2023 ASEE MODEL DESIGN COMPETITION
Sponsored by the Two Year College Division of ASEE

Dear Colleague,

On behalf of the American Society for Engineering Education (ASEE) - Two Year College Division (TYCD), we invite you to encourage the submission of student design projects for the 26th Annual ASEE Lower Division MODEL DESIGN COMPETITION. This event will be held in conjunction with the 2023 ASEE Annual Convention in Baltimore, MD during June 25-28, 2023. This competition is open to 1st and 2nd year students at two-year and four-year colleges and universities.

Each student team will design and build an autonomous robot that will defend a model of Fort McHenry from the attack of British War ships and landing parties. The name of this year's contest is "The Star Spangled Defender" and it commemorates the Battle of Baltimore in the war of 1812. Each team's entry should repel the war ships by shooting Nerf Rival Balls into "ship" containers and knocking over landing boat cutouts all while remaining inside the fort. Raising the American flag also scores points. The robot must adhere to the rules of the model design competition which includes an exhibition session.

The main reason for this competition is for students to gain a better understanding of the design process from start to finish. Designing and building something from an idea is probably why they chose engineering in the first place. Use this design competition as a platform to reinforce their ideas and have some *engineering fun!* We hope to see you and your students' entries in June.

Please find enclosed the guidelines and registration forms for this event. The interest and registration forms are on the back of this letter.

Sincerely,

Kenny Grimes
Phone: 757-822-7278
Email: kgrimes@tcc.edu

Geoff Berl
Phone: 585-502-8484
Email: gberl001@monroecc.edu

Clint Kohl
Phone: 937-766-7672
Email: kohlc@cedarville.edu

Results from the previous

25th Annual ASEE Model Design Competition

June 28, 2022 - Minneapolis, MN

The recent competition in Minneapolis required teams to design and build an autonomous robot that would catch full sized yellow fish and deliver them to the fish bin, while leaving undersized red fish in 3 round lakes.

The results were as follows:

- 1st Place: ***Peter & Andrew – Cedarville University (Cedarville, OH)***
- 2nd Place: ***Anchor Management – The Apprentice School (Newport News, VA)***
- 3rd Place: ***Merciless Tillie – Tidewater Community College (Norfolk, VA)***

Group photo from Minneapolis, June 2022

Event Name: The Star-Spangled Defender

Objective:

To design and build an autonomous robot that can successfully shoot 3 Nerf Rival Balls into 5 containers representing 5 British War Ships and knocking over 4 shore assault boats. Raising an American flag also earns points. The robot can hold at most 25 Rival balls and must always remain inside the pentagon shaped Fort McHenry with 13.5" exterior side walls and should not exceed 10" in height (except for the flag). The robot must utilize one shooting mechanism and shoot one ball at a time. The robots will have a maximum time of 90 seconds in each of their four allotted trials. An exhibit session will precede the robot trials.

Field Specifications:

