LAWRENCE TECHNOLOGICAL UNIVERSITY ROBOFEST 2024

GAME 010 1010

Autonomous Taxi

V 3.0 – Final Version for 2024 Season

This file can be found on the **Game** page on the website

Coaches are responsible for communicating rules updates to participants

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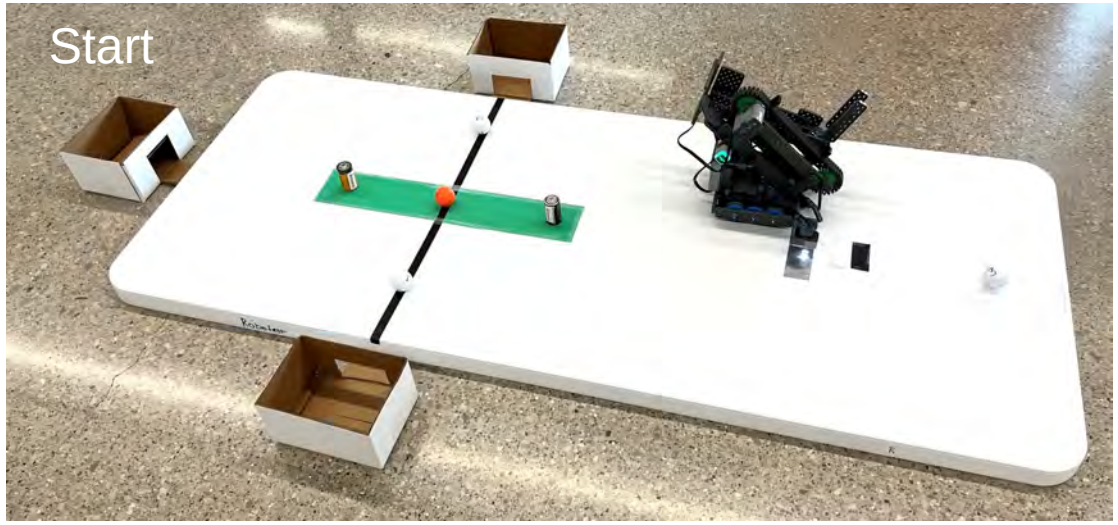
1.1: Game Scenario

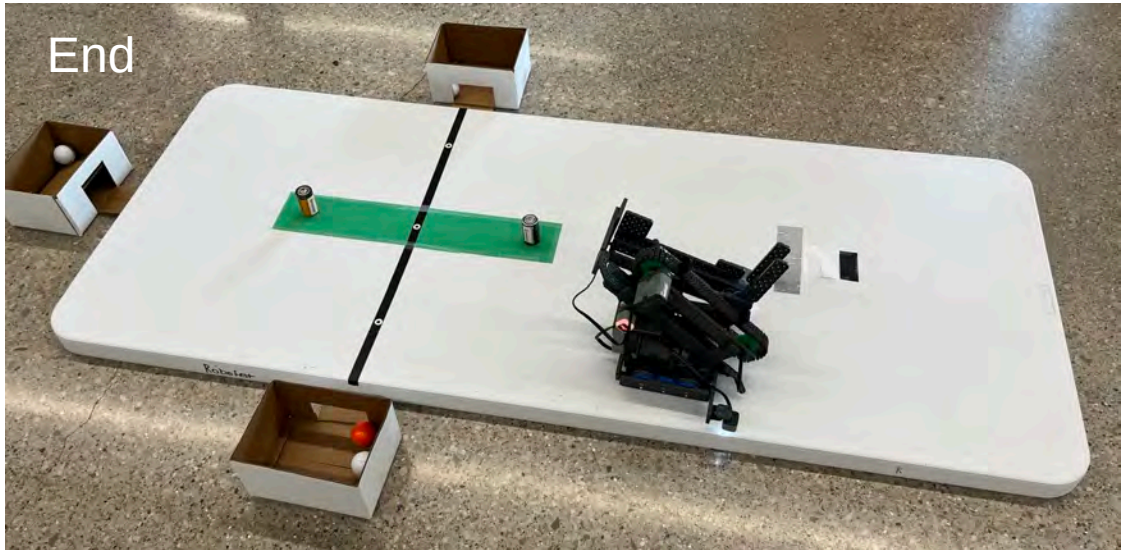
For those who cannot or choose not to drive, self-driving vehicles could be safe and reliable transportation. Those with a disability or the elderly would be able to travel without putting others at risk. Self-driving vehicles could reduce the stress of driving, eliminate driver distraction, lower the number of accidents, and make traveling more sustainable.

Imagine a world where an autonomous taxi can take people to where they want to go or deliver their food. In addition, imagine if the autonomous vehicle can help an elderly or disabled person get to the second floor of a building.

Qualifier Category: Teams compete at local qualifiers, or through video submission, to advance to the Robofest World Championship Finals

