

2025 ASABE Student Robotics Challenge

Egg Collection and Sorting

DRAFT RULES FOR TEAM & ADVISOR INPUT

Students and Advisors: While the competition theme is unchanged, several changes to the competition details have been made from the version circulated at the 2024 competition. We are circulating this draft version for your input and feedback regarding the overall structure and tasks for the competition.

Important Note: Additional information regarding dimensions, measurements, masses, and arena assembly information will be provided at a later date.

Please use the comments feature to ask questions or leave comments regarding the overall structure and tasks of the competition.

Thanks!

The ASABE P-127 Robotics Competition Organizing Committee

Background and Purpose

The ASABE Student Robotics Challenge provides undergraduate and graduate students a challenging and fun hands-on learning experience. The 2025 challenge will be held during the ASABE International Meeting in Toronto, Ontario, CANADA, July 13th - 16th, 2025.

Competition Summary:

Student teams will build autonomous robots that will race to collect and sort as many chicken eggs as possible within 5-minute trials. Points will be earned for each egg correctly collected and sorted. There will be two different sizes of eggs (medium and large). There will also be “bad” eggs. In addition to the physical competition, teams will also submit a written design report which will be scored. Robot performance and the quality of the written design report will be combined to determine the winners of each division. The competition consists of two divisions: Standard and Advanced. The primary differences are that the Standard Division will have eggs at pre-defined locations and the arena floor will be painted plywood. In the Advanced Division, eggs will be located at random locations within a predefined grid and the floor will be covered with a thin layer of straw. The arena diagrams are shown below in Figure 1.

Advice Regarding Sources of Variability

New in 2025!

Conditions in agricultural settings are highly variable. Your robot should be designed to deal with variation from many sources. For example, construction dimensions will not be exact, eggs may vary slightly in weight and dimensions, surface friction may be inconsistent, etc. A good design will produce reliable performance in spite of variation. Testing plans should be designed accordingly.

Updates Log:

11/4/24	The “Medium solid eggs” turned out to be far too small. These were replaced with plastic medium eggs. Added paint colors for eggs
10/21/24	Office hours date, time, and Zoom link added (see page 10)
10/7/24	- Black foam tiles added as the surface for the Standard Division. This was done to prevent eggs from rolling on the hard plywood surface. Black foam was chosen because it is more readily available and consistent than white or brown foam. - Tiles for the Standard Division Navigation Task changed to black foam with white lines. Information on foam tiles added. Line specifications added. - Egg Handling Task “Miniature Arenas” updated with dashed lines, additional dimensions, and changes to the manner in which eggs are replenished. - Arena construction drawings added.

