



April 8-10 2005
Broward Section & Nova Southeastern University

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Student Program Hardware Design Rules

LAST UPDATE: March 15, 2005 9:10 PM

[IMPORTANT ANNOUNCEMENT FOR STUDENT HARDWARE TEAMS](#)

All questions dealing with the hardware competition should be directed to:

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SoutheastCon 2005 Hardware Competition Rules Hosted by: Nova Southeastern University



Robo Knights

Overview:

SoutheastCon 2005 provides a challenging game of robotics skill. Each team must successfully

pickup five small metallic balls located in random positions on the opponents side of the playing field and bring it back to your side and then return with the balls to your original starting square. In the process they must avoid the opponent's vehicle which is trying to do the same thing. Each team will have 5 minutes to get the opponents metallic balls. The metallic balls will be different for each team. Five will be matte black (black oxide plating) and five will be matte silver (clear zinc plating). Each team that [registers](#) will receive 10 (5 of each) free balls and one 1/2 inch washer. New balls will be provided at the competition.

This competition is open to undergraduate teams and graduate teams separately. Undergraduate students will compete only with undergraduate students and the same for graduate students. If possible one final round will be played that is made of the first place winner for undergraduate versus the first place winner of the graduate teams. Teams can only bring one robot per level. One for the undergraduate team and one for graduate team is applicable.

NOTE: PLEASE DESIGN YOUR ROBOT TO TAKE INTO ACCOUNT VARIATIONS ON THE MEASUREMENTS OF THE COMPETITION TRACK. WE WILL DO OUR BEST TO ENSURE THAT ALL MEASUREMENTS ARE WITHIN 15% OF THE PUBLISHED COORDINATES.

DESIGN TO ADAPT!

The Playing Surface:

The competition will take place on a single sheet of plywood 4' x 8'.

[Playing Surface Construction Steps](#)

The Vehicle

The vehicle must fit in a 6" x 6" square, may not be taller than 8", cannot weigh more than 20 pounds and cannot change in size **SEE FAQ #16. It must be self-propelled, autonomous and may not be remotely controlled in any manner. It cannot contain any flammable liquids, gases, or explosives. The vehicles cannot project any objects either in the playing field or out of the playing field, and all parts of the vehicle must remain attached (i.e. the vehicle may not split into two separate pieces). The vehicle may not present any danger to the judges, the spectators, or the playing board.

Playing Rules

When called, the team will have 30 seconds to place their vehicle in the starting square and wait for the IR signal to be received. Once the signal is sent (steady on) the timer will start, and the vehicle will have a maximum of 5 minutes to get and bring back the metallic balls placed on the opponent's side of the track. The vehicle should aim to return to the starting square (see Scoring, below). When the vehicle has completed this mission, it should illuminate a blue LED at the top of the robot, which will have been designated by the team, to the judge, prior to the start of the competition, as the finish indicator.

Once this indicator is illuminated, a vehicle receives no further points for picking up balls or returning to the starting square. The game will end when both vehicles have enabled their finish indicator or 5 minutes have expired, whichever happens first.

Once the first round has begun and the playing surface has been exposed (viewable) then no team is allowed to work on their robot (hands off). The only exception is for charging of batteries.

Judging and Scoring

In matters of scoring and judging, the judge's word is always final. Scores will be determined by:

- 1) If you correctly get all of the balls and return to the correct spot.
- 2) The amount of time it takes.

The final score will be the total of the three rounds. No balls may be pre-loaded on the robot. The balls can only be on the playing board.

Scoring: 20 points for each ball picked up (from the opponent's side).

If you mistakenly pick up an opponent's ball (on your side), you lose 20 points, and your opponent gains 20 points. If you fail to return to your base before five minutes expires, you lose 50 points.

If you correctly pickup and then return to the designated spot your team would receive 100 points for that round.

The team with the greatest number of points, summed over all three rounds, is the winner. In the event of a tie, the team with the smaller total time elapsed over the three rounds will be declared the winner. Total time for a round is measured beginning with the emitting of the "go" signal, and ending with the illumination of the blue finish indicator. If the indicator does not light, the round is measured as lasting 5 minutes.

Tournament Format

One qualification round (no other cars will be on the track) will be done prior to starting the competition. Qualification will take place on one of the practice tracks prior to the competition starting. To qualify to compete in the competition a car must:

Move off the start square when the go signal is sent ((it might not be received)) and pick up at least one correct ball in the qualification round.

