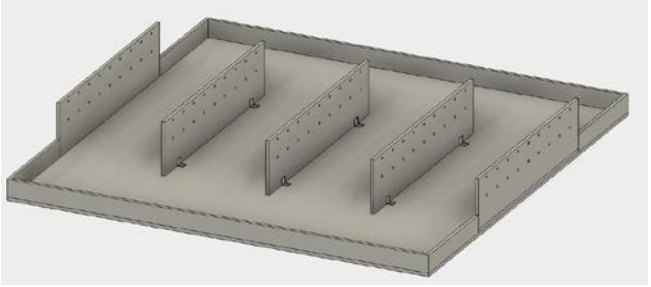
2018 ASABE Student Robotics Challenge

Updated in January 2018



The ASABE Student Robotics Challenge provides a challenging and fun hands-on learning experience for undergraduate and graduate students to demonstrate their knowledge and skills of robotics in agriculture. For 2018 the challenge, which will be held during the ASABE International Meeting in Detroit, MI, July 29 to August 1, 2018, will simulate the harvesting and storage of apples.

New to the event in 2018 the challenge is being divided into two divisions, a "beginner" division and an "advanced" division. There are several differences between the two divisions as noted below.

Objective: Autonomously designed and operated robots will harvest "apples" on an 8' x 8' playing field. The robots will harvest eight (8) mature apples (red colored ping-pong balls), remove eight (8) diseased/rotten apples (blue colored ping-pong balls) and leave eight (8) immature apples (green colored ping-pong balls). There will be a total of 24 apples (ping-pong balls) on the board.

COMPETITION RULES

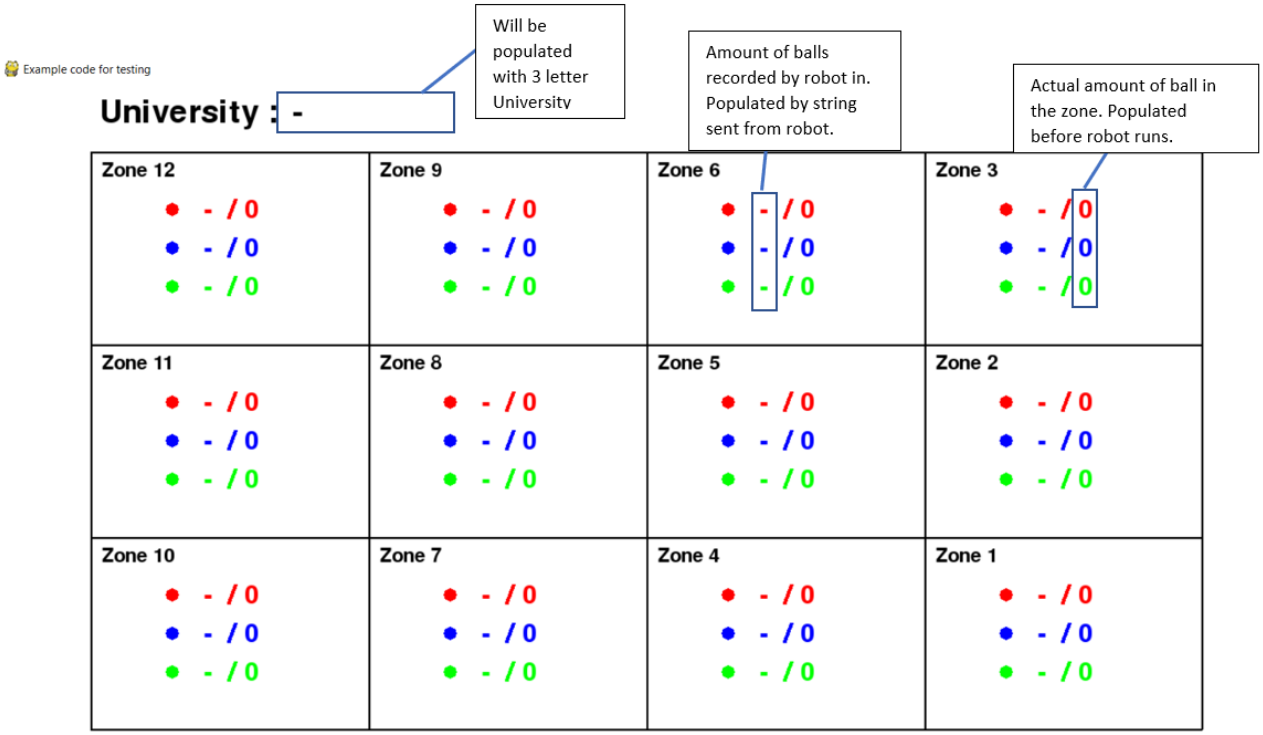
1. **Two-tiered system**
    a. Beginner Division
        1. Designed for undergraduate students with limited coursework in programing and microprocessors or who are new to the competition.
        2. Membership
            - Undergraduates only
        3. Limit of one robot per team
        4. Max robot size 12"x12"x12"
        5. Fruit will be placed at a fixed height from the surface of the board and a fixed distance from the tree wall.
            - Height = 7" (to center of the ½" diameter hole)
            - Distance = 2" (The fruit's diameter is 1.57" and the magnet diameter is 1/8", so the total distance from the wall to the outer edge of the fruit is ~3.7")
        6. A black line (width ¾") will be incorporated into the "playing field" to aid with navigation
        7. The start and end locations on the board is specified on page 10
        8. Max two teams per institution
        9. Yield monitoring is NOT required