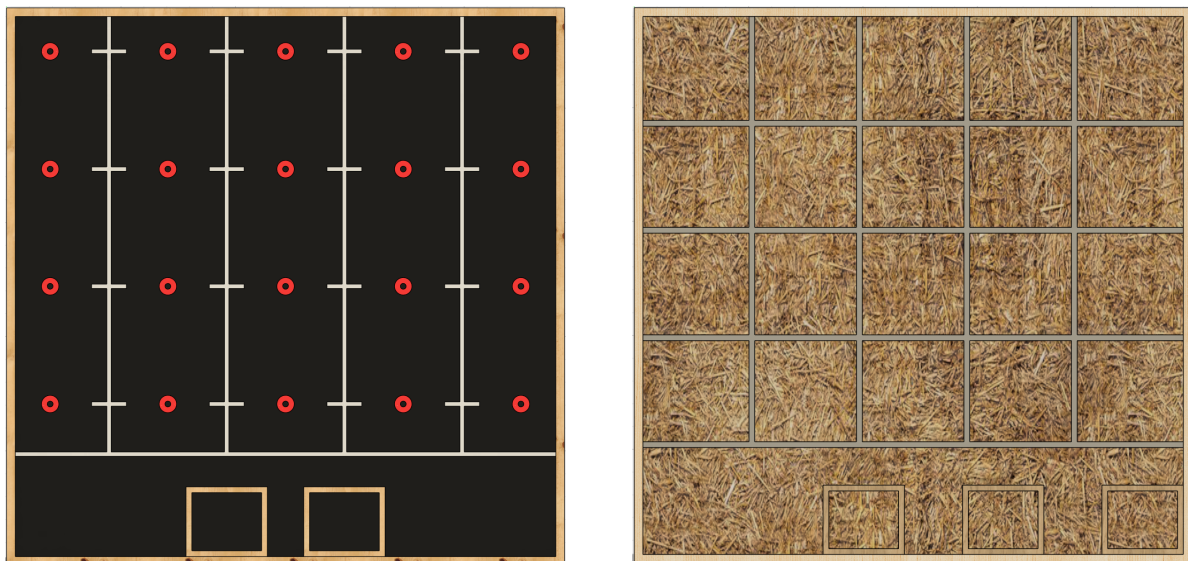


Figure 1: Arena layouts for Standard (left) and Advanced (right). Each arena is an 8 foot x 8 foot square. Robots start at the lower left corner of each arena. Standard division (left): red circles represent the location of eggs and the white lines will be present on the board for line following. Advanced division (right): each of the squares created by the grey squares can have eggs within them. The gray lines will not be present on the board, at the competition it will be a frame that judges will use for egg placement.

Definitions of Divisions

There are two divisions: the Standard Division (simpler, more structured robotic tasks), and an Advanced Division (less structured, more challenging tasks).

The Standard Division is designed to help teams develop basic skills in robotics. This Division provides a less complex task with more structure and provides clear lines to aid in navigation. As such, this Division is for teams that are not highly experienced in robotics.

The Advanced Division is intended to help students refine their skills in robotics. The tasks are less structured and generally more difficult than in the Standard Division. This division is intended for students that have prior experience in robotics or are looking for a more challenging competition.

There are no explicit rules regarding which division a team may enter. Performance scoring differs between divisions, but the criteria for Design Reports are identical for the two divisions.

1. Teams must declare their division (standard or advanced) at the time of registration (by June 1, 2025). Teams may elect to change their division until July 1, 2025, after which no division changes will be allowed.
2. A robot may not be used in both the Standard and Advanced divisions.
3. Each student may only be a member of one team.

Scoring

The competition consists of two primary components, the robot Performance Score and a written Design Report Score. These components are combined to obtain an Overall Score, which will be calculated as:

$$\text{Overall Score} = (\text{Performance Score}) \bullet (\text{Design Report Score})$$

Performance Scores will be determined through multiple competition trials, and multiple reviewers will judge the Design Report Scores. Awards will be given for the top scores in Performance, Design Report, and Overall Competition.

Robot Performance

New in 2025!

Autonomous egg collection requires the ability of the robot to navigate the arena, identify eggs, and handle the eggs with care. Robots will earn points in each of these component tasks, as well as in the integration task of egg collection and sorting. Thus, the competition will consist of the following components:

Table 1: Competition Tasks, Weights, and Descriptions.

Task	Weight	Short Description
Navigation	20%	Robots will navigate in a manner matching their Division. No eggs will be involved in this task.
Egg Identification	20%	Robots will identify eggs based on their physical characteristics. No navigation or egg handling will be involved in this task.

Egg Handling	25%	Robots will pick up eggs from one location and deliver them to another location. No identification of eggs will be required, but simple navigation will be necessary to complete this task.
Egg Collection and Sorting	35%	Robots will navigate the arena, collect eggs, and sort them according to physical characteristics. This task will require all of the preceding capabilities.

Egg Types

All eggs are commercially available and can be purchased on Amazon.com. Four types of eggs will be used in the competition as outlined in the chart below.

Table 2: Egg Types, where used, and links for purchasing eggs.

Egg Type	Standard Division	Advanced Division	Weight (g)	Task(s)	Links for Purchasing Eggs
Large Solid Eggs	✓	✓	~42 g	Identification, Collection and Sorting	Amazon Link (the “2-1/2 inch” option)
Large Magnetic Eggs	✓	✓	~42 g	Handling,	Amazon Link (3 of each type per order)
Medium Bad Eggs	✓	✓	< 20 g	Identification Collection and Sorting	Amazon Link
Medium Solid Eggs	Not used	✓	~30 g	Identification, Collection and Sorting	

As shown in this table, the Standard Division will use only large eggs while the Advanced Division will use medium and large eggs. Both Divisions will have bad eggs.