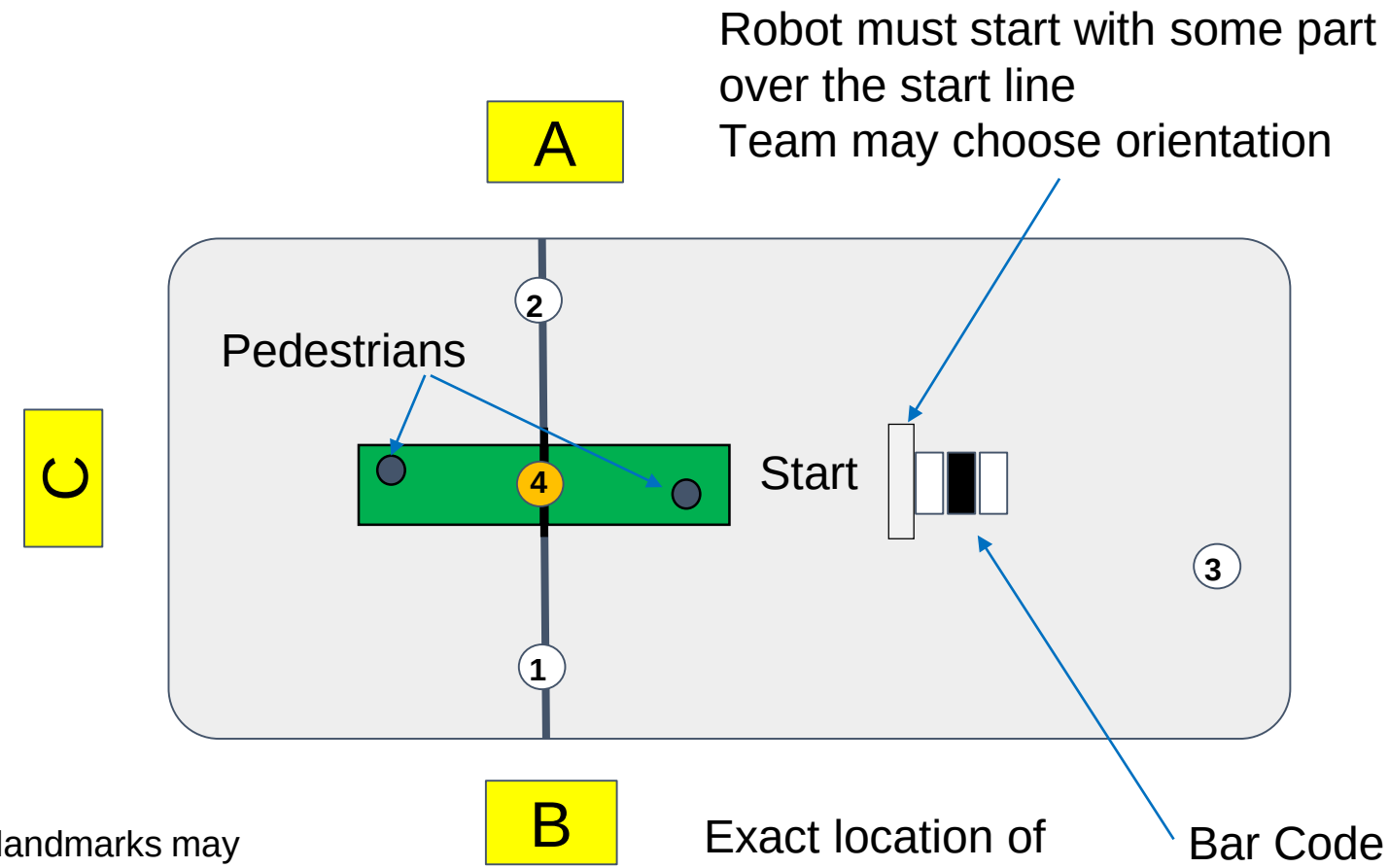
1.2: Game Synopsis





- Autonomous vehicle has to take three passengers and a food delivery to their desired destinations while obeying traffic laws and avoiding collisions
- For a game run, max 2 minutes are given and one full-reset is allowed
- All the tasks must be done autonomously without any external help
- UTF (Unknown Tasks and Factors) will be unveiled just before the 30 minute work-time:
  - Passenger destinations (except passenger 3 for Sr Division)
  - Game-Ending Task
  - Items/landmarks may be added for the Game-Ending Task
- STEM Learning Goals
  - Geometry/degrees/logic/computational thinking
  - Localization and navigation
  - Object detection and manipulation

1.3: Game Details - Jr Division

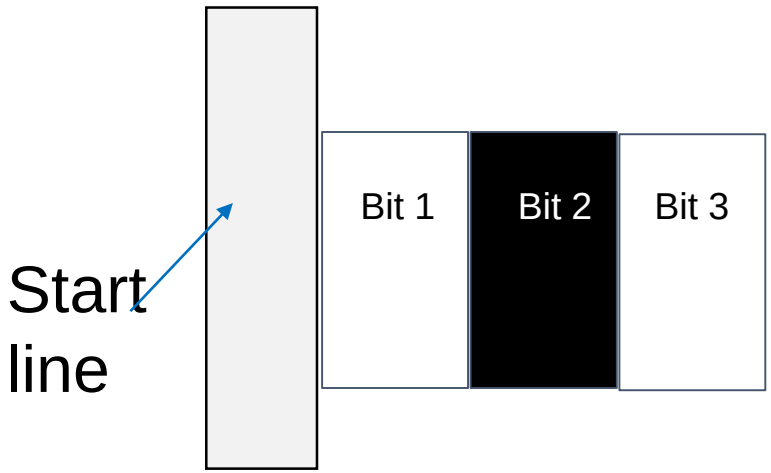


Note: Items/landmarks may be added or modified for the World Championship Finals

- Passenger 1 needs to go to Building C second floor for full points (see scoresheet)
- Passengers (2, 3) have to be brought to Building A,B or C
- Passenger (2, 3) delivery destinations unveiled before worktime
- Food (orange ball 4) delivered to B
- Robot must avoid two pedestrians in the green median
- Robot must stop for at least 1 sec each time it completely crosses the line or will get a penalty for each violation

1.3: Bar Code - Jr Division

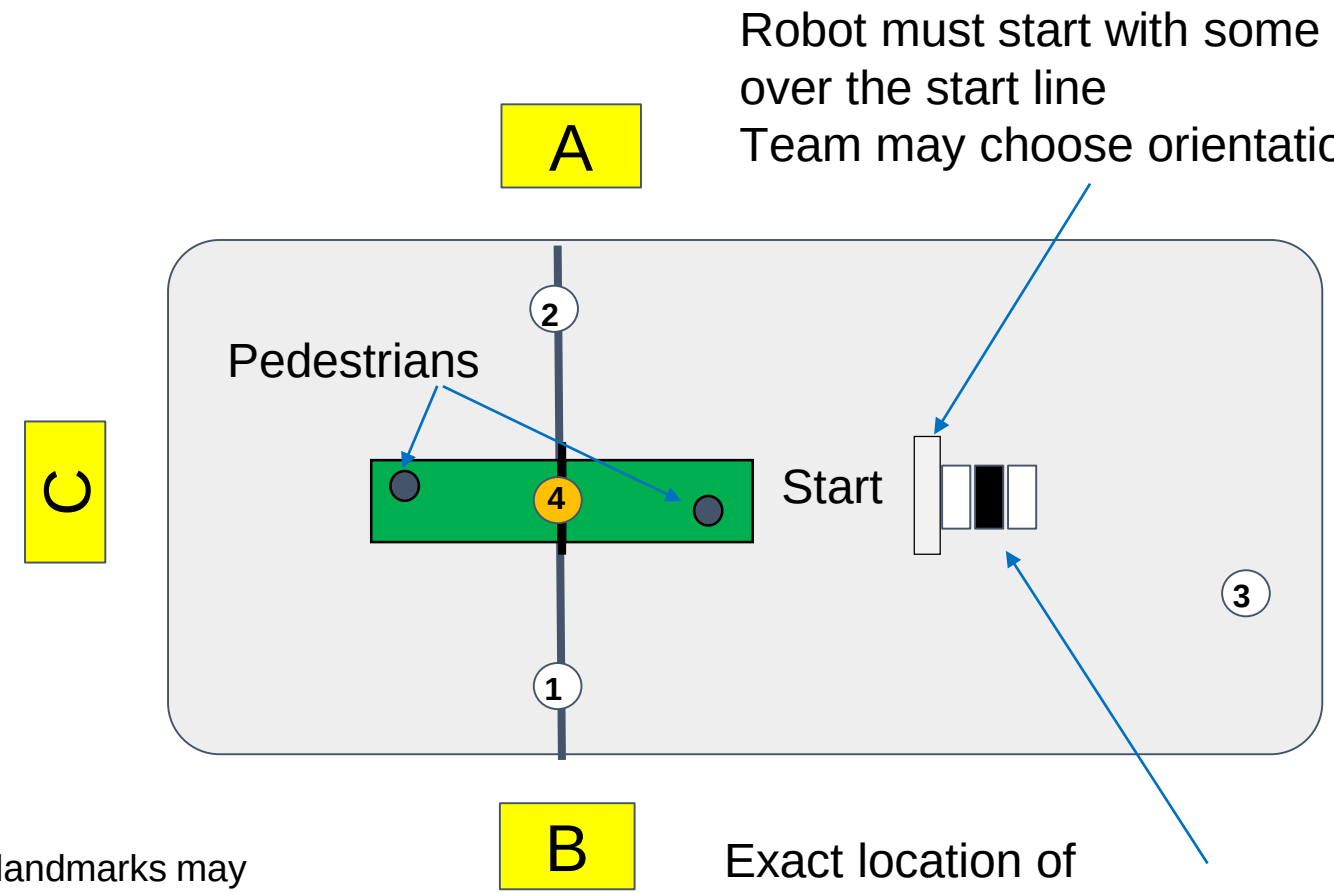
- Bar code may be used for the end task
- Code unveiled after impound



Examples:

- Display the color of Bit 2 at the end of the round
- Stop in front of Goal A if Bit 1 is black, stop in front of Goal B if Bit 1 is white