b. Advanced Division

1. Designed for upperclassmen and graduate students who are majoring in robotics or remote sensing or who are experienced in programing and robotics
2. Membership
    - Graduate and Undergraduate Students
3. Maximum of two robots per team
4. Robot can start from any corner on the board. If a team has two robots, they should start from two different corners of the board.
5. Max robot size 12”x12”x12”
6. Fruit will be placed at various heights (7” and 11”) from the surface of the board and a fixed distance from the tree wall
    - Height = 7” and 11” (to center of the 1/2” diameter holes)
    - Distance = 2” (The fruit’s diameter is 1.57” and the magnet diameter is 1/8”, so the total distance from the wall to the outer edge of the fruit is ~3.7”)
7. Navigation will need to be done without the aid of a black line
8. Max one team per institution
9. Yield monitoring is required. Yield monitoring will be conducted by transmitting a yield matrix to a wireless display at the time of the competition. Wireless display will be provided by the organizers.
10. Wireless Communication Rules
    i. XBee S1/S2 802.15.4 is the only allowed wireless communication module on the robot.
    ii. No Wireless communication with the robot is permitted after the time trial has begun.
    iii. At the end of the time trial, the robot must transmit the yield map to the XBee S1 receiver base setup at the competition venue.
    iv. Each team will be issued a three-letter team code and the format of the data string to be transmitted is #ABC_ZZRBG_ZZRBG.....#
    v. Eg: If the Theoretical State University team’s robot with team code TSU harvested 2 red, 0 blue and 1 green from zone 1; 0 red, 3 blue and 0 green from zone 11etc., then string to be transmitted would be:

    #TSU_01201_11103.....for all 12 zones.....#

    vi. The transmitted string will be interpreted on the receiving end as shown in the figure in page 3.
    vii. Teams may not set up their own 802.11a/b/g/n/ac (2.4GHz or 5GHz) wireless communication (e.g. access points or ad-hoc networks) in the venue.
    viii. No Team or Team member shall interfere or attempt to interfere with any other Team’s or *the competition venues* wireless communication. Violations of this rule may lead to dismissal from the competition and/or legal action based on applicable law.



2. Timing

a. The competition will consist of two or three rounds (will be decided later based on the number of entries) of time trials. Each team will complete one-time trial in each round.

b. The order in which teams will complete their time trial will not be announced prior to each round.

c. Each team with be given a 4-minute heads-up before placing their robot on the board.

d. Judges will not wait for teams that are making last-minute changes to start their time trial.

e. Teams will have a total of 6 minutes to prepare their robot on the board, complete each time trail, and score as many points as possible. Touching the robot after it starts navigating the course is considered as intervention.

f. No bonus points will be awarded for time remaining. In the event there is a draw, the time will be used as the tie-breaker.

3. General Regulations

a. Teams must declare their division (beginner or advanced) at the time of registration (March 1). Teams may elect to change their division until July 1, 2018, after which no division changes will be allowed.

b. A robot may NOT be used in both the “beginner” and “advanced” divisions.

c. An undergraduate student may be a member of both a “beginner” and an “advanced” team.

d. 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 time trial. Additional team members will be permitted in the setup/work area as long as space permits.

e. Wireless communication to the robot from a laptop or other mobile device is prohibited during the time trial. All commands, including stopping and starting, must be conducted by components physically attached to the robot (such as a push-button).

f. Flying devices are NOT allowed.

4. Scoring

a. 3 different colored apples

1. Red Apples (Ripe)
    - Removed from the trees and stored in the robot, are worth 5 points
2. Blue Apples (Diseased)
    - Removed from the trees and left on the ground (completion board), are worth 2 points.
3. Green Apples (Unripe)
    - Left on the trees, are worth one (1) point.
4. Any apples touched by the competitor (human interference) will receive no score for that apple.

b. Yield Monitoring (only for the advanced division)

1. The “apple orchard” is divided into 12 pre-determined zones (see the diagrams on page 10). The number of apples for each classification (i.e., red apples, blue apples and green apples) should be reported for each zone. Yield will be calculated based on a matrix. Teams will be expected to identify the number of apples by classification in each zone (a zone is a total of six trees, three consecutive trees on each side of the robot). A row would consist of three zones (see diagrams for clarification).
2. Scoring:
    - Accurate identification of an apple is worth 1 point for each apple and must be transmitted through xBee.
    - Incorrect counting for each zone will result in zero (0) points for that zone.

c. Autonomy Score (bonus)

1. Robots will be scored based on their degree of autonomy from human interaction. Each team will have 10 point credits as autonomy score.
2. Two (2) points per each interaction will be deducted from bonus autonomy score
3. Autonomy score (AS) will be calculated using the following formula:
    - AS = 10 – 2x (x = (number of interactions)
4. An interaction is any situation in which physical human intervention is initiated to aid a robot once the robot has begun to move on the competition surface. This includes but is not limited to:

- Moving a robot back to its starting position
- Pushing a robot to correct its direction of travel
- Manually articulating a device on the robot
- Resetting the robot's electronics
- Removing debris which obstructs robot functions

5. Robots which are placed on the board, but do not interact with any apples, will receive an autonomy score of 0 for that round.
6. Any apples that the robots interact with as a result of human interaction will receive a score of zero for that apple.

d. Additional Scoring Criteria

1. If robots are placed on the board, but do not interact with any apples (or at least report the yield map for the advanced division), the team will receive a score of zero autonomy (bonus) for that round.

