

IEEE Southeastcon 2014

Student Hardware Competition Rules

I. Introduction

In Kentucky, collegiate basketball is serious business and we'd like to bring the thrill to you in a lighthearted competition. For this year's competition, you will design a robot that will shoot a projectile from various distances to emulate the playing and shooting dynamics of basketball.

II. Objective

Teams will build a robot that operates on a simulated basketball court. The robot must follow three lines with randomly positioned shooting blocks and then fire a dart while positioned on top of the shooting block. Winners will be decided by number of points earned by completing goals and completion time so the highest scoring robots will be both fast and precise.

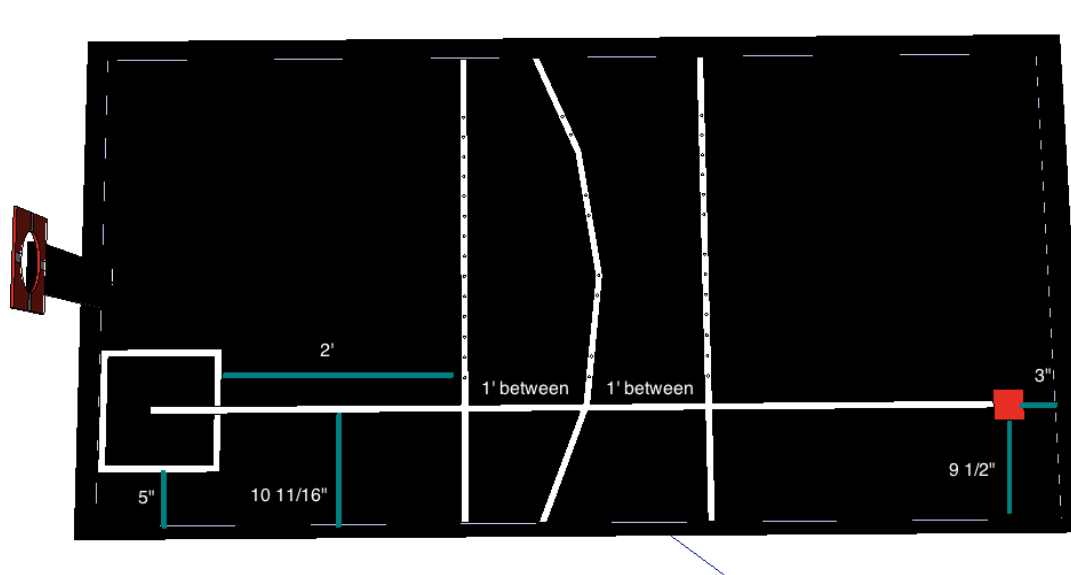
III. Field Materials

All items can be purchased from Lowes, Walmart, Amazon.com, and Digikey. Lowes part numbers are provided here as well as web links, which are provided at the bottom.

The list numbers are used below in the description of the course. The paints all share a common unlisted part number because an associate at the store mixes them. Given the details below, they should be able to make the paint.

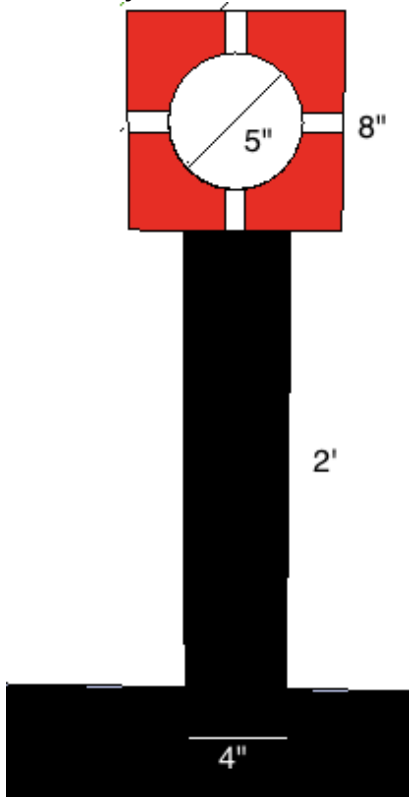
1. $\frac{1}{2}$ x 4' x 8' Premium MDF (#74794)
2. 4 pieces of 1' x 4' x 8' Spruce-Pine Furring Strip (#4510)
3. Olympic One A01 True White Flat (White)
4. Olympic One B51 Suddenly Sapphire Flat (Blue)
5. Olympic One B33 Red Gumball Flat (Red)
6. Olympic One Base 5 Black Flat (Black)
7. Hillman Sign Center Blank Sign (#236805)
8. Madison Mill $\frac{1}{4}$ " Diameter x 3' Round Dowel (#432502)
9. Blue Nerf N-Strike Elite Darts (Available at Amazon)
10. Nylon Mandel Fabrics Craft Net, Black (Available at Walmart)
11. 9 Simple Green LEDs LTL-4238 (Available at Digikey)
12. 1" x 10' PVC Piping (#23976)
13. PVC Elbow Joint (#315499)