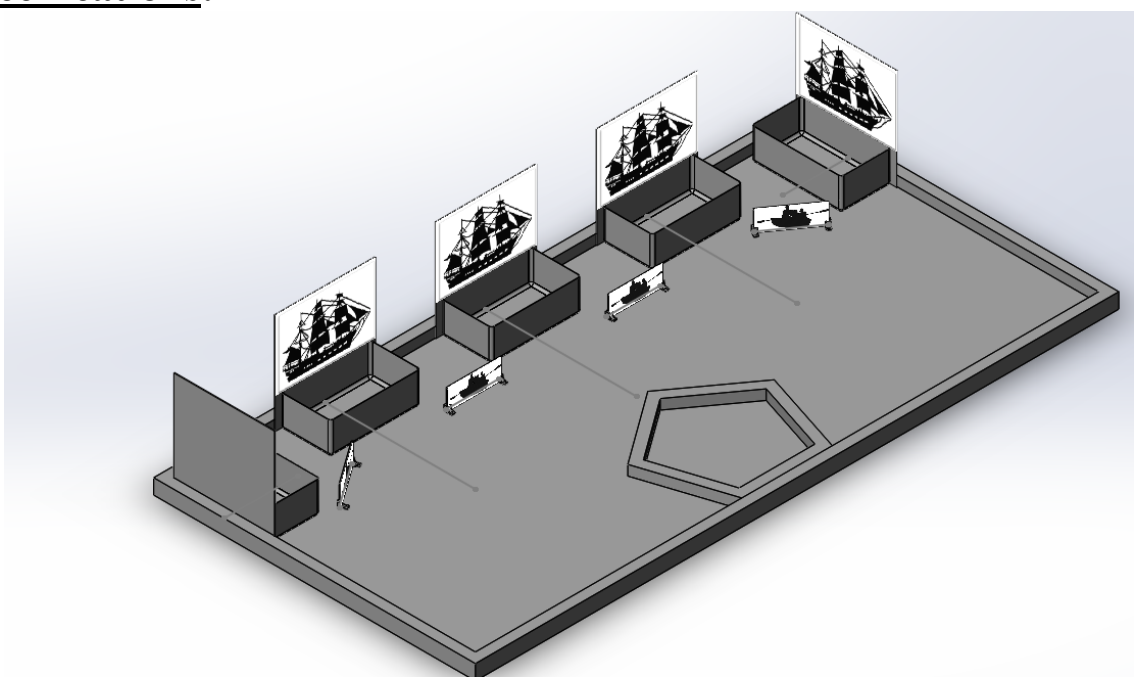


Figure 1: Isometric View of the Field

1. **The field contains 5 six quart Sterilite Clear Plastic tubs with a 15”x15” boat silhouette etched onto an acrylic backstop that is 1/8” thick.**

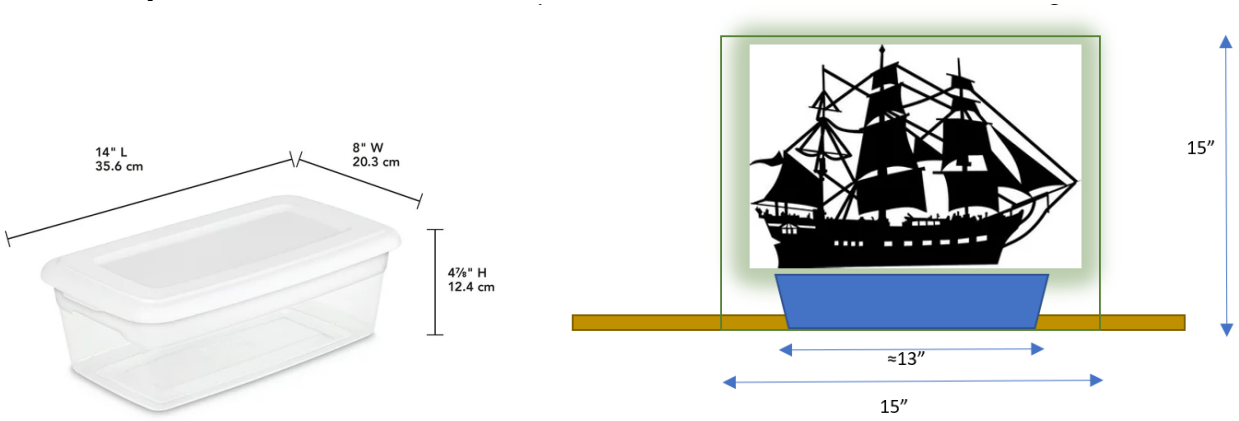


Figure 2**:** Sterilite 16428012 6 Quart with 15” by 15” Silhouette back stop

The field also contains 4 assault boat silhouettes etched onto acrylic rectangles 8” by 3” with 3D printed feet. Silhouettes are laser cut from Clear pink 1/8” Acrylic sheet fastened to two braces (one on each end). These row boats are free standing, with 3D printed braces facing toward Ft. McHenry, thus having minimal resistance to falling over backward when struck by a projectile launched from the fort.

