The size of the electronic poster must be 24 × 36 inches (width × height). All information should be contained on **one single slide**. The electronic poster must contain the following information:

1. **School Name and School District**

2. **MESA School Coordinator(s) and Adviser(s) Names**

3. **Team Members and Their Roles**—The display board introduces all team members and their contributions to the project. Only two to four team members can be included.

4. **Graphic Display**—A well-labeled graphic of how the device functions

5. **Description of How Super Clean Machine Is Helping Your Community**—A brief description of the area that Super Clean Machine is cleaning:

    - Does it clean water, land, or both?
    - Reasoning for selecting this particular area in your community to be cleaned
    - Impact on Maryland's environment (e.g., Professor Trash Wheel is stopping the flow of trash into the Chesapeake Bay, so the Professor is not only cleaning up the Baltimore harbor but also protecting the Bay)

6. **Engineering Design Process**—The team should describe the process they used to design and engineer the device, including the following:

- How the design was tested and selected (including sketches of the original design)
- Improvements or changes that were made to the design and why
- A complete (but brief) description of some of the problems the team encountered in designing the device and how they resolved those problems

7. **Bibliography**—List at least six sources used to solve and design a solution to the challenge problem. Include books and websites. Reference citations must be formatted according to the American Psychological Association (APA) style for reference citations.[1]
8. **Materials**—List all the component materials of the device (except provided materials). Indicate the cost of each item. Estimate the retail value of donated materials. At the bottom of this list, provide a total cost of all component materials used in the device, which must be less than 50 U.S. dollars. See the Example Budget Sheet.
9. **MESA Logo**—Include the APL MD MESA logo, no smaller than 3 × 3 inches.

Example Budget Sheet

The following is an example of an itemized sheet listing each component and its cost:

Item	Quantity	Cost ($)
Popsicle Sticks	200	4.00
Marbles	2	2.00
Motor	1	5.00
	TOTAL:	**11.00**

Note: Donations must be assigned a value and included in the budget sheet calculation. Receipts and/or descriptive purchase documentation must be provided (if requested by head judge) for all items.

Electronic Poster Submission Instructions

1. Complete an electronic poster. We recommend using PowerPoint.
2. Save the poster as a PDF file, using the following format for the file name: **School name_cleanup_Poster**.
3. Submit the file via the MESA website **no later than 11:59 p.m. on the specified due date**.

Presentation with Demonstration (35 Points)

Each team will create a video-recorded presentation that describes their Super Clean Machine. The presentation can be no longer than 5 minutes 0 seconds. All student members should actively participate in the presentation. Each team is required to provide a video-recorded presentation that includes the following:

[1] Available at: https://apastyle.apa.org/style-grammar-guidelines/references.

1. **Introduction**—Introduce your team members, teachers/coaches, and advisers.
2. **Description**—Clearly show that the design meets all of the design and construction requirements.
3. **Demonstration**—Demonstrate the operation of each component of the device and show that the Super Clean Machine can effectively carry "trash" from the areas around the device to a trash container for two test runs (see "Demonstration" for details).
4. **Explanation**—Each team member is required to explain the role they played in the creation of the device.
5. **Questions**—The team must provide responses to the following questions that focus on the design process and the role team members played in the creation of "The Adventures of Super Clean Machine." All team members must participate. Responses to these questions will be factored into scoring for all categories. The specific questions team members must address are:
    - Why was the particular area selected to be cleaned up by Super Clean Machine, and how will its impact help the community and the Maryland environment?
    - Why did your team select the design for the device's automated movement?
    - What scientific research was required to construct a fully automated device?
    - Which materials were recycled/repurposed, and how did you select them?
    - How was the design tested, and what improvements were made (Engineering Design Process)?
    - What steps were taken to ensure the efficient collection of the "trash" items?
6. **Conclusion**—Summarize what your team learned and thank the judges for taking the time to review your video-recorded presentation.

Demonstration (25 Points)

The following are the judging requirements for the performance demonstration.

"Three Count" and Launch—Once the device is set up, the student should give a "three count," during which time the device must not be activated and the team members must not be in contact with the device. Once the "three count" is completed, the switch may be activated to initiate the device by brief physical contact from the team member. This should be the start of both collections.

No Physical Contact—At no time should any physical action from a team member generate a force that directly contributes to the automated device.

Trash Collection—Super Clean Machine must be designed to effectively carry the following items, also referred to as "trash," from the areas around the device to a trash container. It must do so for two test collection runs:

- One ping-pong ball

- One aluminum foil ball (about 4 cm in diameter)
- One item of choice

MD MESA will provide teams with the ping-pong ball and the aluminum foil for the aluminum foil ball. **Teams provide their item of choice.** Inclusion of all three "trash" items is scored in the design and construction rubric. You can pause your recording to reset your device between the two collection demonstrations.