UPDATED 2/24/05 The competition consists of three rounds and one final championship round for the 1st and 2nd place teams. Each team will have three rounds in which to accumulate their final score. Each team will be given a random number and will be matched up against another random team. Each team will complete the game once then each team will go again and once more to total three rounds. At the end of the

three rounds, the scores will be calculated and a 1st, 2nd, and 3rd position will be announced. Third place will be then awarded and the 1st and 2nd place teams will then compete once again during the awards dinner for one final round which will determine the final 1st and 2nd place winners. We will have two large projection screens showing the school's logo's and live video of the event.

To ensure a fair game the three playing boards will not be displayed until the start of each round. Three different playing boards will be on hand during the competition and once the call for hands off robots has been announced then the board for that round will be revealed.

Both sides of the playing surface will have the same locations of the balls.

Between each round there will be a fifteen minute break.

Two practice boards will be available to teams starting Friday morning.

Traditional Film, Digital Cameras, and Digital/Analog Video cameras (with FLASH) will be allowed in the spectator area. All designs should take this into account.

Additional Awards will be given for:

The most creative design will be one which implements strategy, shows originality, and one which displays a high level of engineering skill.

- 1) Additional awards should be given for:
 - a) Best original hardware design
 - b) Best mechanical design
 - c) Best use of custom designed chips (LSI, VLSI)
 - d) Best power system
 - e) Best ball retrieval system

Dedric Carter will be the main judge for the SEC05 hardware event.

Dedric Carter is an experience practitioner in advanced networks design/development, and the application of emerging technologies. He has participated in robotics competitions at MIT and served as a co-sponsor/VIP of the 2004 MIT ACM Artificial Intelligence/Gaming Competition. His early research pursuits were in human intelligence and machine learning and migrated to advanced network design and development specifically with technologies such as radio frequency identification. He has guest lectured or discussed technology topics at universities and conferences throughout the US and abroad including MIT, the City University of New York, and UVA. He has appeared on multiple occasions on the NBC Digital Edge technology showcase during his tenure as the youngest Director of the CGI-AMS Center for Advanced Technologies.

Mr. Carter has performed research at MIT Lincoln Labs and AT&T Bell Laboratories. He is currently a member of the Board of Trustees of MIT where he sits on the first Engineering Systems Division Board of Visitors. He was the David M. Adler Thesis

Award winner from the MIT Department of Electrical Engineering and Computer Science in addition to receiving nomination to the Sigma Xi Scientific Research Honor Society where he is an Associate Member. Mr. Carter is a member of IEEE and ACM. He has a B.S. in Electrical Engineering and Computer Science and a Master of Engineering in Electrical Engineering and Computer Science from MIT. Mr. Carter is a 2005 Candidate for the PhD in Information Systems at Nova Southeastern University.

FAQ's -> Last Updated: March 15, 2005 9:10 PM

Answers are in **BLUE**

- 1) Issues dealing with what happens when two cars collide? *If two robots collide they will have 5 seconds to clear themselves. If they do not then they will be separated at the judge's discretion. The clock will not be stopped.*
- 2) What happens if a ball is dropped? *You can pick it up. (SEE FAQ#64)*
- 3) What happens if the opponent by mistake picks up your ball(s)? *They lose 20 points you gain 20 points.*
- 4) What happens if the opponents car dies in your path? Can you push it out of the way? *You can move it away if possible, if not after 10 seconds the judges will move any car that died and allow you to continue to play.*
- 5) What happens if the opponent's car dies on top of one of the balls you need? *The judges would move the dead car out of the way.*
- 6) Do we rotate the playing sides? *Yes and the color of balls*
- 7) How close do we allow team members/visitors to be to the playing board? *Everyone will be at least 4 feet from the board's edge.*
- 8) How do we handle two teams that both complete the objective at the exact same time and accuracy level? *If a tie (time and accuracy) then another match will take place.*
- 9) Do we have a preliminary round to qualify which cars should be matched? *No.*
- 10) Is more than one undergraduate team per school allowed? *Yes but only one robot can compete so pick the best one.*
- 11) Does the robot itself have to remain completely inside the playing field? By this I mean, if, say, half the robot extends past the edge of the plywood but does not contact the floor and is able to recover without making contact with anything but the plywood playing surface, is this allowed or would it be a violation of the rules? *Allowed*
- 12) In the Judging and Scoring section, paragraph two, it says, "No balls may be pre-loaded on the robot." Could you please clarify this point? Does this mean we may not collect all five balls before returning to the start area? *This means that you cannot start the competition with balls in your robot since the goal is for you to pick all of them up.*

If balls are found within the robot the team will be disqualified.