5. Processor Restrictions

In an effort to level the playing field and reduce costs for teams, processor restrictions will be implemented for the 2018 competition. The processor restrictions are as follows:

a. Processors may not be embedded in consumer- or enterprise-grade electronics, such as laptop computer, NUC-like devices, tablets, mobile phones, or gaming devices.

b. Processors and RAM will be limited based on a credit allocation system.

c. Teams have a total of six (6) credits to utilize per robot. Teams may utilize the credits in any manner they wish for either the processor or RAM. Credits will be allocated in the following way:

d. One (1) credit for each 1.0 GHz of processing speed, rounded to the nearest 0.10 GHz of manufacturer stated clock speed.

e. One (1) credit for each 1.0 GB of RAM, rounded to the nearest 0.10 GB of manufacturer stated RAM.

f. Teams must present detailed manufacturer-supplied spec sheets of any RAM or processors at the time of the competition. Processors and RAM cards must be positioned on the robot such that the judges can visually inspect them during the competition.

Rankings and Prize structure

1. Rankings for each team will be determined by adding the two highest-scoring rounds together. The team with the highest combined two-round score will be the winner for that division.
    a. In the event that there is a tie, the time will be used as a tiebreaker.
    b. In the event that there is still a tie after the time is considered, teams will split the prize for that ranking, and the competition committee will revise the prize structure to fairly compensate all teams.
2. Prizes will be awarded for the top three teams in each division.
3. Prizes will also be awarded to the best poster, as determined by the judges.

4. Prizes will be awarded in the following ways:
    a. Trophies for top three teams in each division.
    b. Ribbons for top three posters, as voted by judges.
    c. Prize money for top three teams in each division:

Division	1st Place	2nd Place	3rd Place
Beginner	$500	$350	$200
Advanced	$800	$600	$400

COMPONENTS:

- Ping-Pong Balls: https://www.amazon.com/dp/B06XWNPM3H/_encoding=UTF8?coliid=I3BPYSFSIYWZHI&colid=1FIXJCE9E07DP
- Magnet: https://www.amazon.com/dp/B06XVPHMJL/ref=dp_sp_detail?psc=1
- Wooden Rods: https://www.amazon.com/dp/B00XQI2F3I/_encoding=UTF8?coliid=I21YDOPW9Y5ZAQ&colid=1FIXJCE9E07DP
- Super Glue: https://www.amazon.com/dp/B001IY82FM/_encoding=UTF8?coliid=I3PI83CK8QPKPS&colid=1FIXJCE9E07DP
- Corner Brace: https://www.lowes.com/pd/Stanley-National-Hardware-1-5-in-Metallic-Corner-Brace/3037433
- Plywood: https://www.lowes.com/pd/Pyro-Guard-3-4-CAT-PS1-09-Pressure-Treated-Southern-Yellow-Pine-Plywood-Sheathing-Application-as-4-x-8/50318425
- Flat Washer: https://www.lowes.com/pd/Hillman-24-Count-x-1-2-in-Zinc-Plated-Standard-SAE-Flat-Washer/3035986

FOR QUESTIONS ABOUT WIRELESS COMMUNICATION, PLEASE CONTACT:

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FOR OTHER QUESTIONS ABOUT THE COMPETITION, PLEASE CONTACT:

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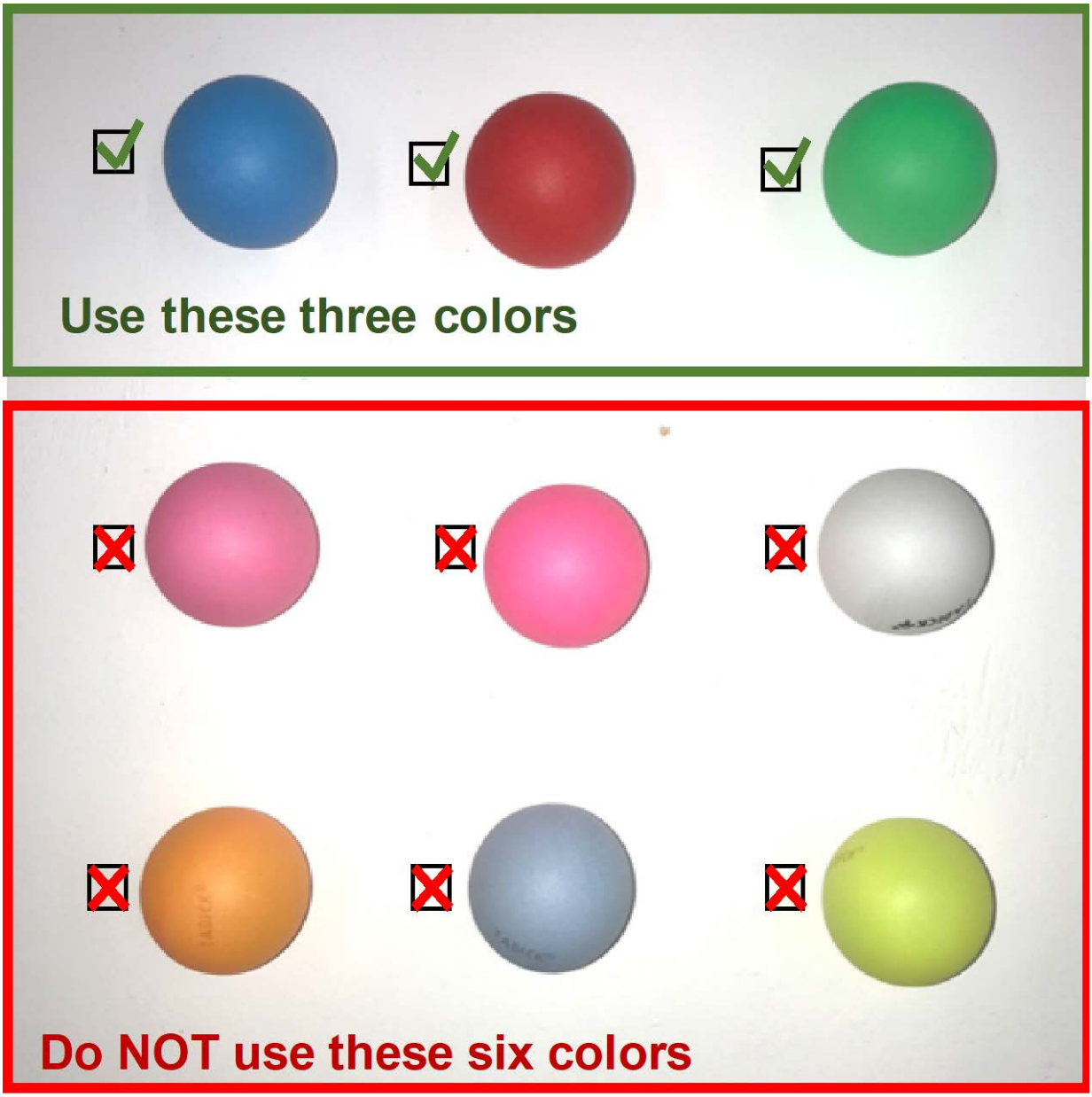
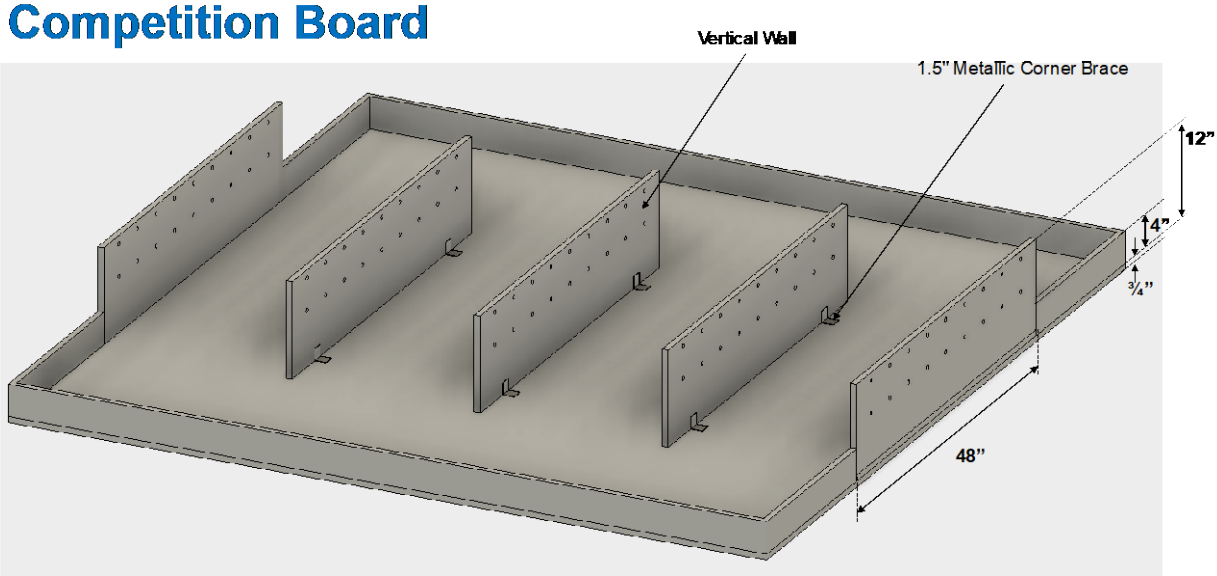
Contest Chair, 2018 ASABE Student Robotics Challenge
apourreza@ucdavis.edu

Please only use the red, green, and blue ping-pong balls as shown in the following figure:

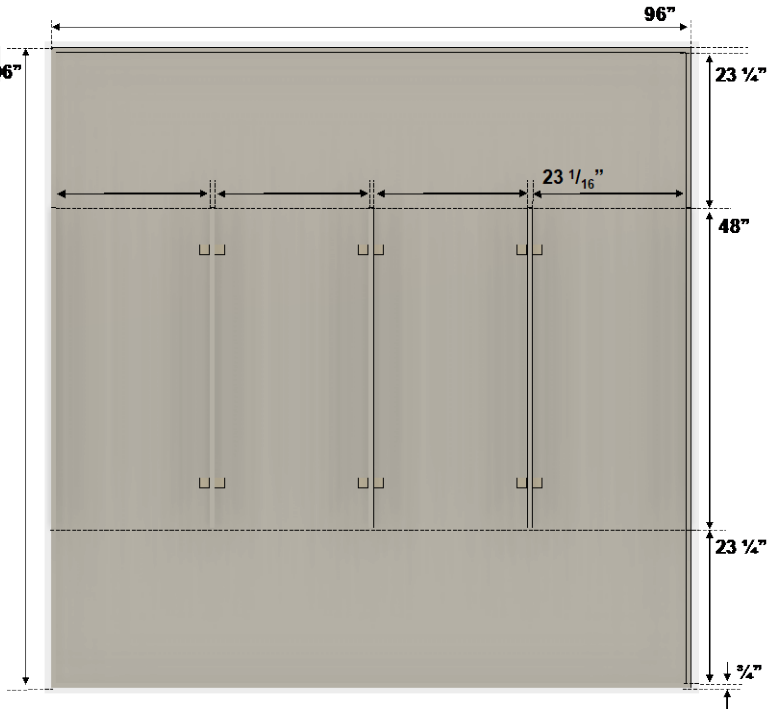


Competition Board

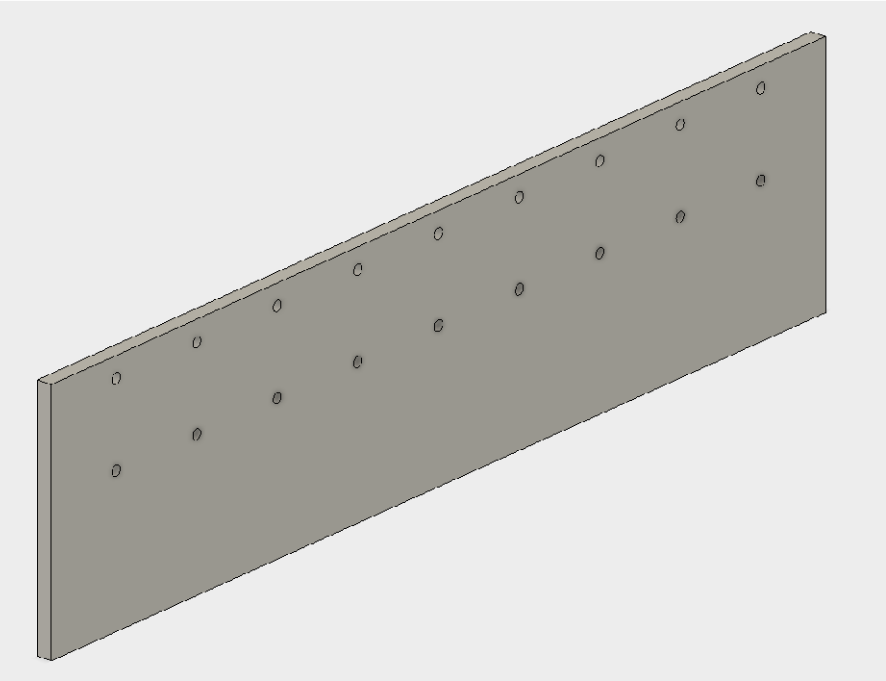


The competition board, the vertical walls, and the Board Edges should be painted with white color using a standard matte interior paint, such as BEHR Premium Plus Ultra Medium Base Plate/Matte Interior Paint and Primer.