Egg Colors

All “good” eggs will be a satin white color. All bad eggs will be an off-white/tan satin finish color.

<https://www.rustoleum.com/product-catalog/consumer-brands/painters-touch-2x-ultra-cover/satin>

Good Eggs: Satin Blossom White 346950

Bad Eggs: Satin Ivory Silk 334073

Note: The use of a [primer](#) will help the paint adhere firmly to the eggs. This is especially important for painting plastic eggs.

Standard Division Navigation: Line Following

A diagram showing a closed loop (white line) on a black background. The loop has two gray boxes labeled 'A' and 'B' attached to it. The loop is divided into two segments by a vertical dashed line. Segment A is on the left, and segment B is on the right. The loop is connected to a horizontal dashed line at the bottom.

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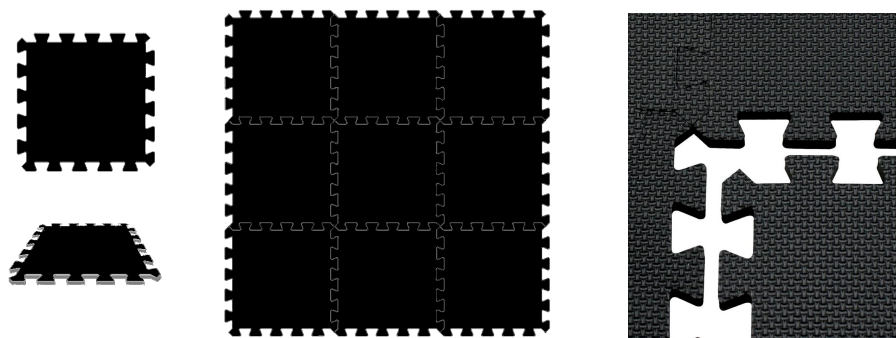


Figure 4: Foam tiles for creating navigation paths. [Representative product from Amazon.com](https://www.amazon.com/s?k=foam+tiles&ref=sr_pg_1)

Navigation Task for Advanced Division

Robots will be placed at a random location within the Advanced Division arena and the team will be allowed to orient the robot's direction manually before the task begins. The task is for the robot to autonomously navigate to the center of the arena. Robots will be scored based on the distance of the robot from the center of the arena, and the elapsed time of travel. A navigation trial will end when 2 minutes have elapsed or when the robot signals that it has reached the center (a flashing green LED light). Although the starting location will be randomized, all robots within a single trial will begin at the same distance from the center of the arena. The final position of the robot will be judged by placing small markers around the robot's final position, then removing the robot and measuring the largest distance between the markers and the center of the arena. The score will then be calculated according to the equation below:

$$NavigationScore = \frac{D_i - D_f}{D_i} \frac{1}{ElapsedTime}$$

Here, D_i represents the initial distance between the robot and the center of the arena. D_f represents the final distance.

If a robot becomes stuck, students may intervene by moving the robot back to the starting position. There is no penalty for this intervention, but time will naturally be lost in the process of restarting. Scoring will be based on the final position of the robot, not the closest position attained during the trial.

Egg Identification Task

Robots will be presented with a random sequence of eggs and must report the type of egg presented. Reporting will be accomplished with a set of LED lights, one for each type of egg. Because the Standard Division uses only one size of eggs, the LED lights only will be used to indicate whether an egg is good or bad. A green LED will indicate a good egg while a red LED will indicate a bad egg.

In the Advanced Division, robots will need to differentiate between large good eggs, medium good eggs, and bad eggs. A green LED will indicate a large good egg, a blue LED will indicate a good medium egg. A red LED will indicate a bad egg.