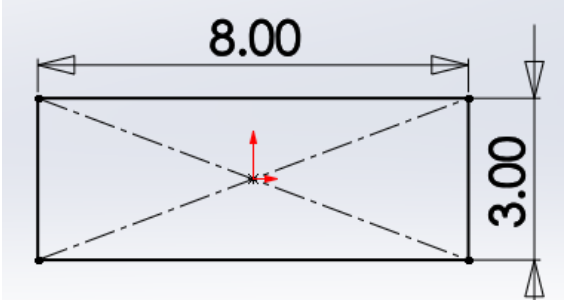


Figure 3. Assault boats

3. The field contains a Model Fort McHenry. Made as a pentagon from 1.5” by 1.5” lumber.

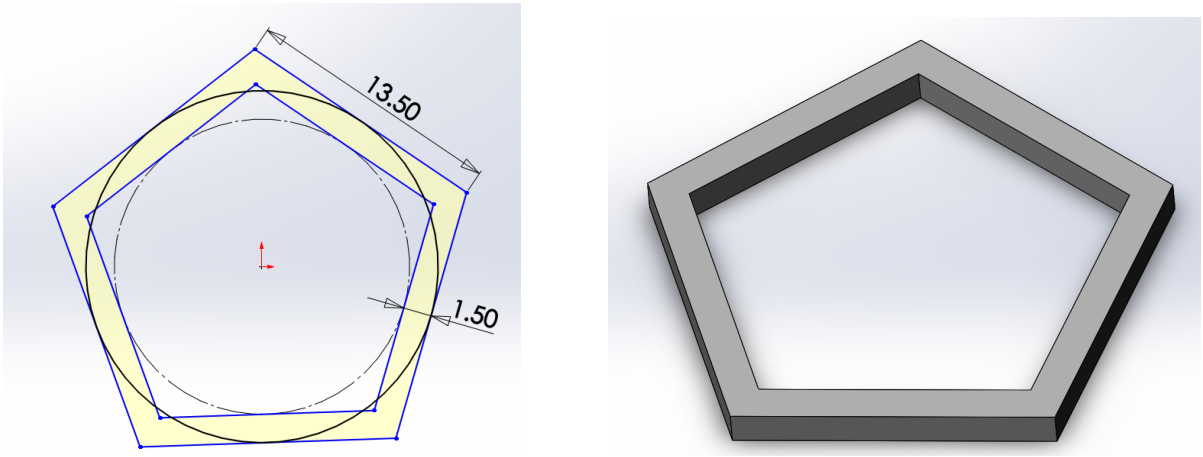


Figure 4. Model Fort McHenry

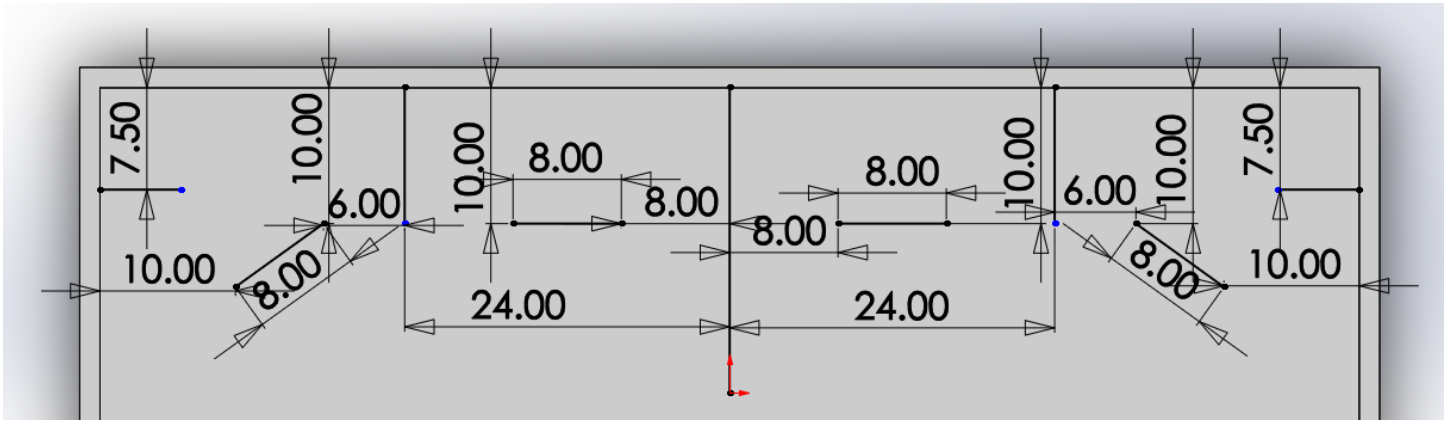


Figure 5. Key Field Dimensions

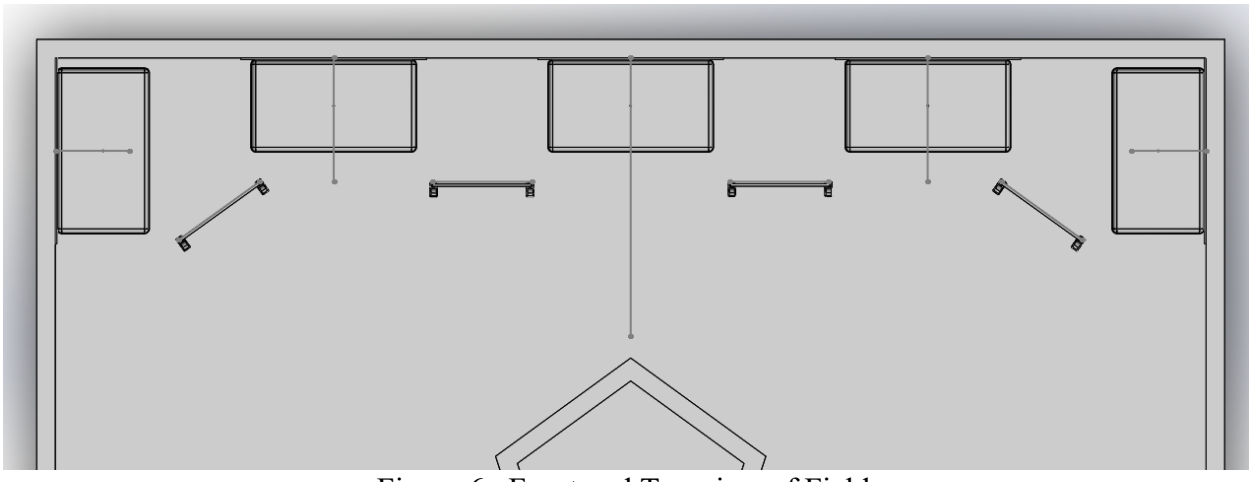
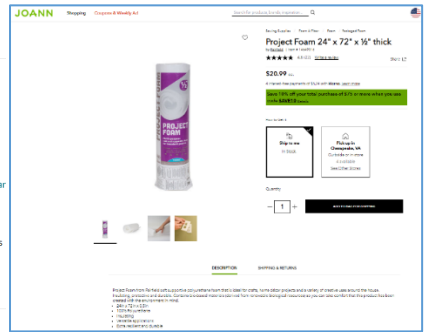


Figure 6. Front and Top view of Field

Required Materials:

1. **One** 4’ X 8’ X ¾ ” plywood (grade BC or better)
2. **Four** 2” x 2” x 96” boards (actual size 1.5” x 1.5” x 96”) to be cut into the following lengths:
   - 96” (2 boards for the sides of the track)
   - 45” (2 boards for the ends of the track)
   - 5 boards to make Fort McHenry. Each one is 13.5” long (outside). Set Miter-Saw to 36 degrees.
3. HMS Ship silhouette background made from fluorescent green 1/8” acrylic sheets with dimensions 15” by 15”. Total of 5 needed.
4. Assault craft silhouette background made from pink 1/8” acrylic sheets. 8” by 3”. Total of 4 needed.
5. **One** Box of 2” Wood Screws (or deck screws) for attaching 2x2 barriers and Fort McHenry.
6. **One** Box of ½” wood screws to attach backgrounds to edge boards
7. **Five** Sterilite 16428012 6 Quart/5.7 Liter Storage Box
8. **Cannon Balls –** 25 Yellow/Red Nerf Rival foam balls. These may not be altered.
9. **Old Glory** One handheld size U.S.A. flag 4” by 6”
10. **Project Foam -** ½” thick, serves as bin lining to help prevent bounce-outs.