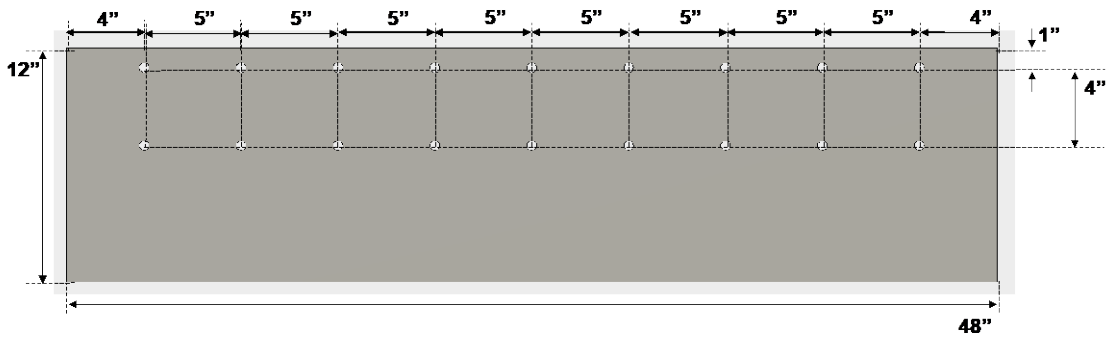
Competition Board
Top View



Vertical Wall



Vertical Wall
Cross Section

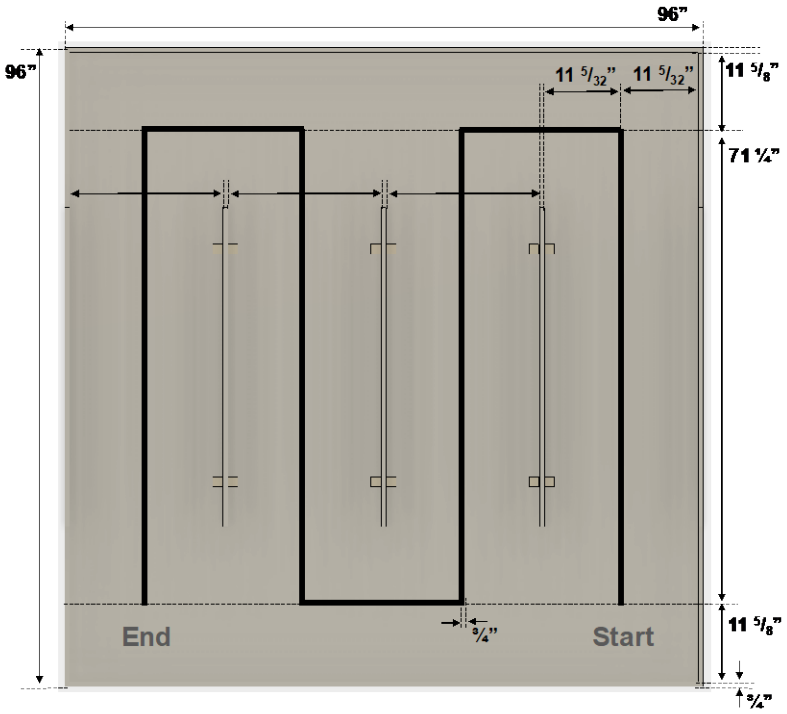


18 holes in two rows
Hole diameter = ½”

Black Guide Line Layout

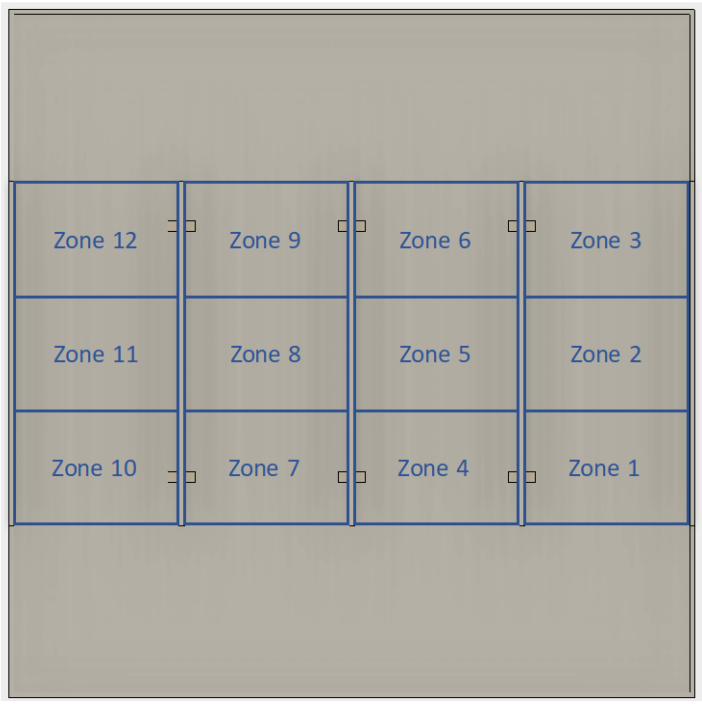
(For beginner class)

- The width of the black guide line is ¾”.
- The measurements for positioning the tapes are from the center of the tape.