The following are the requirements for scoring during the performance demonstration:

1. **Set Up Next to the Device**—The "trash" must remain next to the model before its demonstration and only be placed into the path of the device while in the camera view before testing begins.
2. **Trash Visibility and Effectiveness**—Super Clean Machine and the "trash" may be decorated, but they must remain clearly visible throughout the process of the device's activation, and the "trash" must properly end up in the trash collection container.
3. **No Fasteners**—The "trash" items may be secured during testing, but they may not be fastened to the model with any type of adhesive or fully enclosed within the device during the performance demonstration.

Video-Recorded Presentation and Demonstration Submission Instructions

1. Upload the video to YouTube as an unlisted video.
2. Create a document containing the school name, team member names, MESA School Coordinator name(s), and a link to the video on YouTube. Please only list two to four members per team.
3. Save the document as a PDF file, using the following format for the file name: **School name_Cleanup_Demo**.
4. Submit the file via the MESA website **no later than 11:59 p.m. on the specified due date**.

Note about Videos:

Remember to watch the video and make sure all of the required elements are included and easily seen or heard. For example, viewers can't read a ruler, so say the length as you show the measurement.

If the judges can't clearly observe something that is scored, you will not get points for that item.

Bonus Points (15 Points)

To distinguish themselves, teams can earn additional points for completing one or more of the following bonus design challenges. Each completed bonus challenge is worth an additional 5 points:

- Super Clean Machine is activated via a wireless remote.

- Super Clean Machine is able to function on water AND land.
- Super Clean Machine is mobile (for example, it can move to different locations to pick up trash, instead of the trash coming to it).

Tiebreakers

Ties will be broken via the use of the highest score on the following:

1. Performance Demonstration
2. Electronic Poster
3. Design and Construction

ALL DECISIONS MADE BY JUDGES ARE FINAL.

Extension Activity—The Fastest Trash-Eating Machine!

For clubs with more than one Community Clean-up team, have a trash-gobbling competition! Which Super Clean Machine can eat the most trash in one minute? Perhaps the winner is the one who represents your club at regionals.

Feel free to create your own rules, time frame, etc.

Field-Trip Opportunity—Community Clean-up

- Participate as a club or invite the whole school to a school yard or Community Clean-up day.
- Contact Blue Water of Baltimore to help organize a clean-up field trip and possibly even visit one of the Trash Wheels! https://bluewaterbaltimore.org/

Note about the 2023–2024 Competition:

Projects submitted to each Regional Competition will be scored ahead of time, and winners will be announced during the in-person showcase and awards ceremony. All files must be submitted no later than 11:59 p.m. on the due date specified by the MESA Regional Coordinator.

The teams that win the Regional Competition will advance to the 2024 Statewide MESA Competition. The Statewide MESA Competition will also be judged in advance, and an in-person MESA Day showcase and awards ceremony will take place in May on the campus of the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland.

Scoring Sheet
Community Clean-up Challenge (Elementary)

School Name: _____ **Judge:** _____

Performance Area	Level of Mastery (Select One)					
Community Clean-up Challenge	**Not Present (0 pts)**	**Poor (1 pt)**	**Fair (2 pts)**	**Met Criteria (3 pts)**	**Excellent (4 pts)**	
Video-Recorded Presentation with Demonstration – TIEBREAKER 1						
Oral Presentation						
Introduction—Team members introduce themselves and their role in the project.	(0)	(1)	(2)	(3)	(4)	____/4
Description—The presentation offers a highly insightful view into how the device design was tested and selected (including sketches, if applicable).	(0)	(1)	(2)	(3)	(4)	____/4
Academic Rigor—The team presents a complete (but brief) description of some of the problems they encountered in assembling and/or designing the device and how those problems were resolved.	(0)	(1)	(2)	(3)	(4)	____/4
Engineering Design Process—The presentation allows judges to readily assess that the students were highly involved in the engineering and design process with evidence of working through the process.	(0)	(1)	(2)	(3)	(4)	____/4
Questions—The students are able to thoroughly answer the questions, showing a clear understanding of their project and environmental impact.	(0)	(1)	(2)	(3)	(4)	____/4
Programming—The presentation clearly shows how the students were able to use a programming element to run the Super Clean Machine.	(0)	(1)	(2)	(3)	(4)	____/4