1.4: Game Details - Senior Division

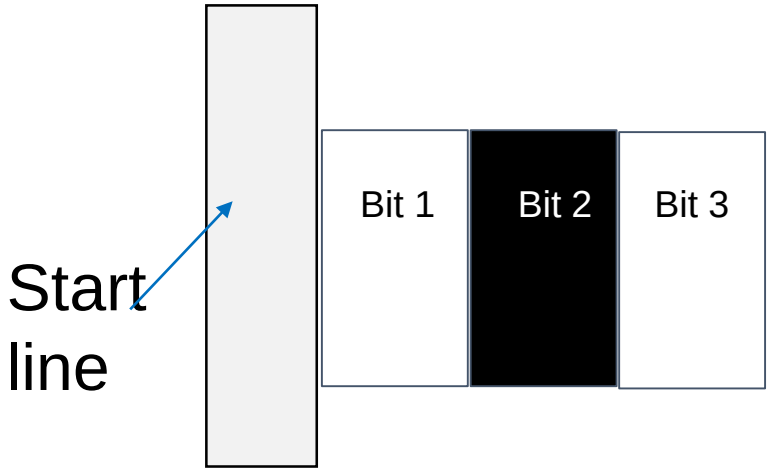


Note: Items/landmarks may be added or modified for the World Championship Finals

- Passenger 1 needs to go to Building C second floor for full points (see scoresheet)
- Passengers (2, 3) have to be brought to Building A,B or C
- Destination for Passenger 2 unveiled before work time
- Destination for Passenger 3 is unveiled via a bar code just before the start of the round
- Food (orange 4) needs to be delivered to Building B
- Robot must avoid two pedestrians in the green median
- Robot must stop for at least 1 sec each time it completely crosses the line or will get a penalty for each violation

1.4: Bar Code for End Task - Sr Division

- As with Jr Division, bar code may be used for the end task for Sr Division
- Code unveiled after impound

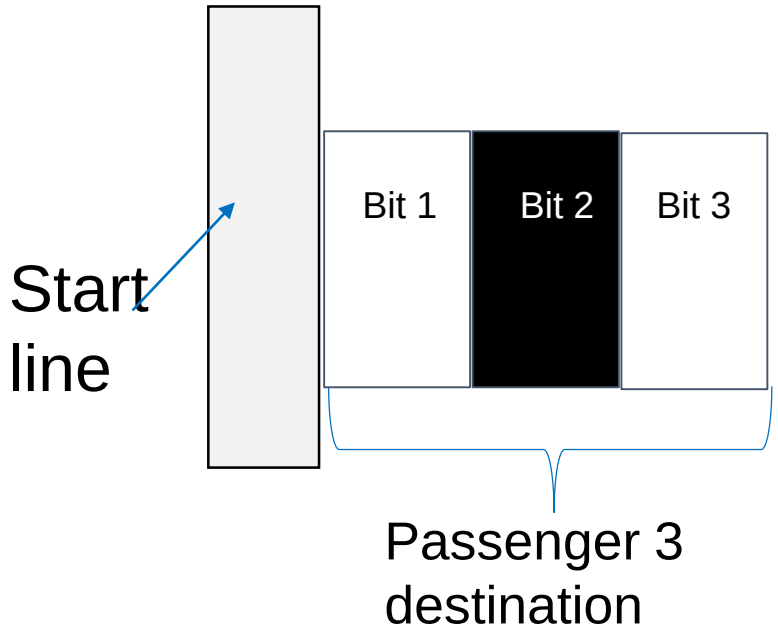


Examples:

- Display the colors of Bit 1, Bit 2 and Bit 3 at the end of the round
- Stop in front of Goal A if Bit 1 is black, stop in front of Goal B if Bit 1 is white
- Display the sum of Bit 1 + Bit 2+ Bit 3 (assume white 0, black =1)

1.4: Bar Code for Destination - Sr Division Only

- 3 bit sequence used for destination of Passenger 3
- Each segment is a binary digit representing a destination
- White= 0, Black =1



Bit 1	Bit 2	Bit 3	Destination
0	0	0	A
0	0	1	A
0	1	0	A
0	1	1	B
1	0	0	B
1	0	1	B
1	1	0	C
1	1	1	C

THIS EXAMPLE: Passenger 3 to Building A

2: Age Divisions, Team Size and Fees

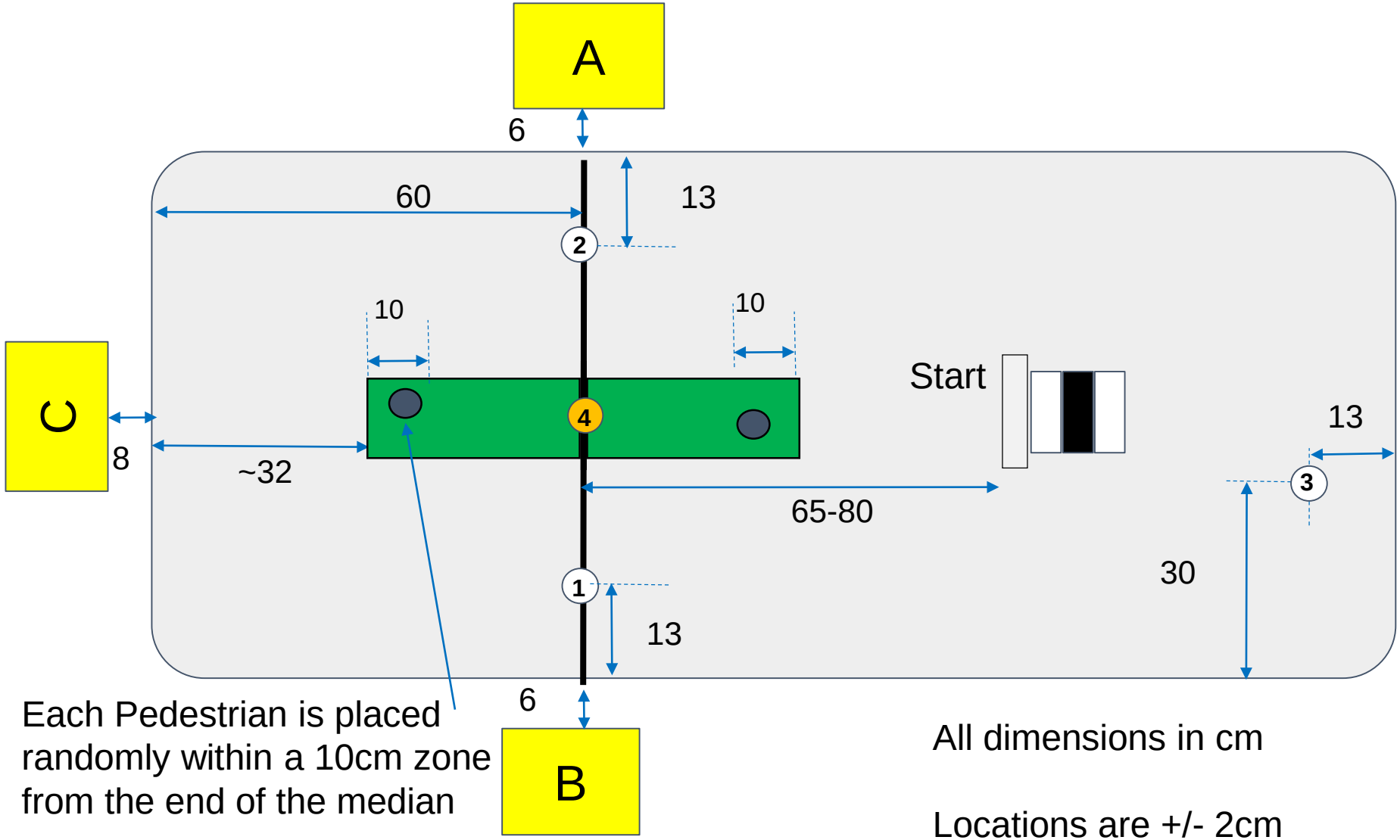
- Age Divisions:
  - Junior Division (Grades 5-8)
  - Senior Division (Grades 9-12)
- Team Size: Maximum five (5)
- Team Registration Fee:
  - $75 - Local or Video Qualifier (may differ for international events)
  - $75 - Robofest World Championship Finals (if team advances)
- Related important document - Robofest 2024 General Rules
- Each team member must bring the signed Robofest Consent and Release Form on the day of the event, if not completed online