https://www.amazon.com/Nerf-Rival-50-Round-Refill-Yellow-red/dp/B074MXCRXV/ref=sr_1_4?crid=2P8RHO53NYFS1&keywords=nerf+color+refill+rival&qid=1669665693&sprefix=nerf+color+refill+rival%2Caps%2C59&sr=8-4

https://www.joann.com/project-foam-24in-x-72in-x-%C2%BDin-thick/14649016.html

https://www.amazon.com/GiftExpress-Proudly-Small-American-Flags/dp/B01GKHNYPO/ref=sr_1_2?crid=3HM3VBG97KM33&keywords=giftexpress+set+of+12%2C+proudly+made+in+u.s.a&qid=1669665852&sprefix=giftexpress+set+o%2Caps%2C85&sr=8-2

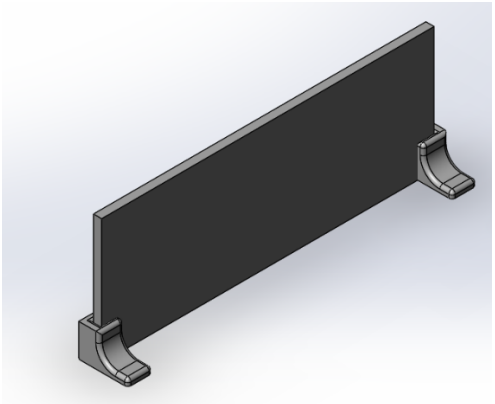
Construction Procedures:

1. First cut the side edge boards that ring the outside edge of the field. These boards should be roughly 1.5” x 1.5” and are generally made by cutting 2x4 lumber in half.
2. Affix these boards to the outside edge of the 4’ by 8’ plywood bottom sheet.
3. Now mark off the lines shown in Figure 4 above lightly with pencil.
4. Since the tubs are rounded and the sides are beveled it is difficult to place them based on their edges. Therefore, all tub and Silhouette backgrounds will be placed in their centers.
5. The Silhouette backgrounds are 15” by 15” by 1/8” thick. They align to the long side of the ship tub and should be screwed onto the 1.5” edge boards on the inside of the field border. The middle ship tub is placed in the exact center of the field with one on either side centered at 24”.
6. The two end boats (located in the field corners) have their 15” by 15” Silhouette backgrounds aligned with the long side of the tub, and touching the back corner.
7. Find the center of the bottom of the tub. Most tubs have a center mark due to the fabrication process.