IV. Playing Field & Tolerances



- The course will be made out of a piece of MDF with actual dimensions 97" x 49" x $\frac{1}{2}$ " **(1)** with walls constructed by pieces of plywood with actual dimensions $\frac{3}{4}$ " x 3 $\frac{1}{2}$ " x 96" **(2)** that is attached to the top of the MDF. The course will be painted black **(6)**.
- A 1' x 1' area will be marked in white paint with thickness of $\frac{3}{4}$ " **(3)** for the starting zone. Note that the painted length is included in the boundary so the inner area is 10 $\frac{1}{2}$ " x 10 $\frac{1}{2}$ ".
- On the course, there will be a line painted with white paint **(3)** 7' long, starting 6" from each end of the course that is located directly through the starting box. This line will have the start position box at one end and the end zone at the other.
- From the main line, there are 2 shooting lines painted with white paint (thickness still $\frac{3}{4}$ ") **(3)** that span the width of the course. Their centers are 2' apart and are parallel to the target.
- In the middle of the 2 straight lines painted with white paint with the same thickness **(3)** is a curved line representing a "3-point perimeter." on the left straight line, this curved line's center is 1' from each of the straight lines. The center of this circle will be the middle of the bottom of the 1x4. Making a circle starting at this point creates this line. To create this line, one can use a string and a pencil to draw with an exact radius. The radius of this line will be about 4'.
- There are holes straddling the lines that are perpendicular to the shorter walls. The center between these holes is the center of the line at that point 2" apart and the holes have a diameter of $\frac{1}{4}$ " and go through bottom of the course. They begin on the right side of the main line and stop 6" from the wall on the right side to produce 14 dots.

- Placed on each shooting line, there is a (firing block) block of plastic **(7)** that is $\frac{1}{4}$ " thick x 3" x 3" that is painted blue **(4)** that has two dowel rods of length $\frac{1}{2}$ " **(8)** that are $\frac{1}{2}$ " from the left and right side and 1 $\frac{1}{2}$ " from the top and the bottom. This square is the shooting point for each line.
- The target is a $\frac{1}{4}$ " thick x 8" wide x 8" tall block of plastic **(7)** cut from a piece of corrugated plastic with a 5" diameter hole in the center to shoot through. The target is mounted on a base block of wood that is 1 x 4 x 2' **(2)**. The base will be painted flat black; the target area will be painted red **(5)** with white lines painted with thickness $\frac{3}{4}$ " **(3)** coming vertically and horizontally out of the circle. There will be a net **(10)** attached to the back of the net assembly that will be used as the final judge of if a dart made it successfully.



- The end zone will be painted red **(5)** in a 3" x 3" square, if the robot stops and covers the entire red square; the round is over and bonus points will be awarded if applicable.
- There will be netting **(10)** around the course for safety reasons supported by PVC piping. The area of netting is 5' x 10' x 5' and there is an opening on the side of the course. The netting will be attached to the PVC using masking tape to allow for replacement if it should be needed.

Course Tolerances:

All course wooden materials have a tolerance of ± 1 " for the length and width and $\pm \frac{1}{4}$ " for the thickness. All painted squares and lines have a tolerance of $\pm \frac{1}{4}$ ". The tolerance of the target hole will be $\pm \frac{1}{2}$ ". The remote start LEDs have a tolerance of $\pm \frac{1}{2}$ ".

Course Assembly

The baseboard will be the MDF with actual dimensions of $\frac{1}{2}$ " x 49" x 97" and it will have the $\frac{3}{4}$ " x $3\frac{1}{2}$ " x 96" wood boards for the sides. Cut two of the boards down to the length of $95\frac{1}{2}$ " and attach vertically them to the interior of the course with $\frac{3}{4}$ " on each side. From this, we will finish the walls of the course by cutting the other boards to the size of 49" and set them horizontally, adding $\frac{3}{4}$ " to the vertical length, enclosing the course completely. This makes the inner area of the course $47\frac{1}{2}$ " wide x $95\frac{1}{2}$ " long. The walls will be secured from under the MDF with screws through the floor. This whole course will be painted black.