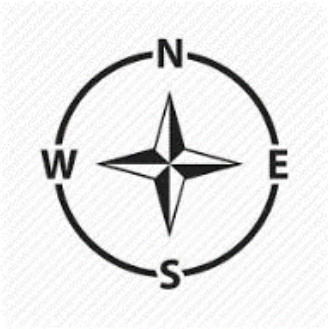
3: Video Demos

- Video Demo
- Video Demo 2

Additional demo videos may be available on the website

4: Field Specifications





Start line, bar code, median, Ball 4, and Building C centered North/South

Each Pedestrian is placed randomly within a 10cm zone from the end of the median

All dimensions in cm

Locations are +/- 2cm

5: Differences Between Jr and Sr Divisions

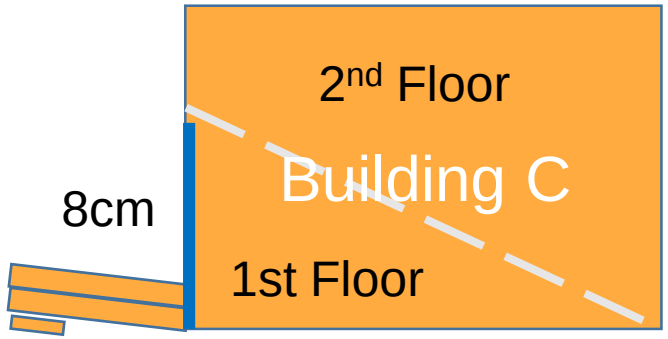
	Junior (5th ~ 8th grades)	Senior (9th ~ 12th grades)
Game-Ending Task	Easier – Unveiled before worktime	Harder – Unveiled before worktime
Destination of passenger 2	Unveiled before worktime	Unveiled before worktime
Destination of passenger 3	Unveiled before worktime	Unveiled **after** impound using bar code
Number of onboard computer controllers	One	No limit
Vision sensor	Not allowed	Allowed

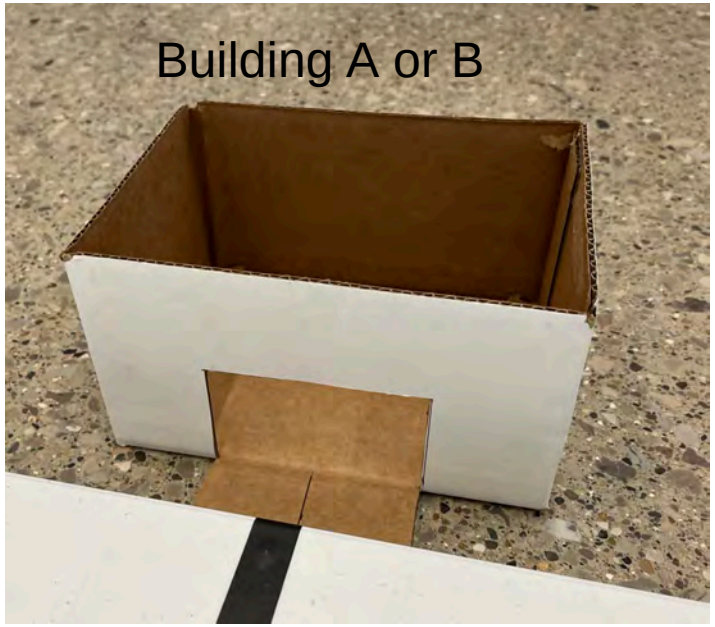
6: Materials List

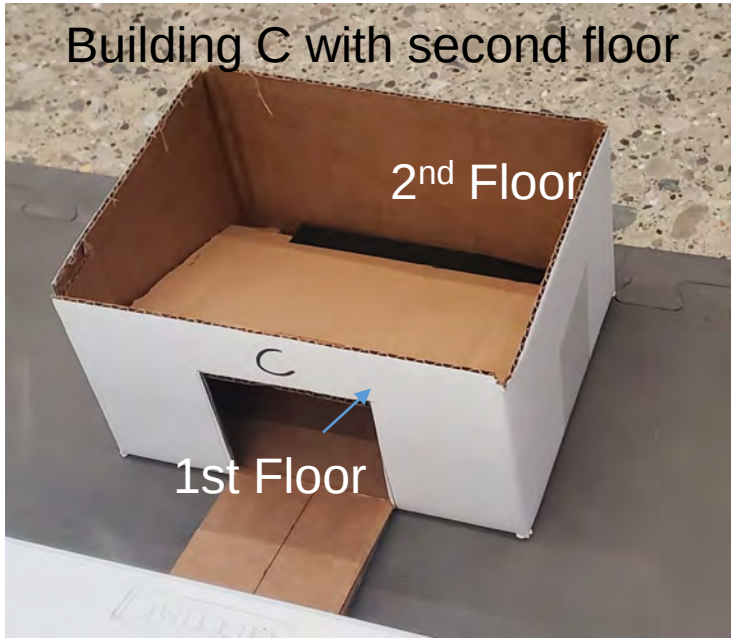
- Field: 6ft plastic folding table placed on the floor:
  - 30in x 72in (actual size is about 75cm x 182cm) - Recommended brand is “LifeTime”
  - Corners are rounded with a radius of 4cm ~ 7cm. Thickness is about 4.5cm
  - Surface is light in color such as white, gray, or almond; exact size, color, brightness, and edge shape is unknown until competition
  - Fold-In-Half plastic tables can be used if the center seam is covered with tape similar to the table color
  - Pieces of plywood cut similarly to the folding tables can be used if plastic folding tables are not available
- Floor color under tables: Unveiled at the beginning of competition day, possibly not homogeneous. However, all the colors should be noticeably darker than the table color
- Passengers/Food objects: Golf Balls, (3) Standard white=Passengers (link) and (1) orange=Food (link)
- Buildings: 3 Boxes, approx. 8”x6”x4” (20cm x 15cm x 10cm) See Section 6.1 (link)
- Pedestrians: 2 D sized batteries, or object of similar size.
- Start line: Foil tape, approx. 5cm wide x 16cm long
- Stop line: Black electrical or painters tape: approximately 19mm wide
- Median: Green paper (one standard sheet cut lengthwise into two approx. 28cm x 11cm pieces)
- Bar code: Black and/or White paper strips (30mm x 60mm) (or use the Bar Code Field Elements template: link)
- Hole reinforcement stickers: used to mark the location of objects (link)
- Transparent Tape: used to secure the median, bar code and boxes to the table

6.1: Buildings

- Balls can be scored from above or through the slot
- Two Building Types
  - Building A and Building B: 10cm wide x 6cm tall slot
  - Building C: 8cm wide x 8cm tall slot, plus a second floor
- Outside color can vary, but flap must be dark so it contrasts with the table, may have graphics

