2024 ASEE MODEL DESIGN COMPETITION
Sponsored by the Two Year College Division of ASEE

Dear Colleagues,

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 teams for the
26th Annual ASEE TYCD ROBOT COMPETITION.
This '**Beaver Bot**' event will be held in conjunction with the **2024** ASEE Annual Convention
in **Portland, Oregon** during **June 23-26, 2024**.
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 "Beaver Bot" robot to knock down 12 (popsicle sticks) trees and transport these sticks to either the river or pond areas of the 4' by 8' plywood play field. A circuitous black line path (electrical tape) is provided on the play field to assist the Beaver Bot in finding the 12 trees, the river, and the pond. Each tree is held nearly upright by 3D printed tree bases (or stumps). The robot must adhere to the rules of the model design competition which includes an exhibition session.

The objective of this competition is for students to experientially appreciate the challenges in every step of the engineering 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 valuable classroom principles and have some *engineering fun* along the way*!*
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 2023 - Minneapolis, MN

The recent 'Star Spangled Defender' competition in Baltimore required teams to design and build an autonomous robot that would aim and launch small Nerf Rivel balls at stationary 5 HMS British ship silhouettes and 4 rowboat silhouettes from within the confines of a pentagon, and in defense of Fort McHenry, within a 90 second time interval.

The results were as follows:

- 1st Place: ***David, the Defender*** – *Cedarville University (Cedarville, OH)*
- 2nd Place: ***Carronade*** – *The Apprentice School (Newport News, VA)*
- 3rd Place: ***Oculus –*** *Tidewater Community College (Virginia Beach, VA)*

Group photo from Baltimore, June 2023

2024 Event Name: Beaver Bot

Objective:

In honor of our Oregon ('The Beaver State') 2024 ASEE host, participating student teams are invited to design and build an autonomous robot that can successfully…

- cut down, acquire and transport 12 (popsicle sticks) trees to either a river or pond area of the 4'x8' playing field (to ostensibly be used to build a beaver dam, which is not required) within in a 120 second time period.
- The (popsicle sticks) trees will be mounted in an upright orientation (within 20° of vertical***)*** on 3D printed bases. These plastic tree bases are permanently fixed to the plywood playfield with two (#5) screws. Each tree base is designed to hold the tree loosely for grabbing, or allow the tree to fall 'inward' across the black line path if lightly jostled.
- The pond is a hexagon region surrounded by a 2" x 2" wood border. The pond is located in the center of the 4' X 8' plywood field, which also has 2" x 2" wood border.
- The river is two regions on the surface of the play field, is painted blue, and bordered only by black electrical tape lines. The river does not have a wood border.
- A black line (of 3/4" wide electrical tape) on the playfield surface will wind through the forest of trees, allowing robots to find, cut down, and acquire trees in any preferred sequence. This line disappears, and is not present in the river area of the field surface.

Field Specifications:

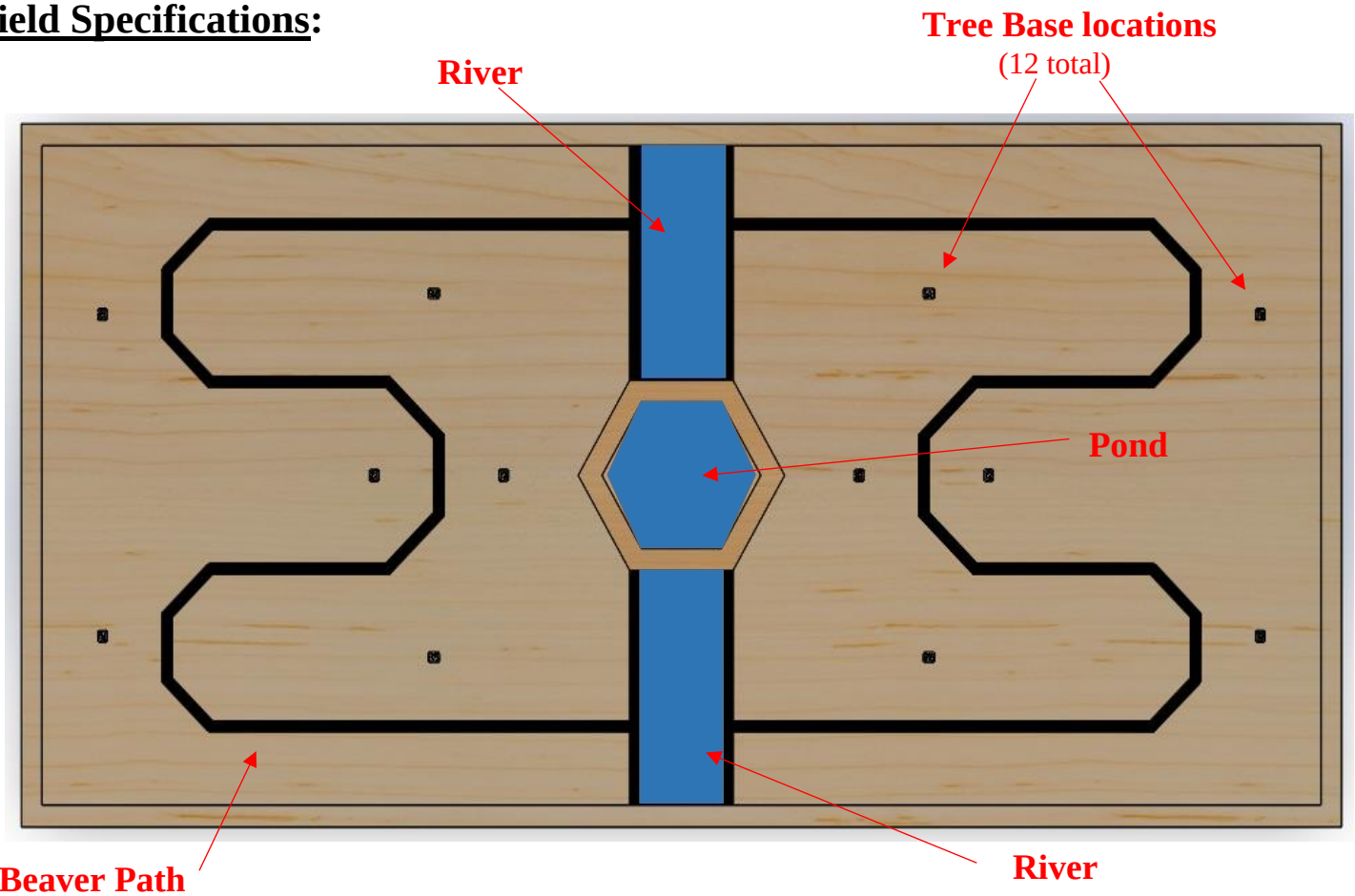
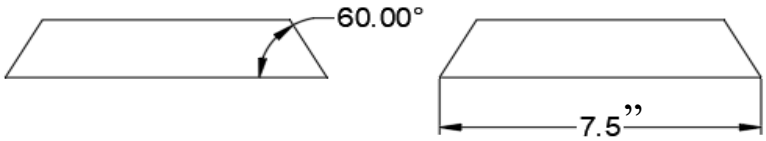


Figure 1: Isometric View of the Play Field

Required Materials:

1. 1 sheet 4' x 8' x 3/4" plywood (Grade BC or better)
2. 4 each 2" x 2" x 96" (1.5" x 1.5" actual) dimensional lumber to be cut as follows:
   a. 2 each. use full length as long sides of field.
   b. 1 each. cut into two pieces of 45" length for short sides of field.
   c. 1 each. cut into 6 pieces (7.5" outside length, mitered at 60 degrees (as shown below).



3. 1 box Wood or deck screws (# 8 x 2") to attach borders and pond to plywood.
4. 2 cans White spray primer.
5. 2 cans Light blue (AQUA) spray paint.
6. 1 roll Green, or blue paint masking tape. To be removed after paint dries.
7. 1 roll Black electrical tape.
8. 1 box wood screws, (# 6 x 3/8) to attach stumps to field. Phillips head will work best.

All materials are available at national and local home improvement and hardware stores.

Construction Procedures:

1. On the blank field (item 1), mark lightly in pencil the inside edge of river for painter's tape lines in accordance with the river dimensions shown in Figure 2.