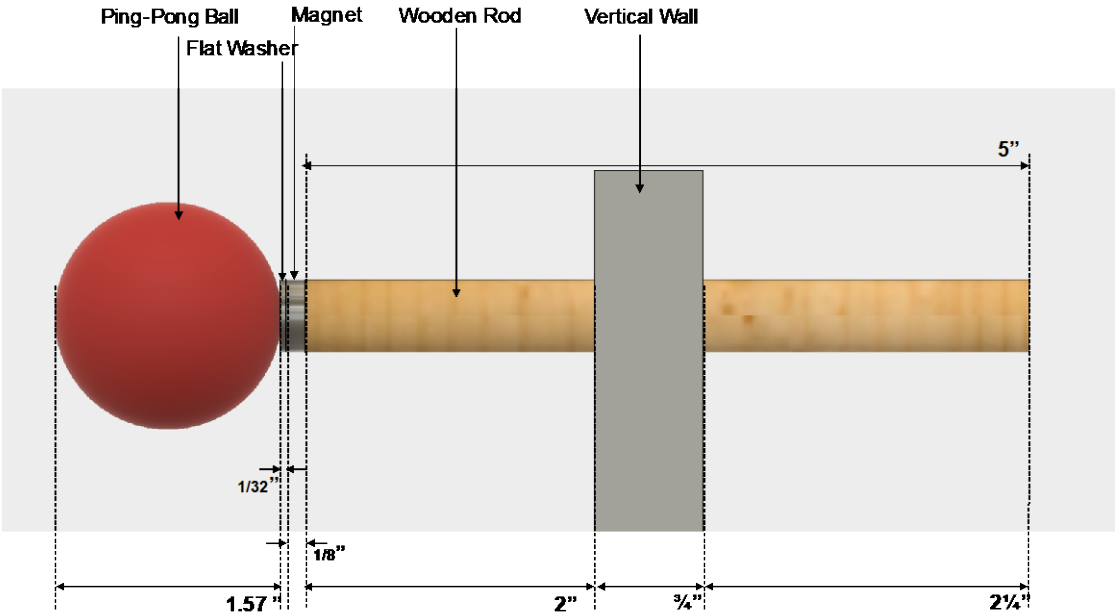


Yield map zones layout

(For advance class)

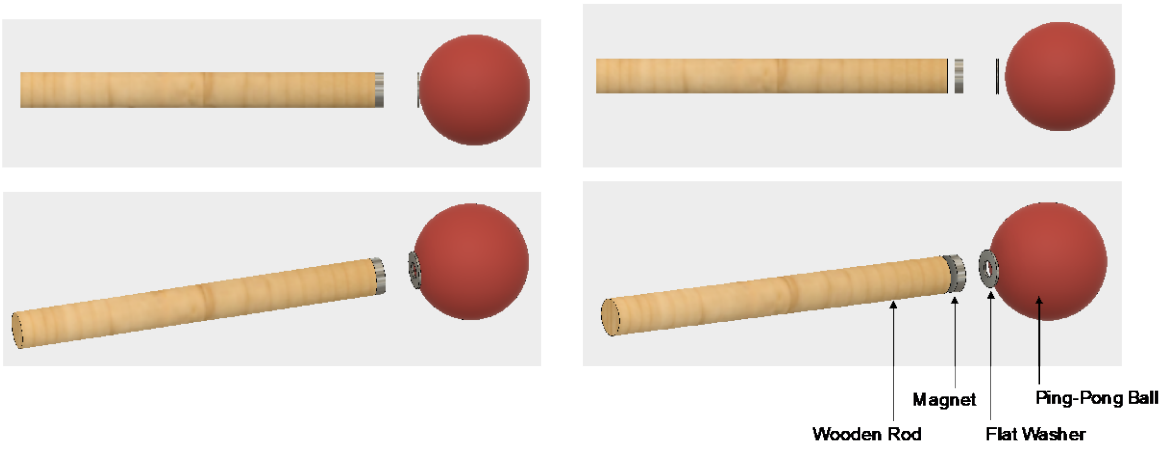


Ping-Pong ball attachment to Vertical Wall

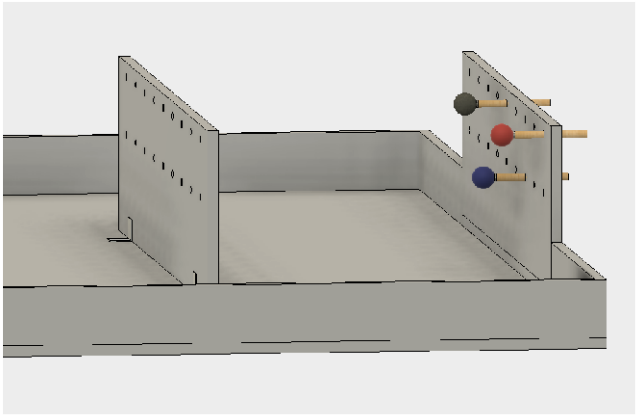


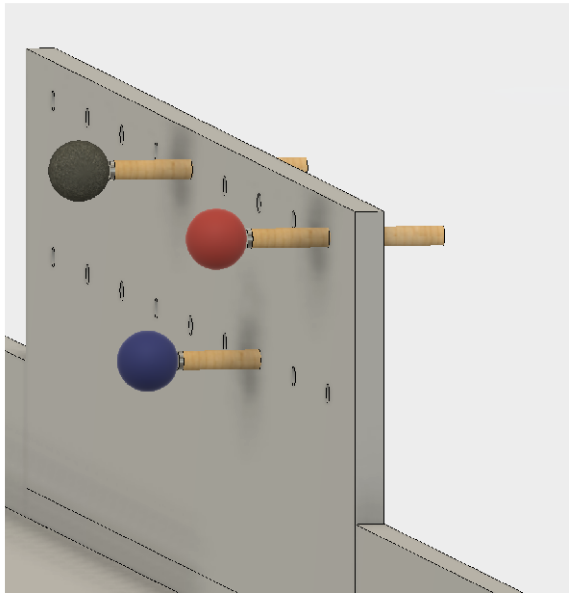
Ping-Pong ball - Magnet - Wooden Rod

- A flat washer (1/2” diameter) is glued to the Ping-Pong ball
- A magnet is glued to the Wooden Rod