13) When you state in the Overview, paragraph one, that the robot must "return with the balls to you original starting square," must the robot be completely inside the square to be considered returned? Or must it be X percent inside the starting square? *The robot should fit 100% into the starting square to be considered returned and come to a complete stop.*

14) Can cars taken in and then expel a ball without penalty? *No*

15) Do cars incur a 40 point differential penalty by ingesting the wrong color ball or 20 points by ingesting and 20 points for having it on the wrong side at the end of the contest? *20 points by ingesting and 20 points for having it on the wrong side at the end of the contest*

16) You say the robot cannot change shape, but in order to pick up the balls with a lever, crane, belt drive or similar devise the robot will have to change somewhat. *The robot must fit into the 6X6 square before starting. If you require some lever, crane, belt, etc. then it must be connected to the robot and if extended it cannot exceed 3 inches from any side of the robot. If your team will be using a device like this then it will be measured prior to competition starting.*

FOLLOWUP QUESTION:

I read FAQ #16 for the 2005 SoutheastCon 2005 Hardware competition and have a question. I read that any type of ball retrieval device when extended "cannot exceed 3 inches from any side of the robot". I would like to know if when the device is extended, may it expand from the "base" of the robot on one or more sides, or is it limited to one side of the robot? In other words, can the size of the robot (originally max. 6"x6") expand 3" on multiple sides to render a dimension up to 12" wide, or can it only expand 3" on one side resulting in a 6"x9" robot? *Correct it can only expand 3" on one side resulting in a 6"x9" robot.*

17) I read QA 16, and it answers allot. Just to clarify: The robot can have an arm or similar devise that extend 3 inch outside the 6 x 6 box. This arm, or similar devise can rotate, move up/down or whatever so long as it stays attached and stay within the 3 inches. My confusion is this, if we get there and the tires of our robot rotate in such a way that the orientation of the rim of the wheel changes, are we disqualified. I believe what you might mean is that the general shape (about 90% of the robot) cannot change and it must stay within the 6 x 6 box, excluding the arm. Is this correct? *Yes*

18) Can we use an external camera outside the playing board to transmit to the robot? *No*

19) So each side of the board will have either black oxide or zinc covered balls, *Yes* or will the type of balls be mixed on both sides; *No* Also is it going to be possible that one type of ball be on both sides possible? *No* Also what happens if the opponent rolls over or moves one of the balls we a supposed to get? *If the ball is picked up for any reason then see FAQ #3.* Am I allowed to knock the opponents balls off the table purposefully

or accidentally? *No*

20) Will each robot need to accommodate a wireless camera? (There was talk about this at SECON 2004). *This is a possibility but we have not decided yes or no at this point. Either way it would be optional.*

21) The two white squares (not the starting/finishing squares) in the center of each side of the playing field are for what? *They are there to help you navigate the playing field.*

22) In the rules you have mentioned that we can't work on our robots during the break. Why is that, why we can't work on it? i.e change batteries etc.? *You can work on your robot as long as no playing surface is visible. Once one of the boards is exposed then it will become hands off. The only exception will be to change batteries. This is being done to prevent any team from mapping the playing field and then simply giving positions (matrix) of where the balls are. The game requires active searching and the judges will ensure that all teams play fairly.*

23) The rules also mention about cameras being used. We think that the cameras shouldn't be allowed, because it can be used as a remote control for the robot. *All robots will be examined closely to prevent this. No team and school would want to be disqualified from this and future IEEE events. Certain electronic test equipment will be used to watch the room as well.*

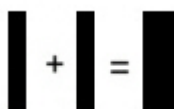
24) Specifically, what types of lights will be lighting the rooms we will be playing in? *You should design for various lighting scenarios (overhead, spotlights, outdoor windows, etc.)*

25) In last year competition, we know that some students got their robot designed from outside companies, how will you catch those guys? *Teams should design and build their own robots, however all teams get some level of outside help. You can argue that buying an evaluation board, or using a PDA to control the robot did not require you to build your own controller. Some teams have team members that have excellent mechanical engineering abilities and facilities. No team should "buy" a robot or have faculty or outside people design or build it for them. IEEE Code of Ethics*

26) Will we be allowed to modify or fix our robot during the break.? *Yes but not during any active competition round. Once a round starts then it's hands off.*

27) Is there white paint around the plywood's edge? *Not specified, the edge (the 3/4" wide surface perpendicular to the playing surface) could be white, black, or just left alone as plain wood.*

28) Is the dividing line created using a single strip of the tape?