Lines will be painted on the course with a width of $\frac{3}{4}$ ". Further details can be found in the Sketchup document. We recommend using painter's tape and a chalk line to make sure you get straight lines. Holes will be drilled alongside the lines along the top and the bottom for the shooting blocks to be slotted into. The dowel rods are of thickness $\frac{1}{4}$ " and the holes in the floor of the course are drilled using a $9/32$ " drill bit.

The target base should be made with the remaining portion of the wall wood and should have actual dimensions $\frac{3}{4}$ " x $3\frac{1}{3}$ " x 24" and will also be painted black. This will be attached to the main course with L brackets. The target will be cut from the corrugated plastic and painted red. It has dimensions $\frac{1}{4}$ " x 8" x 8" and there is a hole with diameter 5" directly in the center of the plastic. From this circle, there are "guide lines" in the form of white paint coming from the top, left, right and bottom of the circle. Netting is stapled to all four corners of this piece of plastic to form an enclosed net to catch the darts. This plastic assembly is nailed onto the target base with the bottom inch of the plastic attaching to the top inch of the base. The PVC pipes should be assembled by making the pieces with 5' length by cutting them in half and then connecting the pieces with the 3 way PVC joints to form a cage of 5' x 10' x 5'. The netting can then be wrapped around this frame and taped to the PVC to form a semi permanent complete wrap. A slit can then be cut on the side facing the starting box for someone to reach in and place the robot in the starting box.

v. Robot

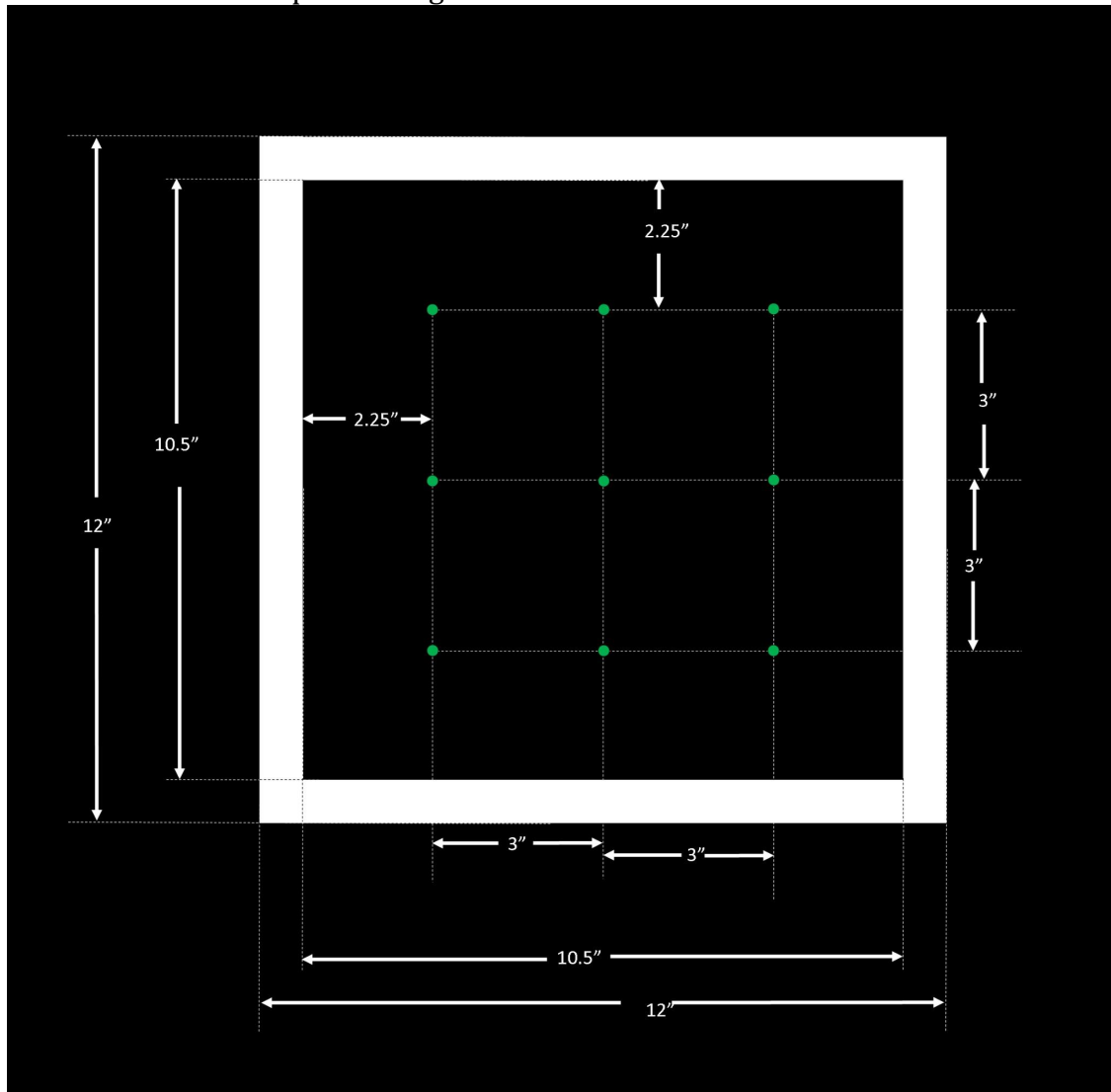
The robot must fit into a 1'x1'x2' (L W H) space at all points in the competition. There will be a separate box independent of the course that will be used to judge size constraints. The robot must be able to cover an area of 3"x 3" so that it can fully cover the squares in the course and must start via our remote start system (described below) and only one team member is allowed to set the robot on the course and turn it on. The robot is only allowed to carry 3 darts, which must be loaded into the robot at the beginning of the round. After that, any touching of the robot or communication with it (wired or wireless) ends the round immediately with no further points being awarded for that round.