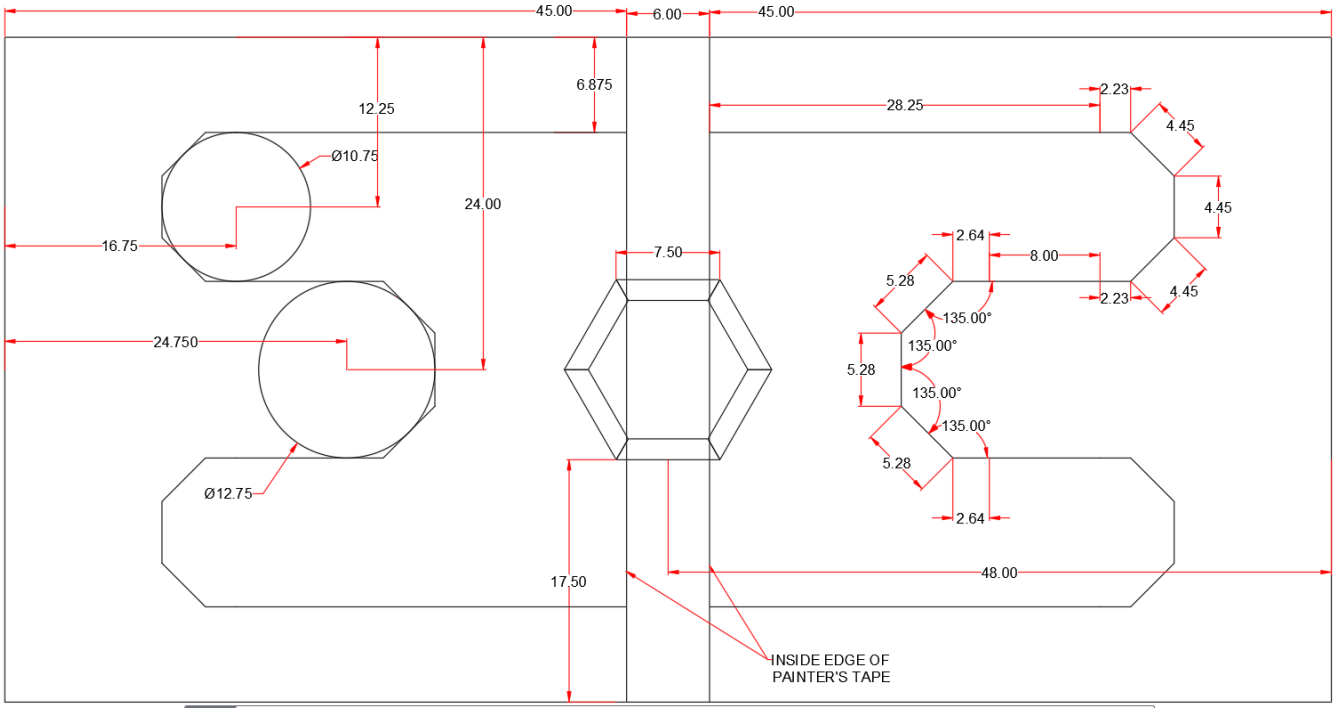


Figure 2. Pre-mark the plywood play field lightly in pencil (with center lines of the beaver path)

2. Add pencil lines to the play field for the center line of the beaver path in accordance with the dimensions shown in Figure 2.
   NOTE: When laying out the pencil drawing of the 'curves' in the path, it may be easier to use a circle or a template of the half octagon shape drawn by a CAD program. A sample for each size of octagonal 'curve' is shown below in figure 3a, and 3b. Figure 3c shows dimensions to the outer edge of tape (added later).

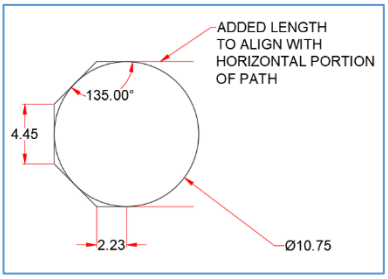


Figure 3a. Small Octagon (centerline)

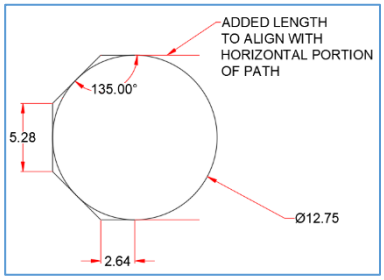


Figure 3b. Large Octagon (centerline)

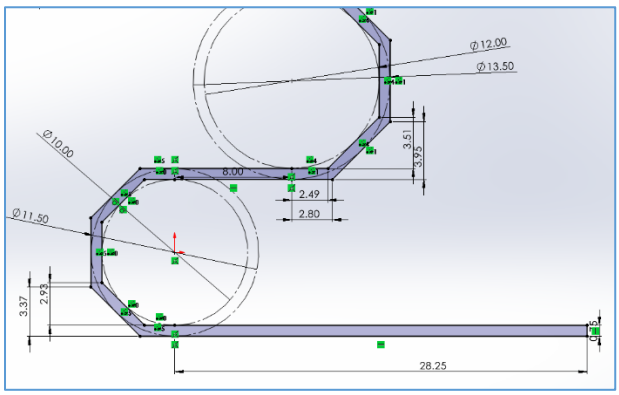


Figure 3c. Small and Large Octagonal path features, for outer edge of black electrical tape.