Two strips of tape 1" side-by-side

29) How long must the infrared LEDs remain on? *The LED's will stay on throughout*

the 5 minutes so that robots can use it as a "parking" signal.

30) Both LEDs should come on at the same time. Will one switch and one battery drive both LEDs in parallel? If not, how will they be synchronized? ***Yes both LED's will be connected to one switch. The LED's will get power from a battery or a fixed power source.***

FOLLOW UP: The "Playing Surface" instructions say that the start LED will be connected directly to a 1.5 V battery. But that makes the diode current (and hence luminous intensity) extremely sensitive to the type and state of charge of the battery. (Note that the LED has a rated (or maybe typical) forward voltage of 1.28 V) It would be better to state the drive current for the LED so that the luminous intensity can be fixed. I suggest to increase the voltage (two 1.5V cells in series, or maybe one 9V battery), then insert a biasing resistor that produces a current of about 10 mA (or whatever is the rated current -- which doesn't seem to be specified in the RadioShack documents.) - 10 mA is about the right drive current (I am 95% sure that is appropriate), then I recommend to use a 9V battery and a 680 ohm resistor.

31) I didn't state FAQ #27 very well. I meant to ask whether there will be a white border on the playing surface. The diagrams seem to show a white border at the periphery.

Yes - http://sec05.nova.edu/hardware_design_construction.htm - Item #4 - Only at the edge but not within the playing surface. 1" tape should be used around the entire board. The 1" tape when removed should expose a 1" white band.

32) Do the "no hole" zones extend 1 inch around the white waypoint squares? ***Yes***

33) As in FAQ# 32, is the boundary 1 inch from the 6 inch home area? ***Yes***

34) Where exactly will the IR signal be coming from? What height? What coordinates on the playing field, or will it be on the playing field at all? Will the object sending the IR signal be a physical obstacle on the playing field? ***The only IR signal that we will be controlling will be the two LED's that are used to indicate "go". Please see the construction URL showing the exact location of the LED's.***

35) Will members of our team be the ones positioning the robot in its starting square at the start of each round? ***Yes (only two people allowed)***

36) Is there a penalty for hitting the opponents ball, but not knocking it off the playing field? If so, explain. ***Yes, the balls will not be flush they are slightly sunken in the board. You can roll over the hole and never touch the ball. If you pick up the ball then you lose points.***

37) Must the balls be dropped inside the starting square, or can they stay inside the robot once you have returned to the starting square? ***All of the balls must remain in the robot.***

38) Define "picked up"? Must the balls be literally picked up off the surface of the board? Or merely returned to the inside of the square by any means (dragged, for instance), as long as the robot still conforms to the no-shape-change constraints? ***The***

balls need to be lifted so that they do not touch the playing surface anymore. If your design picks them up and keeps them clear of the board you are okay.

39) In FAQ 14, you say "Can cars taken in and then expel a target without penalty? No" Would you define "take in" a ball? Moving partially or completely over the ball to detect it's type would not be considered "taking in" a target, right? To clarify, should "taking in" a target be defined as moving the target from it's seat in its hole? ***Yes, moving the target from it's seat in its hole is not allowed.***

40) The bag of targets reads "1/2". Is that the diameter of the targets (so that the targets fall inside the holes in the field?), or the radius? (so that the targets rest on top of the holes in the field)? ***The targets fall within the washer used to draw the white ring.***

41) The rules state "the vehicle may not present any danger to the judges, the spectators, or the playing board", but what happens if the robots harm each other? Is this allowed? If not, will there be penalties for any accidental robot interaction (if the robots are entangled or knocked over, for instance)? ***The robots should not intentionally harm each other. If they do get entangled or knocked over by accident one of the judge will decide if the round is still playable or needs to be replayed. If still playable they might just pick up the robot and return it to its last location on the board. Try to design into the robot the ability for it to detect if it has been moved or turned over.***

42) If one or more of the robots gets physically tipped over due to robot interaction, will the judges set the robots back on their "feet", so to speak? Or will the robots be removed from the board? Or will there be a rematch? ***See FAQ #41***

43) Why are the center-squares such an odd size? ***To distinguish them from the starting square.***

44) If another robot picks up your ball by mistake and you receive 20 pts, must you still retrieve that ball to get all possible points? Is 100 the max points for each round? ***No if that ball is lost, you now only need to pick up remaining balls. We will be paying close attention to teams that pick up the wrong ball. If a robot does not have any control and is randomly picking up balls then it will be disqualified.***