Remote Start

For safety reasons the robots are obligated to comply with a remote start system. Robots are not permitted to start the competition until the remote start signal is sent. The starting signal is the illumination of a 3 by 3 grid of green LEDs, which

will be embedded below the surface of the starting location. The center of the LEDs will be spaced 3 inches apart.

The 3 by 3 grid will be aligned with the starting block. The image below demonstrates the led positioning.



The white border is the starting block.

The tolerance for the LEDs is a special $\pm 1/2$ inch tolerance. The tolerance applies to each LED's absolute position, not the distance between the LEDs. In other words the position error for one LED will have no bearing on the position error for the next LED. The current through each LED will be 19 to 21 mA. The LEDs will stay on for the duration of the round.

Projectile Safety

All team members and spectators are requested to wear protective eyewear when around a course in the competition room. No teams are allowed to fire any projectiles outside of the netted practice or competition courses, failure to heed this warning will result in disqualification. No chemical propellants are allowed. No

area of the robot may contain a pressure of above 50 psi at any point in the competition. This includes the canister, not just the regulated part that would interact with your robot. Teams using compressed canisters should bring a psi gauge with them to verify the pressure in their canister. Any gauge used to measure pressure should be accurate to +/- 1 psi.

VI. Rules

- One team member will set the robot on the course in the start zone. The robot must be contiguous at the start (all in one initial piece) and there is no communication allowed. The team member will press the power button when told to by the judge and then no communication is allowed between the team and the robot. The robot must remain in contact with the course at all times.
- Each round will last 2 minutes. The robot is not required to go to the end zone, however if the robot fully covers the end zone, the round will immediately end.
- In the competition, teams will be provided with three darts that have no clear deformities and are straight. If a team is not happy with the quality of darts they have received, they may request new ones.
- In each round, points will be given for each task only once.
- At any point, a team member or a judge can call for the end of the round. No further points will be awarded from that round and the robot must be removed from the course by the team.
- All teams will be required to bring their robots to the competition area before each round starts and all robots will be tested on a course with the same shooting positions.
- The judges reserve the right to change the competition rules between rounds.
- The judges reserve the right to disqualify any team for unsportsmanlike behavior or unethical behavior.
- The judges' reserve the right to end any robot's run at any time if the robot is a risk to spectators or is causing damage to the course.
- The judges' decision is final.
- The team members are financially responsible for any damages resulting from accidental or intentional projectiles fired.

VII. Competition Format

Qualifying Round

Each team must be able to demonstrate that their robot can move at least 1' along the main line from the starting position of the course before the competition rounds begin. Other tests, such as checking the pressure of compressed areas may also be done at this time. If a robot fails to do so, it may be excluded from other rounds depending on the number of competitors.

Competition Rounds

All qualified robots will be allowed to participate in all 3 heats. For each heat, the shooting positions will be randomly generated and all robots will compete on a course with the same specifications for that round. To encourage teams to be

ethical, all robots will be called to the front before the start of each round to make sure that the robot is not modified to accommodate the parameters for that round. When a team's robot is announced, one member of the team must come and set the robot on the course. After all 3 heats, the sum of each team's scores will be calculated and the top 8 teams will go the final round.