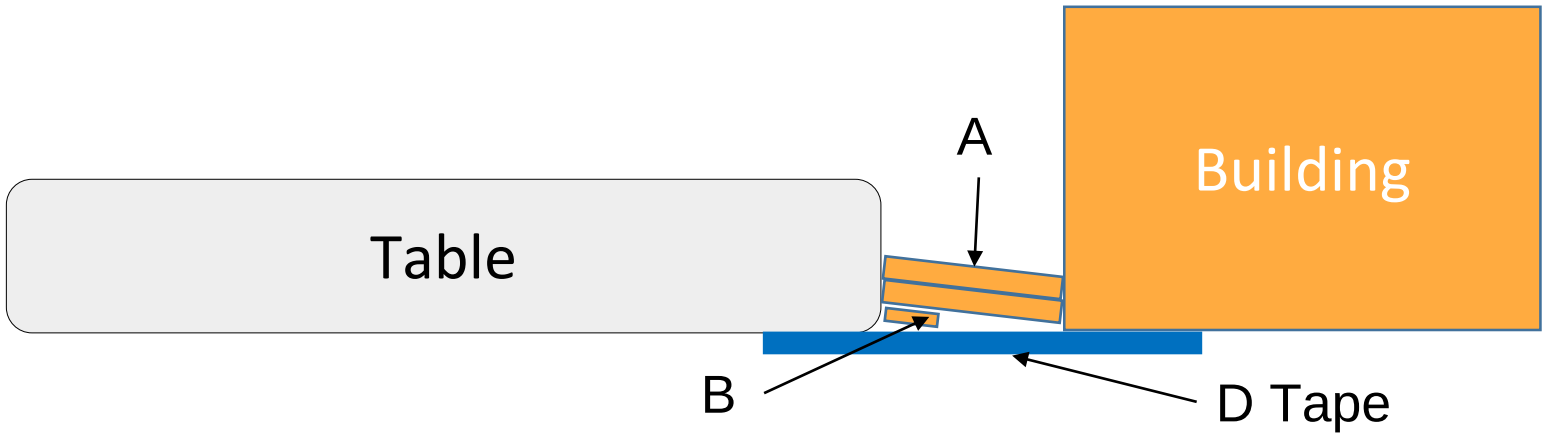


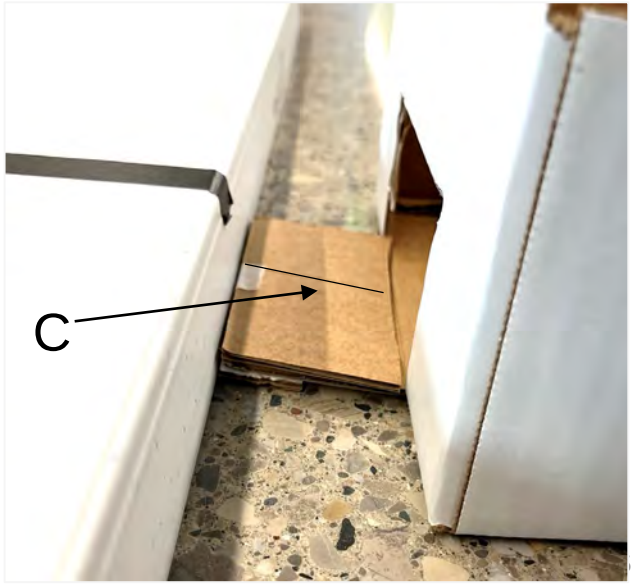




6.1: Building Flap Detail

A. Add an additional layer of cardboard (tape or glue) to the flap to help keep balls inside
   - Buildings A and B: 10cm x 6cm
   - Building C: 8cm x 8cm
B. Add a 1” wide piece of cardboard under front of flap to form a ramp
C. Mark the centerline of the flap with pen or pencil to help align to table
D. Tape underside of Building to underside of table

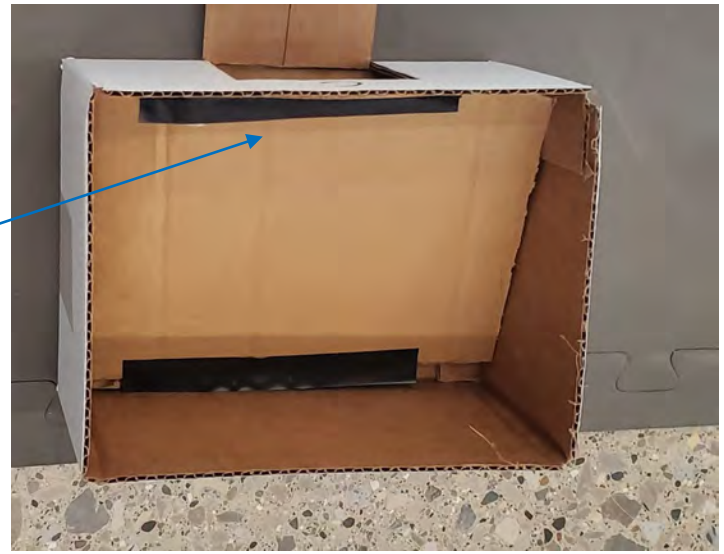




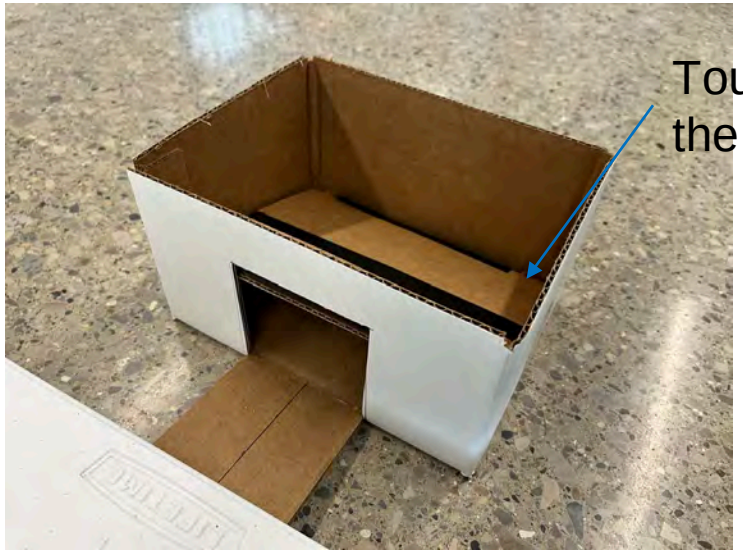
6.1: Building C Second floor

8” x 6” (20cm x 15cm) piece is used to make the second floor

- Can be made by taping two of the long box flaps together



Just above slot opening

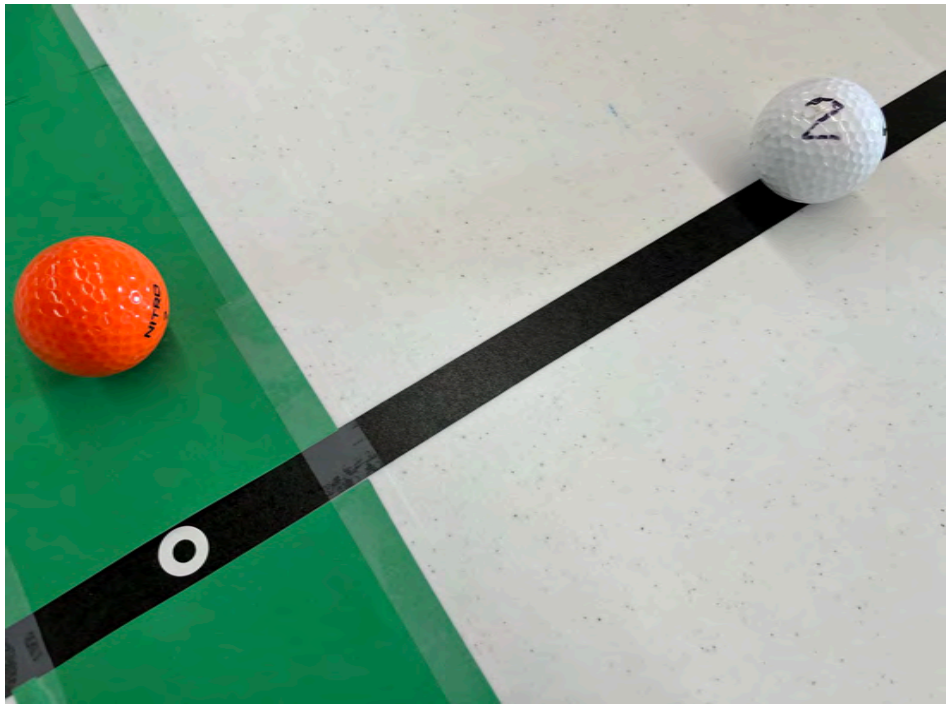


Touching the floor

- Passenger 1 needs assistance to go to the second floor of Building C
- Highest points awarded for delivering Passenger 1 to the second floor, and lower points for delivering through the slot to first floor
- Passengers 2 and 3 can be dropped off at either floor (from above or through the slot) for the same points