45) What is the penalty for bumping/moving a ball? The same as if you picked it up? ***If the ball is removed from its holding spot on the board you lose 20 points the opponent gains 20 points. Cameras that are located in the ceiling will be monitoring each hole.***

46) Is each of the three rounds played against the same robot, or will a robot oppose 3 different robots? ***You will be playing against multiple robots.***

47) From what I understand we will be assigned a target color for each round of the competition. How far may we interact in telling our robot what color balls to go for. For example, will the judges give off some sort of signal indication of the color balls our robot must fetch or are we allowed to tell the robot via some hardware or software switch before each round? ***Good Question - Please have one switch on the top of your robot that will control which type of ball you will be responsible to pick up. A simple toggle switch with a blue handle would be great.***

48) If you could please clarify question 16, I must have missed something when I read it earlier. Is it correct that the 3" arm must be inside the robot, the 6" square, when the competition starts? How about when it ends? The entire robot, including an arm or lever, must fit in the starting square at start and finish, correct? **Yes**

49) Assuming robots A and B are competing on the field, is it absolutely guaranteed that the 5 targets to be collected by robot A are on the side of the field where robot B's home square is located? Is it absolutely guaranteed that those 5 targets are the ONLY 5 targets present on that side of the field? **Yes - you should only collect the balls on the other side.**

50) From the detailed robot competition playing field schematic, the home square is shown to be 5.88" X 6in". From the drawing I find it unclear whether the 5.88" is measured from the edge of the plywood, or from the edge of the white border on the plywood. If the measurement is from the edge of the plywood, how is a 6"x6" robot to fit 100% inside a 6"x5.88" square? **The square is approximately 6 X 6. As long as your robot is 6 X 6 you are fine.**

51) Is the 21.22" measurement from the side of the playing field to the center square of the playing field made from the edge of the plywood? Do I interpret the drawing correctly in thinking that the center square is 3.97" wide? If the answer to both of those questions is yes, why is the sum of those widths (21.22"x2 + 3.97") not 48"? If the center square is 3.97" wide and the 21.22" measurement is from the border and not the edge of the plywood, why then is the sum of the widths (21.22"x2 + 2" + 3.97") not approximately 48"? **Please take a look at the [Example images from Western Kentucky University](#).**

52) The rules specify that once the team is called we have 30 seconds to place the robot in position and wait for the IR signal. question: At what point do we know which balls we are using (ie. the silver or the black)? Is this known before the clock starts or are we told during 30 second setup time frame? **Good question. Each team can either 1) just know based on the distance traveled or 2) have a simple toggle switch for silver/black.**

53) The rules specify that we have to go and retrieve the 5 balls from the opponent side and return them to our side. Question: Does every ball have to be returned independently, or can we obtain all 5 balls and bring them all back an once? Once they are returned, are they dropped or released in some type of compartment/container? **You have to collect all five balls and then return.**

54) When making the measurements for the playing field, what measurement is used for the width of the 1 inch 3M Model 2090 blue painters tape? Is it one inch, 15/16", or some other measurement? **It is the width of the 3M paint tape.**

55) Can the white circles around the holes extend into the "no hole" zones? **No**

56) Is the no-hole margin on either side of the middle line also 1"? **Yes**

57) In the tournament format section you stated that both sides of the playing field will

have the same location of the ball could you please clarify? On the web the location of the balls are not a mirror image of the opposite side of the field. There seems to be a mirror image but it is turned or not position properly. Are the holes going to be symmetrical or random on either side of the field? ***They will be symmetrical. The drawing is not perfect but the board will be as close as possible. Symmetric - having similarity in size, shape, and relative position of corresponding parts***

58) I am still unclear as to which part of the robot can actually extend out 3" and also which sides of the robot can extend. For example, is it a legal operation for the entire body of the robot to go UP three inches, thus having the dimensions 6"x6"x11"? It seems right now, that as long as the extension is only 3 inches on ANY one side of the robot only, it will be legal. And I would also like clarification as to what extends, i.e. if it has to be some sort of device that picks up the balls only, or if it can be any "appendage", or even the entire robot, itself? ***1) The robot may not expand upwards. The three inches is measured as a projection to the playing surface. No part of the robot should be greater than 8" from the playing surface. 2) If an appendage will be used it must have some ball retrieval function.***

59) In the answer to question 58 you say that "If an appendage will be used it must have some ball retrieval function." Could this include a line detection system? ***Yes***