3. Mark the center location of each of 12 tree stumps, as shown in Figure 4. The tree base positions are symmetrical along both long and short sides of the play field.

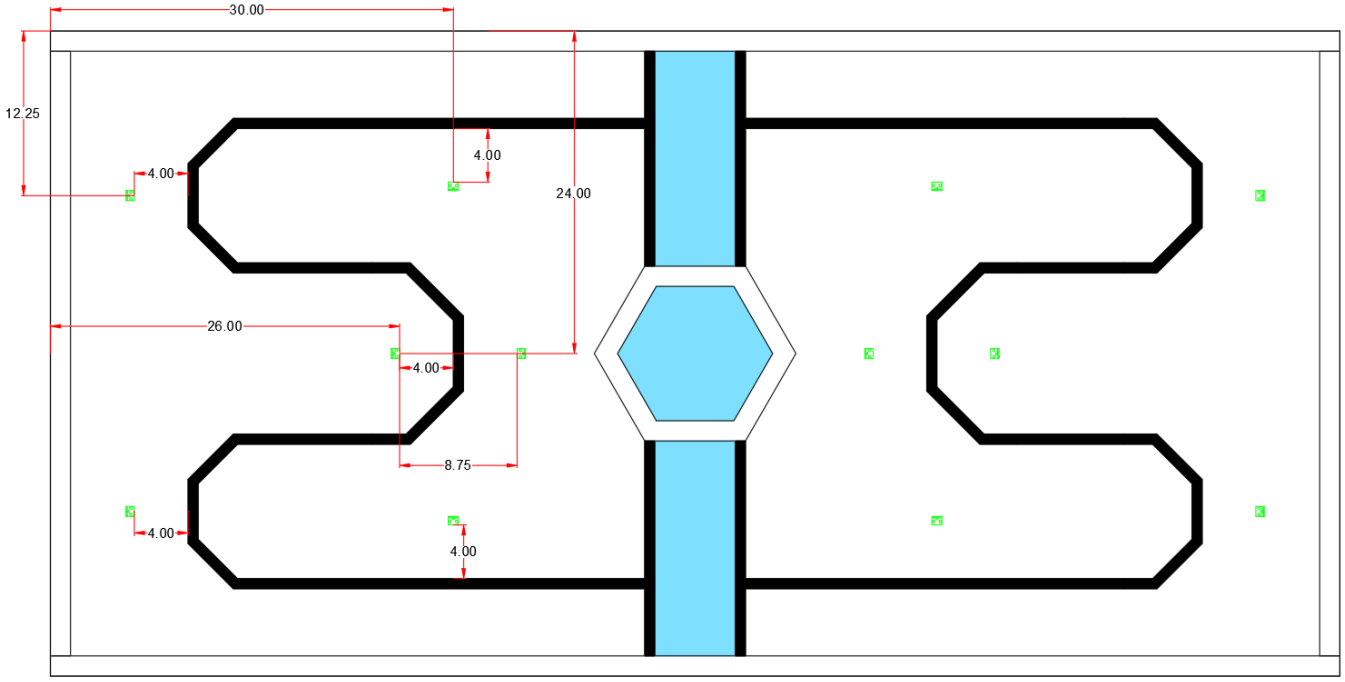


Figure 4. Twelve Locations of 3D-Printed (popsicle stick) Tree Bases

4. Add pencil marks for the hexagonal pond in the play field center. See Figure 2.
5. Add painter's tape such that the inside edges of the river are 6 inches apart, along the inside edge marks created in step 1. As shown in Figure 2, these marks can continue fully across the play field, and will assist in locating 4 (of 6) pond corners. Similarly, use the painter's tape to mask off the hexagonal interior of the pond border. See pond dimensions Figure 2 and Figure 5.
6. Use the white primer and blue paint to paint the river and the pond areas. Use the primer first, and allow to dry. Then apply the blue paint. See Figure 5.