Final Round

The top 8 teams will compete in the same competition as they did in the competition rounds with only a single heat during the banquet at the end of SoutheastCon. Normal judging and rules will apply. If a tie exists at the end of the final round, a tiebreaker round may be added at the judge's discretion.

VIII. **Scoring**

- If the robot moves at all (if any part of the robot is no longer in the starting box) from the starting position, 25 points are awarded.
- For the first correct stop the robot makes at a firing block (covering the entire blue box), 50 points is awarded, regardless if they shoot or not.
- For the first shot from each correct shooting point, 300 points is awarded if the dart makes through the hole into the net. Successive shots beyond the first one from each shooting point will add nothing, but will not void the successful shot. Note that by making successive shots, you cannot get the dart back to the robot and thus cannot shoot from a later point, however points for stops will still be awarded.
- 25 bonus points are awarded if the robot successfully stops at the end zone before the time limit is reached.
- If the robot makes at least one successful shot and has stopped at the end zone, 1 bonus point will be awarded for each second left on the round timer.
- The score of all 3 heats will be added together and used to determine the winners.

IX. **FAQ**

- **Will Darts be provided?**
 - Darts will be provided to each team at the competition however you are encouraged to bring your own to test with.
- **Is there any required order for shots?**
 - The robot must go to the shooting boxes in order of distance from the starting position. If a shot from the second shooting point comes before a shot from the first shooting point, it won't count. If a shot from the third shooting point comes before a shot from the second shooting point, it won't count. If a shot from the first shooting point comes after a shot from any other shooting point, it won't count.
- **Does the robot have to shoot to get points?**
 - The robot does not have to fire any darts at all. Teams will be encouraged to successfully focus on reaching and stopping at the end of the shooting line before trying to shoot darts. Remember that shooting wildly can result in disqualification.
- **Can you clarify how stop is defined?**

- The term stop (as in stopping at the shooting line or at the endpoint) is defined as the robot covering the firing block for 3 or more seconds. A robot is allowed to move in any fashion to orient itself or make any move to make a shot so long as the robot wheels do not move. When stopping at the end of the course for bonus points, these 3 seconds are counted on the round timer.
- **May I re shoot darts?**
 - Any dart that touches the floor is considered shot. You cannot recover any dart that is shot.
- **How is a “successful” shot defined?**
 - A successful shot is defined as when the dart passes through the circular hole in the target completely. Bouncing off the target does not count as a successful shot.
- **Are CO2 Canisters allowed? What are the regulations on them?**
 - CO2 Canisters are allowed but are strongly discouraged. Most canisters store CO2 at around 900-1200 PSI and therefore cannot be used. PSI greater than 50 is not allowed anywhere in the system, even with a regulator. You may use multiple containers up to 50 PSI so long as the single greatest part is no greater than 50 PSI. Our testing has shown that the task is very doable without using high PSI or CO2 based systems.

X. Changelog

1. 4/6/13 Initial Release at Southeastcon 2013
2. 7/8/2013 Beta Release
 1. Changed to floorboard to MDF
 2. Clarified LED Remote Start description/drawing
 3. Checked/corrected sizes of wood
 4. Specified paint
3. 10/10/13 Physical Finalization Release
 1. Changed and specified course netting and PVC cage
 2. Clarified dimension errors due to nominal length
 3. Clarified paint choices
 4. Renamed the end of the main line (and other variants) to “end zone”
 5. Clarified dowel rod design for the shooting blocks
 6. Clarified safety requirements for projectiles
- 3.1 10/10/13 Small Fixes
 1. Added an extra point in Playing Field and Tolerances to clarify positioning of holes
- 3.2 11/16/13 Paint Replacement
 1. Replace discontinued Olympic Premium paint with Olympic One.
 2. Clarifications about the Remote Start LEDs staying on.
 3. Added accuracy tolerance for pressure gauges to Projectile Safety.

XI. **Shopping Appendix**

Nerf Darts: <http://www.amazon.com/Nerf-N-Strike-Elite-Refill-Darts/dp/B0083TXZVQ>

Bird Netting:

<http://www.walmart.com/ip/Nylon-Falk-Craft-Net-Black/19237855>

Green LEDs (LTL-4238):

<http://www.digikey.com/product-search/en/optoelectronics/leds-discrete/524729?k=%20LTL-4238>