8. All tubs should be centered on their backgrounds and just touching the backgrounds. Affix the tub to the field by one screw in the center of the bottom of the tub which will be on each center line.
9. Cut 1 layer of ½" project foam to over-sized 6.5" x 11" dimensions so that it forms a slight arch on the bottom of each tub. Place this liner at the bottom of each ship tub.
10. The two middle assault boats are 10" from the back wall and centered between the middle tall ships.
11. The two side assault boats have one corner 10" from the back wall and 28" from the centerline and the other corner 10" from the side wall.

NOTE: Below are close up views of field construction details:

HMS ship silhouette is fastened to field wall with screws.



The assault craft (with 3D printed feet, file to be provided) Designed to fall over easily in 1 direction.

Over-sized 6.5" width of tub foam liner creates a soft arch in bottom of the tub.

Robot Specifications:

The Robot

- The robot is autonomous. It must aim, launch, and reload without a human operator.
- The robot must remain inside the fort walls.
- The robot size can be as large as the fort interior volume, up to a height of 10 inches.
- The robot may change size and shape during the trial, but all features must remain within the planes defined by the fort wall space and below the maximum 10” height constraint.
- If the robot exceeds allowable dimensions, but does not exceed it by more than 1/4" a penalty will be applied to each run.
- Any robot exceeding dimensions beyond 1/4" will receive a zero score for each trial it arrives out of dimensional specifications.
- The robot can be stationary or move within the fort interior.
- The robot can touch the fort walls but cannot damage the wall.
- The robot can pre-load up to 25 balls. These cannon balls can be temporarily misshapen, but they cannot be altered in weight, or internal composition, or external surface quality, or any other physical manner.
- The robot can have only 1 ball launch firing mechanism. Multiple launch systems are not permitted.
- The robot can launch only 1 ball at a time. Each ball shot must be a result of a unique triggering sequence of the launch system. Multiple balls cannot be loaded and delivered to a bin as a group. Each team must be able to demonstrate that a pause of indefinite length could occur between every shot (if a pause is desired). The single-shot triggering mechanism must be used in competition and not just as a demonstration to the judges.
- If it is determined that a team has shot multiple balls with one triggering mechanism, only the first ball will count (9 points). The second and third balls will be considered disqualified.

Allowable Energy Sources:

Any energy source is allowed as long as it is completely contained within the robot and does not create or emit any gaseous, liquid, or solid emissions. Energy sources must not present any safety hazards to participants or spectators.

Maximum Robot Size:

The robot must fit inside of the Fort McHenry Pentagon and have a maximum height of 10”. The robot may never exceed the 10” height limit (except for US Flag) or nor break the planes defined by the interior walls of the Pentagon fort at any time during a trial.

If a robot exceeds the size constraints the judges will assess a one-time penalty that will be deducted from their exhibit session score. The amount of this penalty will be commensurate with the degree of the oversize and the advantage this infraction would permit. Past penalties for ¼” oversize were 20pts. Entries with dimensions greater than 1” beyond those allowed will be disqualified and not able to compete in the robot time trials.

Components, Fabrication, and Cost:

Team members using materials which are commonly available to the general public must perform all fabrication. Use of commercially available vehicles, robots, or entire kits such as RC cars, Legos, K-nex, Fischer-Technics, Parallax or erector sets may not be used. The use of **Lego Mindstorm microcontroller bricks are prohibited.** Individual components from these cars, robots, or kits (except the Mindstorm Brick) may be integrated into a team’s robot as long as the majority of the robot’s components are not from the same car, robot, or kit source. The cost of purchasing all components must not exceed **$500.**

Robot Time Trial Rules:

1) It is the responsibility of the team to inspect the condition of the track and the placement of the bins and assault boats before starting their robot to be certain that everything is in order. Once a team presses or pulls the start mechanism, the run counts as an official trial and may not be done over.
2) The order of testing will be determined by random draw and the same order will be used for all 4 time trials.
3) Each team will have one minute to begin a trial after being called.
4) All teams will be called for a trial in a current round before any teams begin the next round of testing.
5) Robot sizes will be tested at the beginning of the first run and if deemed necessary by the judges on any subsequent round. If a robot fails to meet the size constraints the judges will assess a penalty proportional to the severity of the violation (See Robot Specifications).
6) The robot may not extend beyond the inside edge of the Fort McHenry pentagon or above the 10" height limit at any time (except for the flag). The robot must have only 1 firing mechanism and may only fire one rival ball at a time. Grapeshot is not permitted where multiple balls are fired at one time.
7) The time for a trial will begin when the judge gives the team the command to start. Once this start command is given, a team may only activate a single switch or mechanism to start the robot.
8) If a robot fails to move once the judge's start command is given, the team members may work on their robot to get it moving but the time will continue to run from the time when the start command was given. If the robot has not moved within 90 seconds of the start command, a score of zero will be assigned for that trial.
9) A trial will end when any of the following actions occur:
    a. The robot becomes disabled or shows no evidence of being able to continue.
    b. The robot has successfully delivered 3 rival balls to each of the 5 tall ship bins and has knocked over all 4 assault boats and raised the U.S.A. flag.
    c. The team chooses to end their run.
    d. 90 seconds elapses from the start command.
10) Teams may make changes or repairs to their robots between trials but they must be ready within one minute of being called to the track, or have that trial score be declared zero.
11) Teams may not make practice runs during the Exhibit Session or after the start of the Robot Time Trials.

Robot Time Trial Scoring:

Each trial will consist of 90 seconds to accomplish as much of the following as possible, with a (pre-loaded) 25 nerf rival ball supply:

TALL SHIPS

First projectile to remain in a tall-ship tub = **9 points**
Second projectile to remain in a tall-ship tub = **5 points**
Third projectile to remain in a tall-ship tub = **2 points**
(3 shots is a successful 'repel' of the tall ship)
Fourth projectile to remain in a tall ship tub = **0 points**
(Sub total of 16 pts per tall ship, 80 pts if all 5 tall ships are 'repelled'.)

SHORE ASSAULT LANDING CRAFT

Knock down a shore assault landing craft (row boat) with a nerf Rival ball = **5 points**
(Possible 4 row boat total: 5pts x 4 boats = 20pts)

RAISING OF OLD GLORY (flag)

A 4" by 6" American flag should be displayed in the fort by the end of each trail. The top of the flag pole must begin the trial below 5 inches from the floor of the track, and be raised to a height of at least 10 inches from the floor of the track by the end of the trial to earn an additional **20 points**. The flag can extend beyond the 10" of height and may pass over the edge of the Fort McHenry pentagon without penalty. In other words, the flag and its lifting mechanism does not need to remain within the previously defined size limits.
NOTE: the flag cannot be a projectile that becomes unattached from the robot.

TIME BONUS:

A perfect score is worth at least 120 pts;

80 pts for tall ships repelled
20 pts for row boats knocked down.
20 pts for flag raised to 10 -inch height.
= 120 points

A complete victory over the British (3 balls in each tall-ship tub) + 4 row boats knocked down + Flag raised in less than the time limit will earn an additional bonus of excess trial time not used:

(90 seconds – trial time to complete) = bonus points.

Exhibit Session Scoring:

A maximum score of 120 points may be earned in the Exhibit Session. Scoring details are described below.

Overall Scoring:

The overall score for a team will be equal to the sum of the scores for the Exhibition Session and the four Robot Time Trials. A team will be disqualified from the competition if they fail to participate in the entire Exhibition Session.

Overall Score = Sum of the Points from all four Robot Time Trials + Exhibition Session Point Total

Exhibit Session:

Prior to the Robot Time Trials, each team must participate in an exhibit session where they will create a booth to promote their project to judges, other students, and conference attendees. Each team will be supplied with a 6' long table, a board behind the table suitable for mounting poster boards, and electrical power. The entire session is scheduled to last approximately 2 hours. The exact date and time will be specified later, but generally takes place on the morning before the robot time trials.

All participants must be present during the entire exhibit session. Teams may use posters, written documents, physical prototypes, multimedia displays, and other visual aids at their booths. In addition, each team's robot must remain on display at their booth for the entire duration of the exhibit session. **Team members may neither work on, nor test their robots during this session.** The number of entries from a given school will be limited by the available space during the exhibit session.

Students from each team are required to visit the exhibits from all other schools. A captain from each school will score each team from other schools on a scale from 0-20 (20 being best) based upon the criteria that the judges will use. Each school will designate a single captain even if that school has multiple teams. The captains' score will be computed by deleting the highest and lowest scores from the captains and then computing the average of the remaining scores.