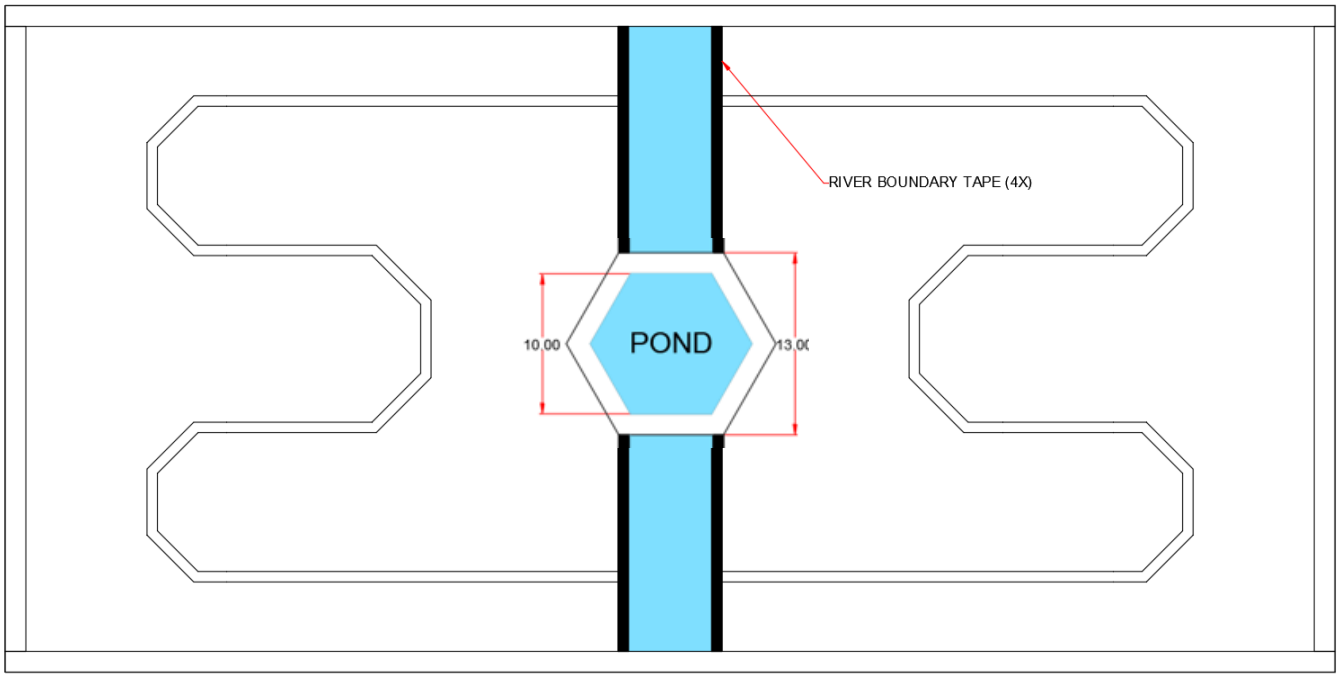


Figure 5. River and Pond areas to be painted. River edges to be taped.

7. After the paint has thoroughly dried; remove the painter's tape.
8. Attach the full length 2" x 2" boards to the long sides of the plywood sheet using (item 3). See Figure 6. Pre-drill screw holes to prevent the 2" x 2" boards from splitting.
9. Measure the length of the remaining short sides. They should be 45 inches. Cut one 2" x 2" board into two lengths in order to fit snugly between the long sides. Attach all 4 sides to the field using screws (item 3). See Figure 2.
10. Attach the six hexagon pieces from step 2c above as shown in Figure 2, Figure 5, and Figure 6 to form the beaver pond border. Use screws, item 3, to attach to the field.