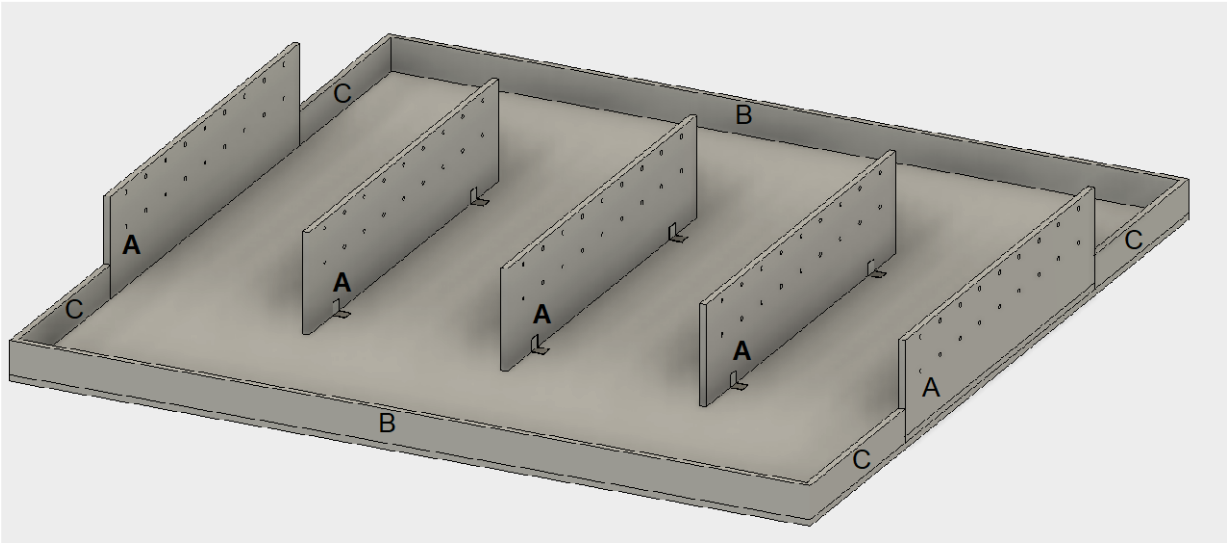


Ping-Pong ball attachment to Vertical Wall



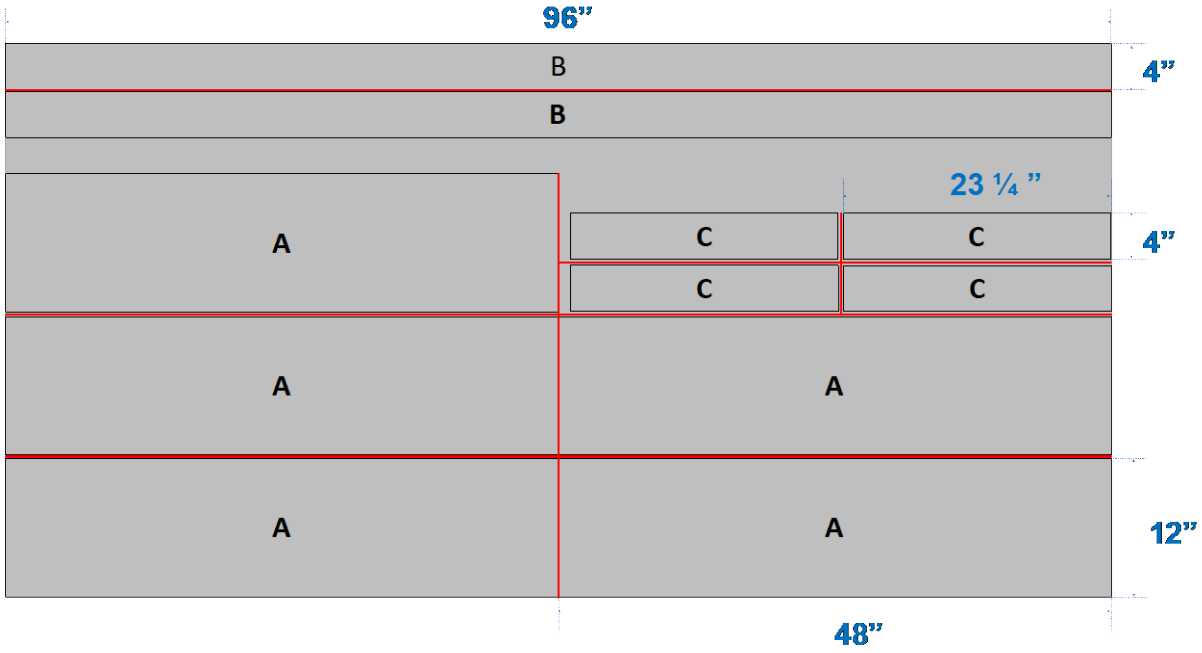


Board Component



Plywood Cut Instruction

Vertical Walls: 5 x A
Board Edges: 2 x B
4 x C



The red lines are indicating a 0.125 inch saw blade kerf thickness when cutting plywood.