The judges will visit each booth for approximately 10 minutes depending on the number of teams competing. During this visit, team members will guide the judges through their display for the first five minutes. In the second 5 minute period, the judges will ask the team questions. Each judge will score teams on a scale of 0 to 20 (20 being best) on the items #1-5 below. The score in each category will be computed by deleting the highest and lowest scores from the judges, and then computing the average of the remaining scores.

1. Design Development:
   Guide the judges through the design process that your team followed from the initial ideas to the final solution. Describe your rationale for making design decisions.

2. Robot Operation:
   Discuss how your robot works.

3. Fabrication Methods:
   Explain how you fabricated your robot.

4. Design Analysis:
   Convince the judges that your design is optimal based upon its performance, cost, and environmental impact.

5. Exhibit Quality:
   Your exhibit quality will be judged on the following items: team and exhibit appearance, technical expertise displayed, communication skills, and effectiveness of visual aids.

6. Captain Scoring:
   The score from the captains will be added to the judges' scores from the five categories above.

Schedule of Events on the day of the competition:

The exact schedule may vary as the competition is subject to the scheduling needs of ASEE. A typical schedule might be as follows (but look for emails from the competition organizers for any possible time changes):

6:45 am: Report to the Exhibition Hall

- Set up your team's table
- Draw for the order of the presentations and time trials

7:00 – 9:00 am: Exhibit Session

- Judges will visit each table in the order determined by the drawing
- Team captains will visit the table of all other teams
- The track is closed during the Exhibit Session. Teams may not work on robots or test robots at this time.

9:30 am – 11:45 pm: Robot Time Trials

- Trial 1: Each team will compete in the order determined by the drawing.
- Trial 2: Each team will compete in the order determined by the drawing.
- Trial 3: Each team will compete in the order determined by the drawing.
- Trial 4: Each team will compete in the order determined by the drawing.

12:00 pm (or when the time trials end): Awards and Team Photos

Rule Interpretation Questions:

Prior to the date of the competition direct your rule inquiries to either of the following:

Kenny Grimes	Geoff Berl	Clint Kohl
Tidewater Community College	Monroe Community College	Cedarville University
1700 College Crescent	1000 E. Henrietta Road	251 N. Main St.
Virginia Beach, VA 23453	Rochester, NY 14623	Cedarville, OH 45314
Email: kgrimes@tcc.edu	Email: gberl001@monroecc.edu	Email: kohlc@cedarville.edu

On the date of the competition:

The judges will interpret the intent of the rules and make all decisions. If the judges determine that a team is in violation of the intent of any rule or specification, they will deduct points in proportion to the severity of the violation. All decisions by the judges are final and may not be appealed. Teams have shown respect for the judges, participants, and spectators in the past, and this positive attitude is expected from each participant this year.

Competition Registration Questions:

Questions related to registering for the competition should be directed to:

Bill Simmons
Tidewater Community College
1700 College Crescent
Virginia Beach, VA 23453
wsimmons@tcc.edu

Please find the entry forms on the following pages. The Interest Form should be received no later than ***May 1, 2023***. A Registration Form for each model design team must be received no later than ***June 15, 2023***.

PROJECT TEAM / ENTRY LIMITATIONS:

Each team must have at least one faculty advisor and at least 2 student members but no more than 10 student members. Each team member must primarily be enrolled in freshman or sophomore level classes. The number of entries from each school will be limited by the space available in the Exhibit Session. If a school has more than one entry then each team must represent a unique solution to the design problem. Multiple copies of the same solution are prohibited.

ASEE ANNUAL CONVENTION PASSES:

It is not required that student team members or faculty advisors be registered for the ASEE Annual Convention. Passes will be provided for all team members and advisors so that they can enter the conference area and exhibition area on the day of the competition. Details for obtaining passes will be made available a couple of weeks prior to the competition.

PRACTICE SESSION:

We hope to have at least one track ready for teams to practice on by the day before the competition. More details will be conveyed via email in the weeks before the competition. Teams should be considerate and only use the tracks for brief periods if other teams are waiting to use the tracks.

On the day of the competition the tracks will be available in the Exhibition Hall for teams to practice on prior to and following the Exhibit Session. No practice runs may be made during the Exhibit Session or after the Robot Time Trials have begun.

AWARDS:

First, second, and third-place teams will receive plaques.