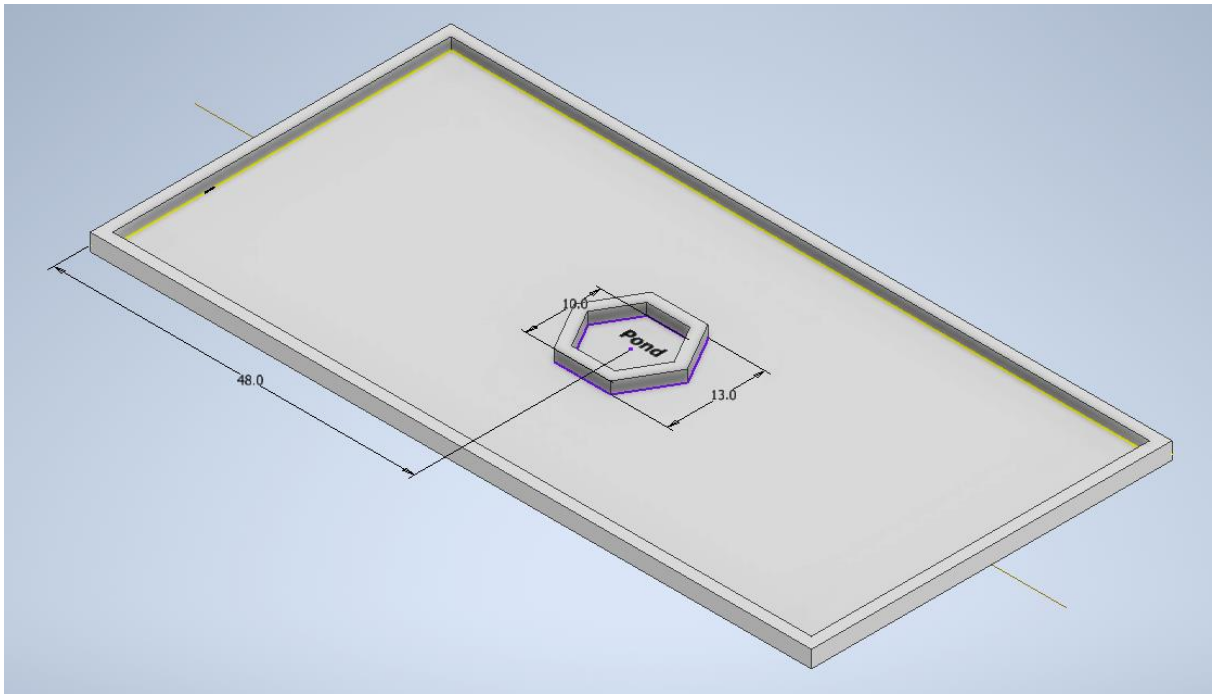


Figure 6. Wood Borders for Pond and Play Field Boundary

11. Apply the electrical black tape as follows:

a) Add 4 pieces of black tape to form the river boundary as shown in Figure 5.
b) Add black tape to create the path shown in Figure 2, Figure 3c, and Figure 7. The black tape is to be centered on the pencil lines created in step 2 above.

12. Attach the tree bases as shown in Figure 4. Use #5 screws, item 8. These tree base (or 'stump') locations are symmetrical in the x-axis (long side) and y-axis (short side) of the play field.
    NOTE: Six bases are inside the beaver the path loop, and six bases are outside the path loop. Traveling in either direction, the beaver bot will encounter six trees on the right and six trees on the left.
13. Details of the completed field are shown combined in Figure 7.

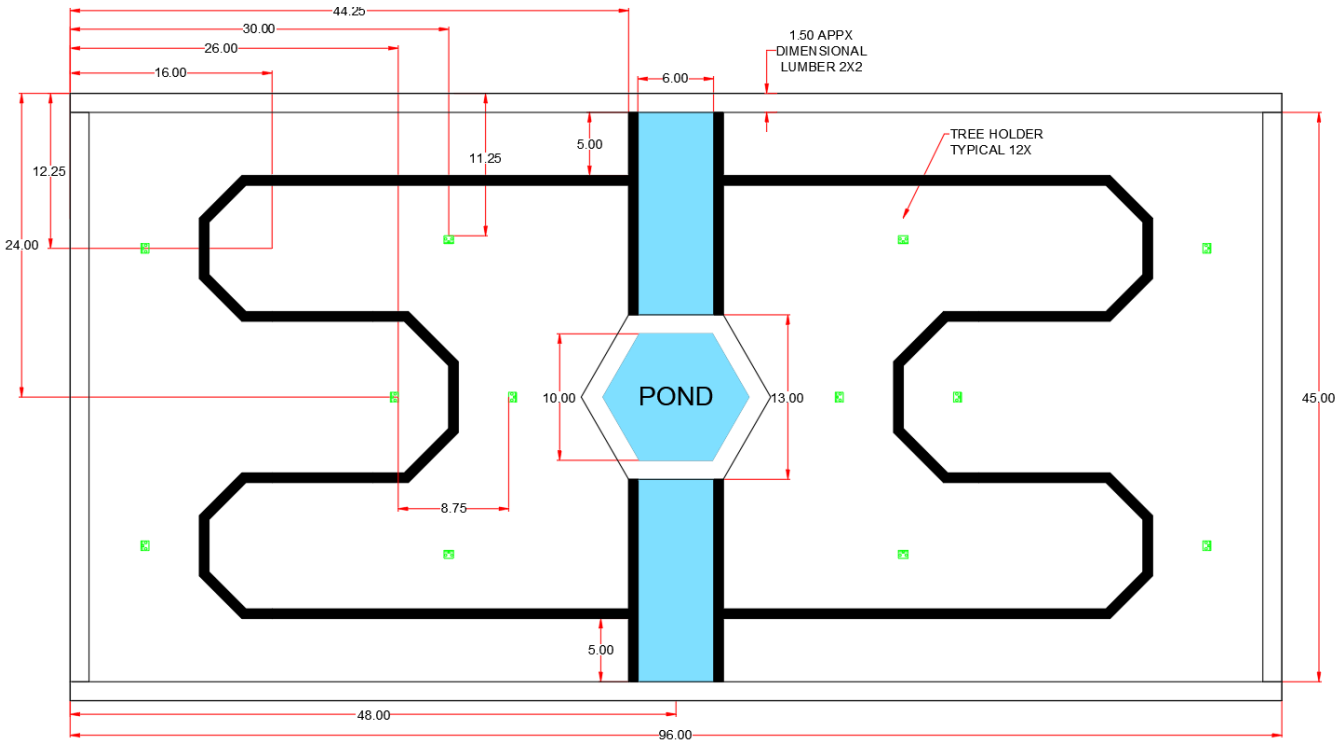
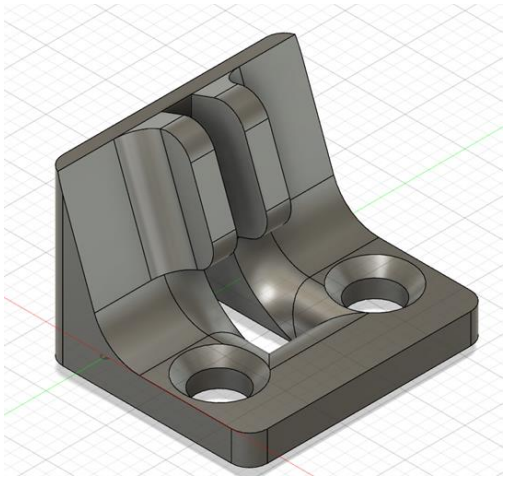