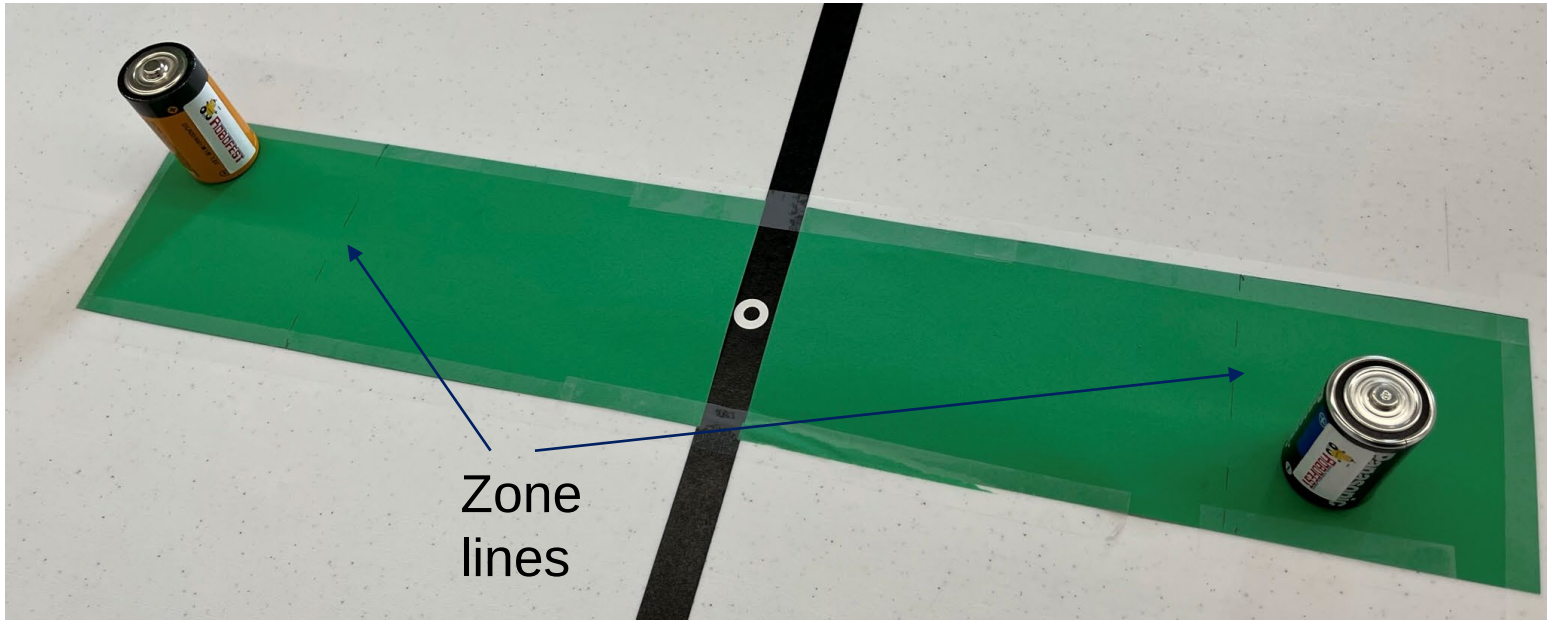
6.2: Passengers and Food Objects

- Hole reinforcement stickers are used to mark locations
- Label white passenger balls with a number (1, 2, or 3)
- Orange food ball does not need to be labeled



6.3: Green Median

- Cut two 11cm x 28cm (4 ¼” x 11”) pieces of green paper
- Mark 10cm zones with dashed lines
- Align short edge of paper with edge of black line and tape down with transparent tape
- Total length of median is approximately 58cm



7: Robot Specifications

- Team may only compete with 1 robot at a competition
- Robot must be created by students. If a team is identified to have a robot too similar to another robot (including robots from the same organization and both Jr and Sr divisions) or clearly not their own, team will be subject to investigation and possible disqualification
- Any robot kit/material may be used to construct your robot including tape, glue, bolts and nuts, rubber bands, etc. (Scoring Objects i.e. golf balls and batteries are not allowed)
- **Maximum length and width: 35cm x 35cm *including expansion (must show during inspection)***
- Height limitation: none
- Weight limitation: none
- Any number of sensors/sensor types (except vision not allowed for Jr Division) unless harmful to humans
- Any number/type of motors/servo motors (multiplexor is OK to use)
- All the wheels for driving must touch the table surface during inspection
- Labeling requirements:
  - Robofest Team ID on any visible surface – (Team Name optional)
  - “Front” indicator
- Display screen for any Game-Ending Task that requires robot to display numbers
- Robot must be started using a button or sensor on the robot (not by tablet, computer, etc)

8: Violations, Full-Reset, End of Run Declaration

- When any of the following violations occur, Judges shall stop the game play (and robot if still moving) immediately to avoid further disruption of the field:
  - Human touches the robot or field materials. Once the robot starts moving, the player cannot touch it
  - Robot falls off the table (any part of the robot touches the floor)
  - Any other illegal activities that a Judge determines
- The team can request a one-time full-reset (with penalty points) at any time. If reset is selected, time continues to run while Judges reset the table
- Team may declare the end of the run at any time. Players should not move the robot until instructed by the Judge
- If the robot is still moving when team calls “end of run” (or at the time limit) no points will be awarded for the Game-Ending Task which requires the robot to stop

9.1: Procedure/Rules to Play 2 Rounds (1/3)

- Only contestants are allowed to access the pit area, team tables, practice fields, and official game fields throughout the competition, including during the setup time before the opening ceremony, during work time, and breaks
- When Unknown Tasks and Factors (UTF) are unveiled, teams will be provided a hard-copy of the UTF and/or it will be projected/displayed on a screen. See 9.3 and 9.4 for UTF examples
- Teams will be given a 30 minute work-time after UTFs are unveiled to work on their robots. Prior to the start of the work time, all people, except contestants and authorized staff/volunteers, will be **dismissed** from the competition area(s)
- During the practice time, teams must share the fields

9.1: Procedure/Rules to Play 2 Rounds (2/3)

- All teams must submit their robot to the impound area when the 30 minute work-time has expired. Robots may be taken to be impounded early. Only one team member should deliver the robot to the impound table. Penalty may be applied if not impounded in time
- During the impounding process, Judges will inspect the robots. (Size of the robot, Team ID, “Front” label, number of computer controllers, etc.)
- No power will be supplied at the impound table and the entire robot must be impounded, including rechargeable batteries
- Teams will compete in a pre-determined order decided by the site host
- During the Game Rounds, all team members must remain in the team spectator area – no pit access allowed

9.1: Procedure/Rules to Play 2 Rounds (3/3)

- When a team is called to compete, a maximum of two contestants per team are allowed to retrieve the robot from the impound area and to be present at the playing field during the run
- Judge (or Emcee) will check if (1) timer is ready (2) Judges' are ready (3) teams are ready. Then count down "3-2-1 - Go" to start a Game Run
- Contestants must stay near the Start Zone. They should not follow the robot. They can approach the robot only to end the run, request a reset, or when Judge tells them
- Final scoring is done after the run is over
- A team member must sign the score card to confirm the team's score
- Teams will play two rounds, each round will have a different set of UTF's (Unknown Tasks and Factors)