The judges will prepare an egg container containing eggs in a randomized order. Judges will hand eggs

one-at-a-time to a team member, who will then present each egg to the robot. A team member will hand one egg at a time to the robot which will attempt to identify the egg. After delivering an egg to the robot, teams may press a button to start the egg identification routine for their robot.

Each egg identification trial will last 3 minutes. Teams will receive one point for each egg correctly identified within the trial period. The total score will simply be the number of points earned by the robot. The speed at which identification is performed will not be incorporated into the score, but robots that do not complete the identification task within the allotted time will naturally not be able to reach a full score.

Egg Handling Task

Robots will have 3 minutes to move as many eggs as possible from a specified location to a collection bin. Both Divisions will use Large Magnetic Eggs for this task. The magnetic eggs will “break” apart if dropped or handled too roughly. The task will be conducted in a miniature arena measuring 24” x 48” (see Figure below). This task will require a small amount of navigation functionality but will not require robots to perform any egg identification. The design, surface, and bins of each miniature arena will be the same as used in the large arena (i.e., black foam tiles for Standard, surface covered with straw for Advanced Division, bin height of 1”).

In both Divisions, robots will start in the square dashed area shown in the Figure below. Eggs will be replenished at each “X” location after the entire robot crosses the **halfway line** of the miniature arena (the horizontal dashed line shown in the Figure below). Both miniature arenas will use the same surface as the main arena (black foam with white line for the Standard Division, plywood and straw for the Advanced Division).

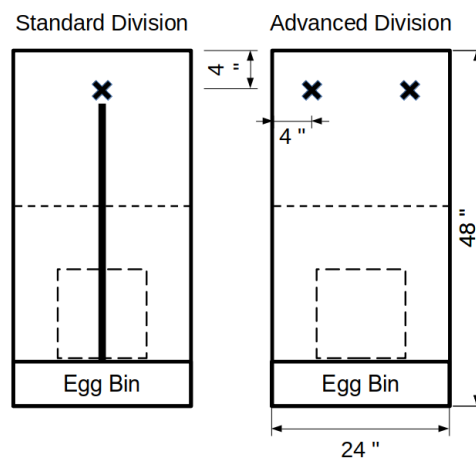


Figure 3: Miniature arenas for the Standard and Advanced Divisions. These diagrams provide dimensions only, not surfaces or colors. Each mini arena will match the large arena for the corresponding Division (black foam tile and white line for Standard, painted plywood with straw for Advanced). The halfway line marks will be present on the outside of the mini arena but lines will not be present inside the mini arena.

Collection and Sorting Task

Robots will start in one corner of the competition arena (see Figure 1). Robots will have 5 minutes to collect and sort as many eggs as possible.

Teams will earn one point for each egg collected and placed in any bin. Additional points will be awarded for each egg correctly sorted.

Egg bins will consist of frames that will be placed on the floor of the arena. Dimensions of the bins are provided below under the heading “Arena Constructions”. Robots simply need to place each egg within the appropriate bin.

Standard Division

As shown in Figure 1, white lines will be provided to aid in robot navigation. The arena surface will be painted plywood. Eggs will be placed at specified locations. All eggs will be large in size, but may be either good, or “bad” (for details see the “Egg Types” section above). Robots will need to collect eggs and deposit them within the “large” bin (good eggs), or the “bad” egg bin.

Advanced Division

No navigation lines will be provided. The surface of the arena will be covered with straw. 30 eggs will be located on the board, with one cluster of eggs in each square region (see Figure 1). Eggs will be medium or large and may be good or bad (for details see the “Egg Types” section above). Robots will need to collect eggs and deposit them within the appropriate bin.