Figure 7.

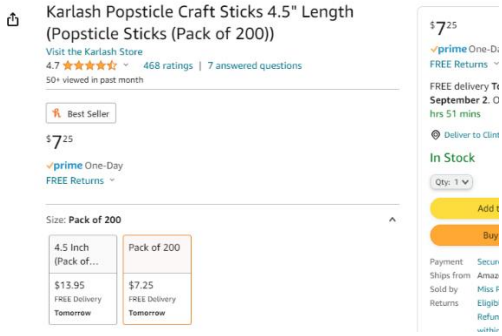
The completed playfield.
River painted and bordered with a black tape line.
Pond painted and with wood border.
Beaver path lines applied. Twelve tree Stumps fastened to the plywood sheet.

Additional field pieces:

1. Tree stump base. To be 3D printed.
   The *.stl file is available from the competition organizers for 3D printing fabrication. NOTE: The base design intentionally creates a slight lean of the (popsicle stick) tree away from the beaver path line.



2. Tree (popsicle stick)
   This is the popsicle stick supplier to be used on the official competition field. Many alternative suppliers exist, but few have the uniformity in stick length, width, thickness, and flatness. This official popsicle stick of the Beaver Bot competition has a greater dimensional consistency and higher wood quality than commonly used for craft projects or popsicle treats.



The Robot

- The robot is autonomous. It must perform its tasks without the aid of a human operator.
- The robot's initial size must fit inside a rectangular volume that is 12" long, 8" wide, and 10" high.
- The robot may change size and shape during the trial, even to the extent that it is no longer confined to initial volume constraints. The robot does not have to resume its initial configuration at the end of the trial.
- If a multiple robot design is chosen, all mini-robots must collectively fit within the 12" x 8" x 10" initial volume constraint.
- A 20 point penalty will be applied to each trial for a robot whose initial configuration does not meet the dimensions constraints, if violated by 1/4" or less. That is, a 'slightly' oversized will be permitted to compete, with a penalty.
- Any robot's initial configuration exceeding dimensional constraints beyond 1/4" will receive a zero (0) score for each of the four trials that it arrives oversized at the playfield.
- The robot starting position must be somewhere within the river. This position can be in any direction or orientation, and in any location on the playfield, as long as at least one feature of the robot is in contact with the river surface.
- The robot must remain within the 4' x 8' play field during the entire trial. The robot can make contact with wooden outer walls of the play field, and make contact with the pond walls but cannot damage these walls.
- The robot can strike, grab, knock down, and/or catch the (popsicle stick) trees as a means of harvesting. However, the robot cannot damage the tree.
- The robot can harvest, acquire, transport, and deliver the (popsicle stick) trees in any sequence desired.
- The robot can carry or push the (popsicle stick) trees as a means of delivery to the pond or river. However, a robot cannot launch trees directly from the tree base and into the pond or river. Robots must acquire or catch or carry or possess each tree for a minimum of 2 seconds of time between harvesting and delivery.