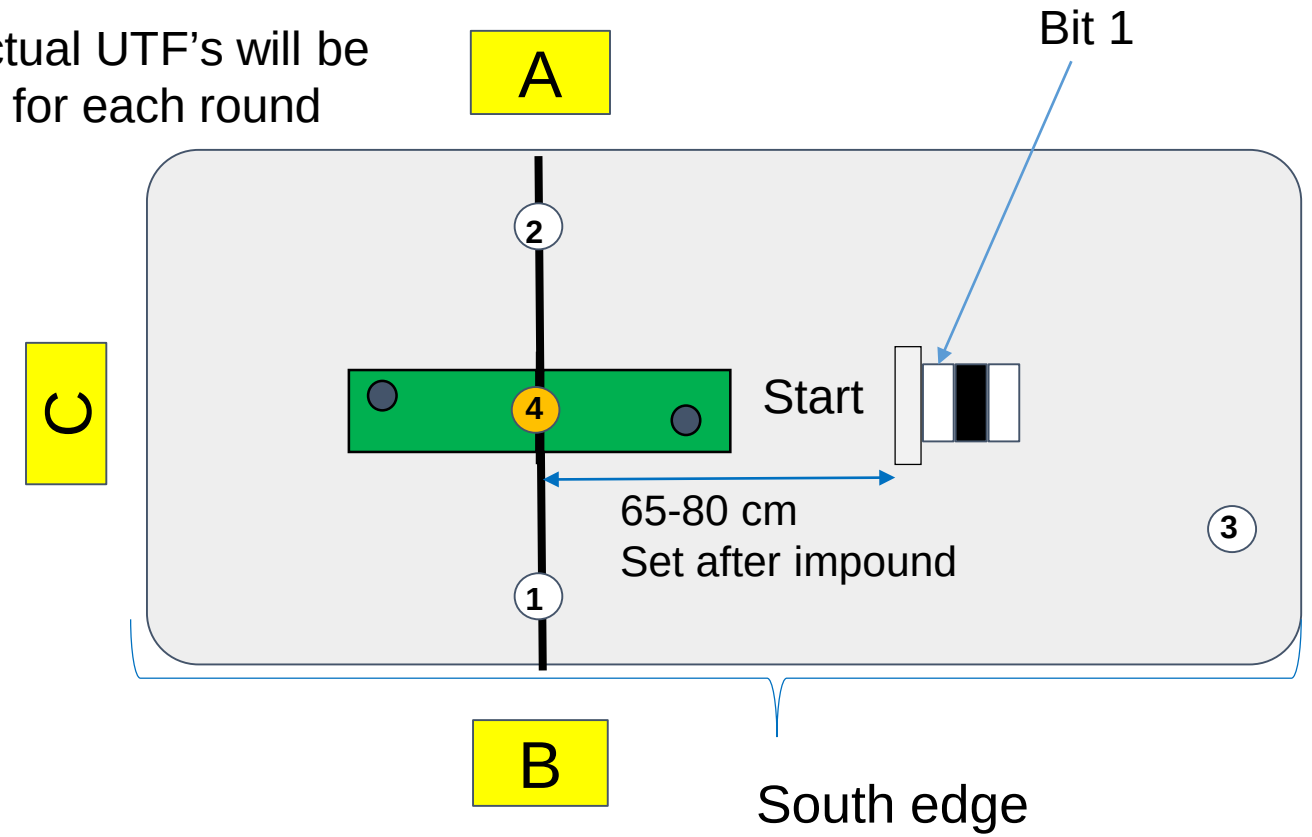
9.2: Score Card

https://www.robofest.net/images/2324/Game24Scorecard.pdf

Judging Items (all but item #7 to be checked at the end of the run)			Count	Actual Count	Point Value	Score Earned/Lost	max value
#1	Passenger 1	Building C Second Floor	0 (no) 1 (yes)		20		20
		Building C First Floor	0 (no) 1 (yes)		12		
		Building A or B	0 (no) 1 (yes)		10		
		Moved	0 (no) 1 (yes)		5		
#2	Passenger 2	Correct Building	0 (no) 1 (yes)		15		15
		Incorrect Building	0 (no) 1 (yes)		10		
		Moved	0 (no) 1 (yes)		5		
#3	Passenger 3	Correct Building	0 (no) 1 (yes)		15		15
		Incorrect Building	0 (no) 1 (yes)		10		
		Moved	0 (no) 1 (yes)		5		
#4	Food (orange)	In Building B	0 (no) 1 (yes)		15		15
		Moved	0 (no) 1 (yes)		5		
#5	Pedestrians	In green median (any part touching green)	0, 1, 2		5		10
		On table completely outside green median	0, 1, 2		2		
		Off table	0, 1, 2		-1		
#6	Game Ending Mission achieved		0 (no) 1 (yes)		15		15
#7	Stop Line violations - Tally below for round (restart tally if reset is requested)		no maximum		-2		0
#8	Robot remained intact throughout the run		0 (no) 1 (yes)		10		10
#9	Reset was requested (reset penalty)		0 (no) 1 (yes)		-3		0
Stop Line violation tally:			TOTAL SCORE Total maximum score = 100				100
Stop Line violation tally restarted if reset is requested:			Time Left in Seconds Record only if score is 100				

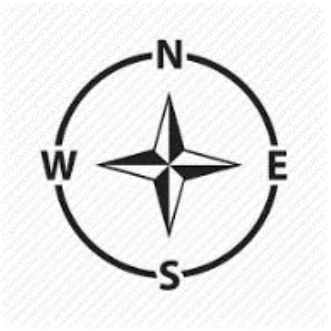
9.3: UTF Example (Jr)