Trials for the Collection and Sorting Task

1. The order in which teams will complete their trial will be announced at least 15 minutes before the start of each round.
2. Teams are responsible for monitoring the progress of the competition and reporting to the playing field with their robot before their trial begins.
3. To keep the competition on schedule, each trial will begin no more than five minutes after the previous trial ends.
4. Preparation Time: Each team will have up to 1 minute to prepare their robot on the playing field. If a team is ready before 1 minute has elapsed, they may inform the judge and activate their robot upon the signal from the judge. However, after 1 minute has elapsed, the round will automatically begin.
5. Competition Time: Once the round begins, each robot will have up to 5 minutes to score as many points as possible.
6. Finishing a Trial: A robot can finish the trial early by returning to corner “A” or “B” before the 5-minute timer sounds AND notifying the judge that the team wishes to conclude the trial. If the 5-minute timer sounds before the robot returns to a corner, a judge will gently pick up the robot.
7. Interventions: If a robot is touched after it begins the trial, it must be returned to the starting position. There is no penalty for touching a robot, but the timer will continue to run as the robot

is returned to the starting position. *Note: this provides a simpler replacement for previous rules surrounding “Autonomy Score” and “Intervention Penalty”. The intent is still for robots to be fully autonomous, but we recognize that occasionally robots may get stuck or need to be rebooted. This is not intended to introduce loopholes or strategic options. Judges have the authority to warn and ultimately disqualify teams suspected of exploiting this intervention policy to increase their score.*

8. Due to space and resource limitations at the competition, each team must designate up to three (3) team members who are allowed in the competition area for each trial. Additional team members will be permitted in the setup/work area as space permits.

Rules Common to Both Divisions

The following rules apply to both divisions:

1. Egg handling arenas are built from a plywood surface of dimensions 24" x 48". Side walls are 3.5 inches tall and are attached to the surface to yield interior arena dimensions of 21" x 45".
2. The Collection and Sorting arena will be a square plywood surface of 96" x 96". Side walls are 3.5 inches tall and are attached to the surface to yield interior arena dimensions of 93" x 93".
3. The bins have a height of 1" (see Arena Construction below for more information).
4. The interior surfaces of both arenas are painted with matte latex paint: Sherwin Williams “Fallen Leaves”, in a flat finish (no gloss).
5. Maximum robot size of 12"x12"x12" at the beginning of each trial. Robots may expand in size after activation.
6. Only 1 robot allowed per team.
7. Each student may only belong to one team.

Arena Construction

For both Standard and Advanced Divisions, the Collection and Sorting Arena will be constructed using two 4' x 8' sheets of plywood. Arena edges will be constructed using 2x4 boards (1.5" x 3.5"). The interior surfaces of both arenas are painted with matte latex paint: Sherwin Williams “Fallen Leaves”, in a flat finish (no gloss). Teams should assume construction tolerances of ± 0.5 "

The Standard Division arena will be covered with black foam tiles of the same type used in the navigation task. Lines will be applied using a stencil and flat white spray paint. Lines will be 2cm $\pm$ 0.25cm wide.

Further details on the playing field construction are provided below. All dimensions are in inches and construction tolerances for all dimensions are ± 0.5 ."

[Advanced Board Construction Details](#)

[Advanced Board Stencil for Egg Placement](#)

[Standard Board Construction Details](#)

[Bin Construction Details](#)

Team Registration

Each *team* must complete the competition [registration form](#) by June 1, 2025; this team registration for the competition is free.

Participant Registration

For access to the competition venue, each *participant* must register for the ASABE Annual International Meeting. A special rate of \$800 (total) is available for groups of exactly four participants until May 1, 2025 by submitting the [2025 ASABE Student Competition Reduced Rate form](#) to awards@asabe.org; contact Corey Sayles <sayles@asabe.org> for more information. ASABE also offers “Early Bird” registration rate to participants who register before TBD, 2025.

Written Design Report (Due July 5, 2025)

A written design report will be submitted to provide documentation of the robot design and functionality. Design reports will be judged according to the criteria below. Reviewers of the reports will be team advisors and Robotics Competition Committee members. However no reviewer will judge their own team’s report. An award will be presented for the best design report. **Design reports must be submitted in PDF format using [this google form](#) before 11:59 pm on July 5, 2025 (Toronto time).** Design reports and scores will be publicly available after the competition.