Allowable Energy Sources:

Any energy source is allowed for the robot as long as it is completely contained within the robot. Robots can pre-load, pre-charge, or pre-fuel their robot's energy storage system before each trial begins, but may not refuel during a trial. Energy sources must not present any safety hazards to participants or spectators.

Components, Fabrication, and Cost:

- Robot designs are expected to use materials commonly available to the general public.
- Design team members are expected to perform all fabrication. Use of commercially available vehicles, robots, or entire kits such as RC cars, Legos, K-nex, Fischer-Technics, Parallax, VEX or erector sets may not be used. Individual components from these cars, robots, or kits 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.
- Design teams are expected to program their chosen microcontroller, of which there are many to choose from: Arduino, Raspberry Pi, Parallax, SparkFun, Teensy, Zumo, Microchip, etc. However, devices with the ability to record and replay a sequence of tasks without student programming (like Lego Mindstorm microcontroller bricks) are prohibited.
- Motor controllers with embedded coding and/or firmware are permitted.
- The cost of purchasing all components present on the final design of the robot must not exceed **$500.** There is no limit to development costs incurred by a team or a school.

Robot Time Trial Rules:

1) It is the responsibility of the team to inspect the condition of the track and the placement of the (popsicle stick) trees before starting their robot to be certain that everything is in order. Once a team presses or pulls the starting 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 time for a trial will begin when the judge gives the team the command to start and the student team has activated a single start switch or mechanism. Once this start command is given and the team has activated a single switch or mechanism, no other assistance to the robot is permitted.
7) 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. However, if the robot has not moved within 30 seconds of the start command, a score of zero will be assigned for that trial.
8) 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 12 trees to the river and/or pond.
   c. The team chooses to end their run.
   d. 120 seconds elapses from the start command.
9) 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 (0).
10) 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 120 seconds to accomplish as much of the following as possible, with a (pre-loaded) 25 nerf rival ball supply:

1 points per tree (popsicle stick) harvested, knocked down, and displaced from the tree base.
+ 1 additional points per (popsicle stick) tree partially delivered to the blue painted river area of play field. or leaning against exterior of the pond wall
or + 3 additional points per (popsicle stick) tree entirely delivered to the blue painted river area of play field. or laying wholly on the pond wall (and not in contact with play field surface)
or + 9 additional points per (popsicle stick) tree 'delivered' to the pond
Total = (1pt harvested tree + 9pts delivered to pond) x 12 trees = 120 points (perfect run)
Bonus = 1 point per second not used in 120 second time trial for a perfect run.

NOTE: if any portion of a (popsicle stick) tree makes contact with the bottom blue interior surface of the pond (or another tree making contact with the bottom) it is considered a successful 'delivery'. Any tree leaning on the outside of the pond wall or resting on only the wood border wall of the pond (and not making contact with the interior bottom blue pond surface) is <u>not</u> considered to be 'delivered' to the pond. Such a tree would earn only river bonus points and not pond bonus points.

TIME BONUS:
If all trees are harvested and delivered to the pond in less than the time limit, additional bonus points will be awarded based on the remaining trial time not used. The maximum score is 120 points, plus this bonus.
(120 seconds – trial time used to deliver all 12 trees to the pond) = bonus points.

Exhibit Session Scoring:

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

Overall Team Score:

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 Team Score = Sum of 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-minutes of the presentation 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 of the competition is subject to the scheduling needs of ASEE conference.
Email notifications (and an updated schedule) from the competition organizers will be sent when more details are known. A typical schedule in past years was as follows:

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
Tidewater Community College
1700 College Crescent
Virginia Beach, VA 23453
Email: kgrimes@tcc.edu

Geoff Berl
Monroe Community College
1000 E. Henrietta Road
Rochester, NY 14623
Email: gberl001@monroecc.edu

Clint Kohl
Cedarville University
251 N. Main St.
Cedarville, OH 45314
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, 2024***.
Team entry 'Registration' Form for each model design team must be received no later than ***June 15, 2024***.

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. The faculty member can sponsor more than one team, and does not have to be unique to each team.
- Each team member must be enrolled in primarily freshman or sophomore level college 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 design 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.

2024 ASEE Model Design Competition Team Entry 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, 2024 (by US mail or email)

2024 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, 2024 (by US mail , fax, or email)