Performance Area	Level of Mastery (Select One)					
Community Clean-up Challenge	**Not Present (0 pts)**	**Poor (1 pt)**	**Fair (2 pts)**	**Met Criteria (3 pts)**	**Excellent (4 pts)**	
Alternative Energy Source—The presentation demonstrates a clear use of an alternative energy source to power the device directly or by recharging a battery source.	(0)	(1)	(2)	(3)	(4)	____/4
Conclusion—The presentation summarizes what the team learned while completing this project.	(0)	(1)	(2)	(3)	(4)	____/4
Creativity and Imagination—The presentation demonstrates that the design is highly imaginative and takes creative risk without losing functionality.	(0)	(1)	(2)	(3)	(4)	____/4
Professionalism—Clear speech (avoids "Umm," "Like," "You know," etc.), good eye contact, professional posture, good pacing.	(0)	(1)	(2)	(3)	(4)	____/4
Performance Demonstration						
"Three Count" —Placing the "trash" in front of the device, the team member gives a "three count" on both runs/trials without fail before activation of the device.	(0)		(4)			____/4
No Physical Contact—When the run is initiated, the team member launching the device demonstrates that they do not maintain constant direct physical contact with the device while launching it and that the device can remain fully functional after activation.	(0)		(4)			____/4
"Trash" Requirement 1—The "trash" remains next to the model before its demonstration and is only placed into the path of the device while in the camera view before testing begins.	(0)		(4)			____/4
"Trash" Requirement 2—The "trash" was picked up and efficiently transported from land/water to the collection container during both runs/trials without falling off the conveyor belt.	(0)		(4)			____/4
"Trash" Requirement 3—The "trash" items landed in the final trash collection container.	(0)		(4)			____/4

Performance Area	Level of Mastery (Select One)					
Community Clean-up Challenge	**Not Present (0 pts)**	**Poor (1 pt)**	**Fair (2 pts)**	**Met Criteria (3 pts)**	**Excellent (4 pts)**	
Penalties?						
Time – 10-point deduction if the presentation exceeds the allotted 5 minutes 0 seconds						Points deducted: _____
						Video-Recorded Presentation with Demonstration Section Total: _____/60
Electronic Poster– TIEBREAKER 2						
Sources—The display board includes at least six cited sources used to assist the team in solving the stated problem (formatted using APA style for reference citations).	(0)	(1)	(2)	(3)	(4)	**_____/4**
Team Member Contributions—The team members are introduced, and the role of each is shown on the display board.	(0)	(1)	(2)	(3)	(4)	**_____/4**
Engineering Design Process (EDP) —The team describes how they worked through the EDP and shows sketches/visuals of different iterations of their design.	(0)	(1)	(2)	(3)	(4)	**_____/4**
Content—The poster offers a highly insightful view into how the Super Clean Machine's design was tested and selected (including sketches, if applicable), to have the largest environmental impact in their community.	(0)	(1)	(2)	(3)	(4)	**_____/4**
Poster—The virtual poster contains all required information and is of high quality. The poster is the required size of 24 × 36 inches.	(0)	(1)	(2)	(3)	(4)	**_____/4**
						Electronic Display Board Section Total: _____/20

Performance Area	Level of Mastery (Select One)					
Community Clean-up Challenge	**Not Present (0 pts)**	**Poor (1 pt)**	**Fair (2 pts)**	**Met Criteria (3 pts)**	**Excellent (4 pts)**	
Design and Construction – TIEBREAKER 3						
Size—The device is no larger than 36 × 36 inches and is not taller than 36 inches before and during operation.	(0)		(4)			____/4
Trash—The device is designed to effectively and efficiently transport all three "trash" items to the trash collections container, during two consecutive tests. The trash items remain clearly visible throughout the course of the model's activation, and they were picked out of the water/off the land and transported to the collection container.	(0)		(4)			____/4
Original Materials and Cost—The device was made using primarily (50% or more) recycled/repurposed materials besides the provided materials from MD MESA and cost no more than $50.	(0)		(4)			____/4
Propulsion and Launch Device—Device propulsion design is elegant, and activation does not require direct, continual physical force from an operator. If a switch is designed to initiate launch of the device, it is activated by brief physical contact from the team member but never requires physical action from a team member to generate a force that directly contributes to the device working.	(0)	(1)	(2)	(3)	(4)	____/4
Creativity and Imagination—The device design is imaginative and creative without losing functionality.	(0)	(1)	(2)	(3)	(4)	____/4
					Design and Construction Section Total:	____/20
Bonus Points – Add 5 points for each of the following bonus tasks completed						
Wireless Remote—Super Clean Machine is activated via a wireless remote.	(0)		(5)			____/5
Land and Water—Super Clean Machine is able to function on water AND land.	(0)		(5)			____/5
Mobility—Super Clean Machine can move to trash (is not stationary).	(0)		(5)			____/5

Performance Area	Level of Mastery (Select One)					
Community Clean-up Challenge	Not Present (0 pts)	Poor (1 pt)	Fair (2 pts)	Met Criteria (3 pts)	Excellent (4 pts)	
						Bonus Points Section Total: _____/20
						OVERALL THE ADVENTURES OF SUPER CLEAN MACHINE TOTAL SCORE (×/100 points): _____/100