I. Technical Merit	Points Possible
A. Establishment of Need and Benefit to Agriculture	5
B. Approach and Originality	5
C. Definition of Design Objectives and Criteria	10
D. Parts List (with MSRP and sale prices) and Table: ■ Actuators, sensors, microprocessors, screen(s), etc.	5
E. Hardware Description ■ Engineering drawings, CAD models, pictures, etc. ■ A clearly written description of how hardware works	20
F. Software Overview or Logic Flowchart: ■ Driving, sensing logic, etc.	20
G. Appropriateness of Tests and/or Performance Data	5
H. Achievement of Objectives	5
II. Design Report Quality & Composition	
A. Professional-looking page design and layout	5
B. Appropriate organization and logical flow of information	5
C. Completeness	5
D. Clarity and style	5
E. Quality of the documentation - including figures & drawings	5
Total:	100

Rankings and Prize Structure

As funding allows, monetary prizes will be awarded to the teams with the top three overall scores in each division.

The first place robot performance and first place report in each division will also be acknowledged, but no monetary prizes will accompany these distinctions.

Performance Scores

1. Each team's Performance Score will be determined by averaging all trials in the finals round except for the team's lowest-scoring trial.

Design Report Scores

1. Written design reports will be scored by at least two different judges.
2. Judges will recuse themselves from scoring reports when a conflict of interest exists.
3. Judges' scores will be normalized before being combined to account for variation among judges.

Equal Scores (Ties)

Where there is a tie, teams will split the prize for the tied awards. For example, a tie for second place will result in the two teams splitting equally the awards for 2nd and 3rd place. In this case, two second-place awards will be given, and no 3rd place awards will be given.

Schedule

The following schedule is planned but is subject to revision by ASABE as needed.

Sunday, July 13:

- **Component Tasks:** Each team has a single scheduled time for each of the simple tasks (Navigation, Egg Identification, and Egg Handling). Note: Multiple trials are not planned for these tasks, so teams should arrive ready to perform these tasks without any "practice". This will require that teams design their robots to be robust and adaptable to a range of local configurations. Teams should design and test that their robot can perform properly in different lighting conditions, with different surfaces, etc. Teams may wish to bring their own versions of materials needed for the component tasks in order to calibrate light-based sensors to the lighting conditions at the competition venue.
- **Practice for the Collection and Sorting Task:** Each team will have two (2) XX-minute Practice slots to practice on the actual arena. Duration of these slots will depend upon the number of teams that participate.

Monday, July 14:

- **Qualification:** Teams that are not able to complete the Navigation and Identification tasks may be excluded from the Collection and Sorting Task.
- **Collection and Sorting Task Trials:** Multiple trials (number TBD) will be held for the Collection and Sorting Task.

Office Hours

New in 2025!

Rules Office Hours: Four 1-hour Q&A Sessions will be held via Zoom to allow teams to ask questions about the competition. Tentative dates: November 5, January 15 and February 15.

Technical Office Hours: To help teams with technical challenges, each Advanced Division Team is required to hold one 90-minute technical help Q&A Session as a service to the Competition. Technical Office Hours will be held via Zoom and must be completed at least 30 days before the Written Report Deadline. Advanced Teams will arrange the office hours with the P-127 Committee who will post the office hours on the competition website and within the rules document.

December 3 Office Hours: (Rules Questions Only)

Hosted by BYU

6pm Mountain Standard Time

[Zoom Link](#)

January Office Hours (Rules and Technical Help)

Hosted by Penn State

Time and date TBD

Technical Resource Links: A set of technical resources will be compiled to help teams learn the basics and more advanced topics in robotics. For example here are some resources on line following:

Line Following Resources:

<https://www.youtube.com/watch?v=H7O-ouoYgZ0>

[Arduino-based Line Follower Robot Using Pololu QTR-8RC Line Sensor](#)

<https://www.instructables.com/PCB-BOT-Line-Follower-Obstacle-Avoiding-Remote-Con/>

[Making a simple Arduino Line Follower Robot](#)

[Line Following Robot Algorithms comparison. Camera vs PID vs Fusion](#)

[Raspberry Pi Robotics #5: Line Follower](#)

[6 Channel Line Sensor Array for Line Follower Robot](#)

[PID vs. Other Control Methods: What's the Best Choice](#)