2023 ASEE Model Design Competition Registration Form

Name of college/university: _____

Team Name: _____

Name of faculty advisor(s): _____

Mailing Address: _____

Phone: _____

Email (print clearly): _____

Student team captain: _____

Other student team members:

1. _____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

7. _____ 8. _____ 9. _____

Which students/advisors need badges for the convention center? (Badges are needed if you are not registered for the convention).
Circle one: **All need badges** **None need badges** **Only those listed below need badges**

Will your team require electrical power at your Exhibition Table? Circle one: **YES** **NO**

Please submit this form to:

Bill Simmons
Tidewater Community College
1700 College Crescent
Virginia Beach, VA 23453
wsimmons@tcc.edu

Return one copy of this form for each team entered by June 15, 2023 (by US mail or email)

2023 ASEE Model Design Competition Interest Form

Name of college/university: _____

Name of faculty advisor(s): _____

Mailing Address: _____

Phone: _____

Email (print clearly): _____

Number of model entries desired : _____

Please submit this form to:

Bill Simmons
Tidewater Community College
1700 College Crescent
Virginia Beach, VA 23453
wsimmons@tcc.edu

Return this form by May 1, 2023 (by US mail , fax, or email)

Additional Resources:

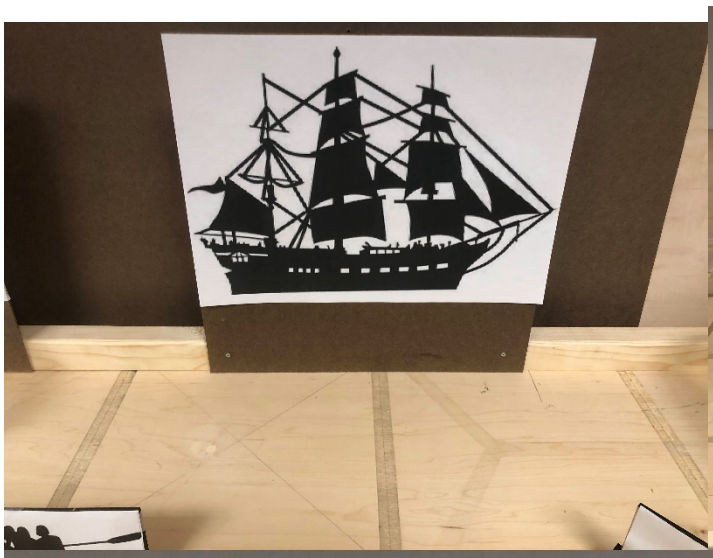
J. Bower, 1819, Library of Congress
A Victorious September - USS Constitution Museum
https://ussconstitutionmuseum.org/2014/09/11/a-victorious-september/

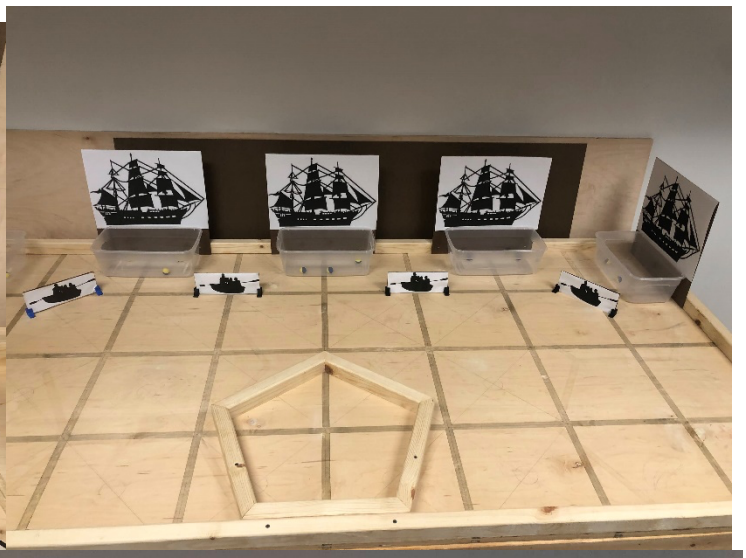
The targets:

Royal Navy HMS *Devastation*,
Royal Navy HMS *Meteo*r,
Royal Navy HMS *Aetna*,
Royal Navy HMS *Volcano*
Royal Navy HMS *Terror*

O Say Can You See: The Bombardment of Fort McHenry | American Battlefield Trust (battlefields.org)
https://www.battlefields.org/learn/articles/o-say-can-you-see-bombardment-fort-mchenry

Plus 4 shore assault boats
The British Attack on Fort McHenry (Spar-Spangled Banner) (thoughtco.com)
https://www.thoughtco.com/attack-inspired-star-spangled-banner-1773539





Pictures of Cedarville (practice) Field