Note: actual UTF's will be different for each round



Passenger	Destination
1	C
2	A
3	B

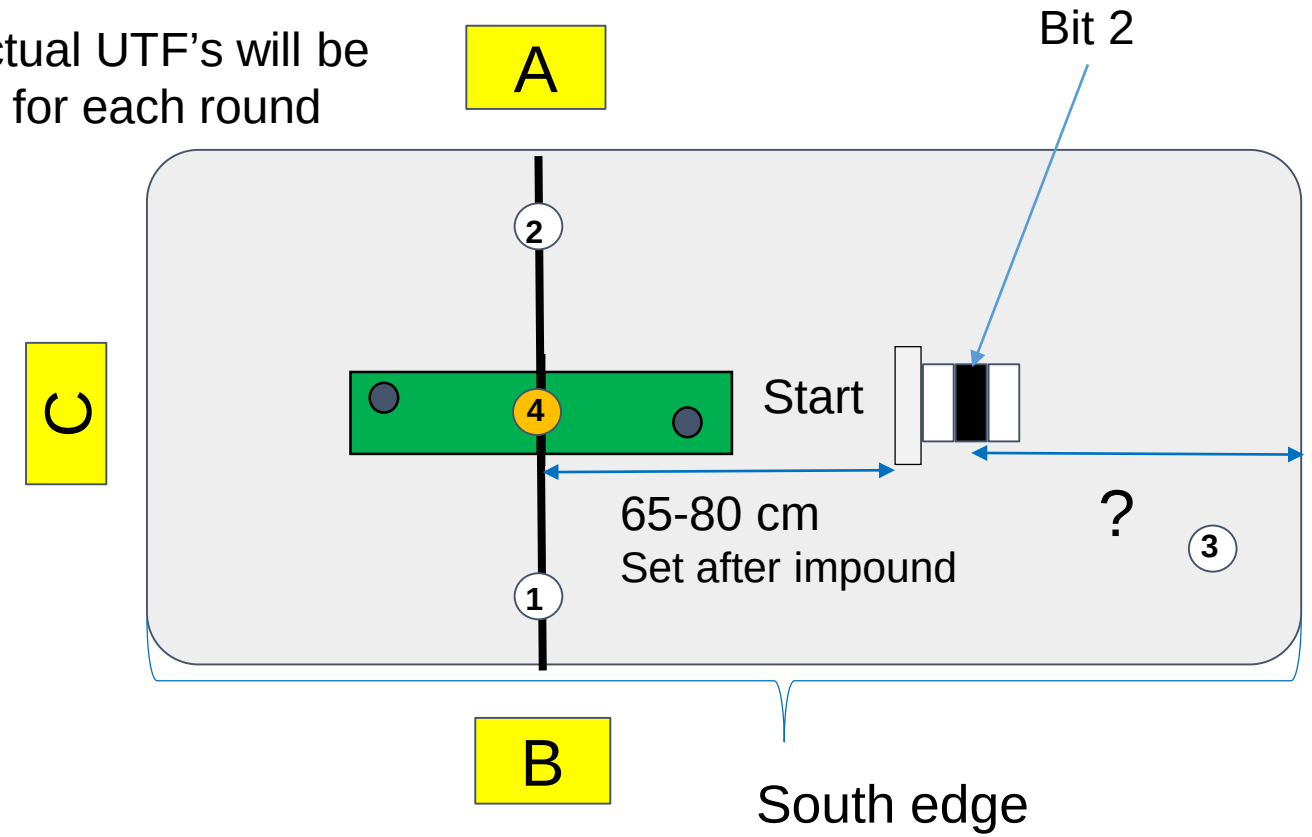
Exact location of start line and bar code will be unveiled after impound



Game-Ending Task: the robot must be stopped with a sensor positioned over the south edge of the field and displaying the status of Bit 1 (0 if white, 1 if black)

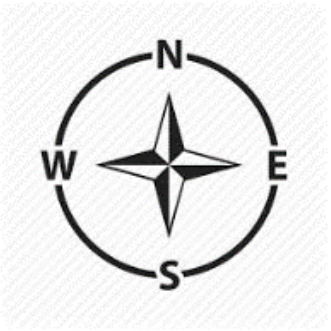
9.4: UTF Example (Sr)

Note: actual UTF's will be different for each round



Passenger	Destination
1	C
2	A
3	?

Exact location of start line and bar code will be unveiled after impound



Game-Ending Task: the robot must be stopped with a sensor positioned over the south edge of the field and display the distance from Bit 2 (midpoint) to the East edge of the table in centimeters (cm)

9.5: Rules to Determine Winners and Break Ties

- Winners in each age division will be decided by the **(Best + Average)/2** score of the 2 rounds
- Tie breakers will be: (1) best score of two rounds, (2) highest time left from best score (if 100pts), (3) rerun, if needed
- For example:

Team Name	Round 1 score	R1 time left	Round 2 score	R2 time left	**Avg. Score**	**(2) Best score**	**(1) (Best+Avg) 2 score**	**(3) Time left @ best score**	**Rank**
Team A	80		100	15	90	100	95	15	**1**
Team B	100	10	80		90	100	95	10	**2**
Team C	100	20	70		85	100	92.5		**3**
Team D	60		100	5	80	100	90		**4**
Team E	90		90		90	90	90		**5**

10: Game Video Submission Option

- Teams that cannot attend an in-person qualifier or would like a second chance to qualify may compete via Video Submission
- Specific requirements for this option are outlined in section 6 of the Robofest General Rules: (LINK)

11: FAQ (1/3)

- Is there any limit on the number of controllers in Robot Game? For example, can I use 2 Spike Prime Hubs? **Jr Division is limited to one controller. There is no limit for Senior Division**
- Do passengers have to be picked up or dropped off in a specific order? **No, scoring will be done at the end of the round so there are no requirements on order**
- Can the slot in the box be used to score? **Yes, balls (passengers) can be put in the box from the top or the opening on the side**
- A player failed in starting the robot. Can the player retouch the robot to start? **Yes. Will not be considered a rerun. Timer will continue to run**
- Robot is touching objects at the end of run. Is this OK? **Yes. The object will be scored the same as if there was no contact with the robot**
- Can more than one passenger be sent to the same destination? **Yes. There is no restriction for Passenger 2 or Passenger 3, so their destinations could be the same.**

11: FAQ (2/3)

- Is Building A a potential destination for Passenger 2? **Yes. There is no restriction for Passenger 2, so the destination could be A.**
- How will judges know if the correct passenger is in the box? **Passengers (balls) will be numbered.**
- Is a sensor required to detect the color of the balls? **No, while a color or vision sensor may be helpful, enough information is provided or unveiled to do the challenge without them.**
- It looks like it will be difficult to judge if a robot stops at the line and if it's for 1 sec. What if the robot crosses the line, then turns around? **Judges will look for the robot to stop only if the whole robot goes past the line. The robot must come to a complete stop that is clear to the judge. Robots may be programmed to stop for longer than 1 second.**
- The Sr UTF example requires the robot to measure a distance. Will measuring the distance always be required on UTF? **No, but teams should be prepared to program on fly.**
- For the green median, is the whole size 56 X 11 CM? **Please refer to Section 6.3. Each piece of green paper is approximately 28cm long and placed on either side of the black line (approx. 2cm), so total is 58cm x 11cm.**

11: FAQ (3/3)

- What happens to balls that go off the table? **Balls that go off the table are considered out of the playing area. Judges may stop them from rolling too far. Balls will be scored as moved.**
- What happens if the robot moves one of the goals? **If the team requests a reset, the boxes will be put back in place. If not, they will not be reset. No penalty for moving boxes.**
- Will the location of the batteries (pedestrians) be consistent from table to table or round to round? **The location of batteries can be any where in the designated areas. The locations will be determined by the judges and do no have to be the same.**
- Are LiDAR sensors allowed for Jr Division? The rules state the Junior division does not allow vision sensors. **LiDAR is not classified as a vision sensor and is allowed for Jr Division.**
- Are pneumatics allowed? **Yes, any robot kit or material may be used.**
- Does the robot have to start the round facing East? **No, the robot starting orientation is chosen by the team. Robot can start in any orientation as long as some part of the robot is over the start line.**

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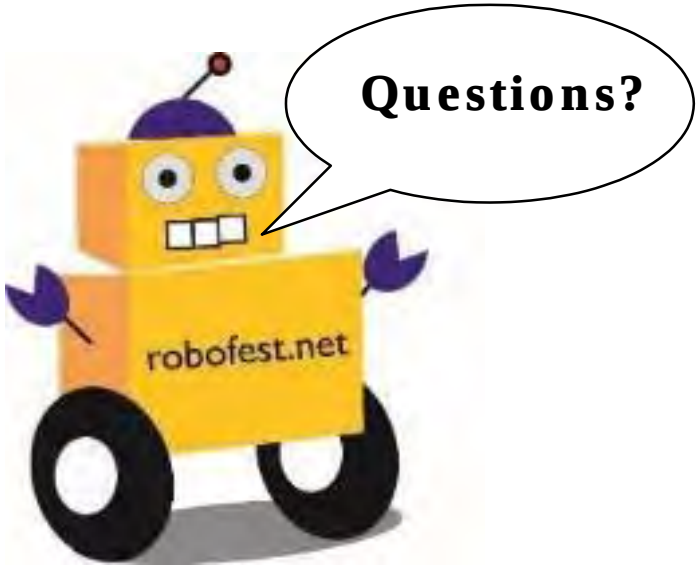
Little Robots, Big Missions



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