60) When the robot returns to the starting square does it have to be in the same orientation when it started? ***No***

61) Can the balls be dragged for any length of time whatsoever. In other words if the balls were only dragged during the time they were being picked up on the opponents side of the playing field and then lifted before the vehicle crossed the white line, would it be O.K? ***Not allowed - The balls need to be picked up while the robot is over the hole which holds the balls. - SEE FAQ #64***

62) Will the playing field have the opponent's targets during the qualifying round? In other words, will there be balls on both sides during that round? ***Yes***

63) Does the finish LED have to be blue? For example, If I have a RED led on my robot, can I tell the judge to watch for that before the round starts, instead of a blue one? Red is much more visible than blue to the human eye. ***Yes***

64) This FAQ clarifies earlier responses for FAQ 2 and FAQ 61.

Definition of dropped ball: If a ball is lifted/moved from its seat, clearing the surface of the board and then regains contact with the surface of the board, the ball is considered dropped. Reasonable judgment will be used in the determination of a balls status as dropped or not. A dropped ball may be recovered as long as no excessive dragging or herding of the ball occurs. Intentional dropping of balls as a strategy is discouraged and may be penalized if the judges rule as such.

Definition of dragging: If a ball is lifted/moved from its seat and pushed

with some intent along the surface of the board, the ball is considered dragged. Reasonable judgment will be used in the determination of a balls status as dragged. For instance, in the event that the ball makes slight contact with the surface of the board after being moved from its seat in route to being collected by the robot without intentional pushing for extended time along the surface or herding of one or more balls, the ball may be deemed not dragged by the judge. There is no specified period that it is acceptable to push the ball along the surface of the board as this time should be very minimal if at all. Robots should be design to acquire the balls with minimal contact of the ball with the surface of the board from the balls seated position to avoid potential dragging penalties.

In general, herding balls in an area is penalized; however, we do not want to unduly penalize a robot that in an honest attempt to collect a ball, drops the ball and is able to recover the ball.

65) Can one robot intentionally try to “confuse” another robot? For example, can white circles be painted on a robot to try to “confuse” the other team? *No*

66) How much time does each robot have to get to the other side of the board? If one robot remains on the side of the board where you are retrieving balls, will this robot be moved off of the board after a certain period of time? Or if the robot remains on the wrong side of the board and is retrieving your targets? *See FAQ #3 & 4*

67) I don't think you are understanding my question. Sure, you get points if he successfully picks up the balls, but what if he doesn't? If he doesn't then he may just be moving around on your side "lost". In this case he could be interfering with my ability to pick up balls. I don't mean to harp on this point but avoidance becomes very difficult when two robots are trying to track the same target. I am just considering whether or not to take this into account in my design. *You should take this into consideration but if a robot is just wandering lost then the judge has the right to pick up that robot and remove it from the playing surface.*

IEEE SoutheastCon 05 Fort Lauderdale, Florida



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Student Program Hardware Design Playing Surface

LAST UPDATE: September 28, 2004 3:49 PM

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Hosted by: Nova Southeastern University



Robo Knights

The Playing Surface:

The competition will take place on a single sheet of plywood 4' x 8'.

All items listed below can be purchased from Home Depot.



**A single sheet of 3/4 inch 4 X 8
SANDEPLY
Home Depot# 454-559**



**3/4 inch Forstner Bit
Home Depot# 577-619**



**1 inch 3M Model 2090
Blue Painters Tape
Home Depot# 958-999**



Rust-Oleum Flat Black # 7776 - Home Depot# 448-990
Rust-Oleum Flat White # 7790 - Home Depot # 449-083

When your team [registers](#) you will receive the following:



Each team that registers will receive 10 (5 of each) free balls and one 1/2 inch washer.

Construction Steps:

NOTE: PLEASE DESIGN YOUR ROBOT TO TAKE INTO ACCOUNT VARIATIONS ON THE MEASUREMENTS OF THE COMPETITION TRACK. WE WILL DO OUR BEST TO ENSURE THAT ALL MEASUREMENTS ARE WITHIN 15% OF THE PUBLISHED COORDINATES.

DESIGN TO ADAPT!

[Click here for a large detailed image showing measurements \(see thumbnail below\)](#)



FIGURE #2

5) Decide where the five holes are to be located on each side of the board. The location are random and be anywhere in the blue squares shown in the diagram below. The only rule is that no hole may be less then one washer from another. In the picture below the red dots represent the closest that another ball could be placed.



FIGURE #3

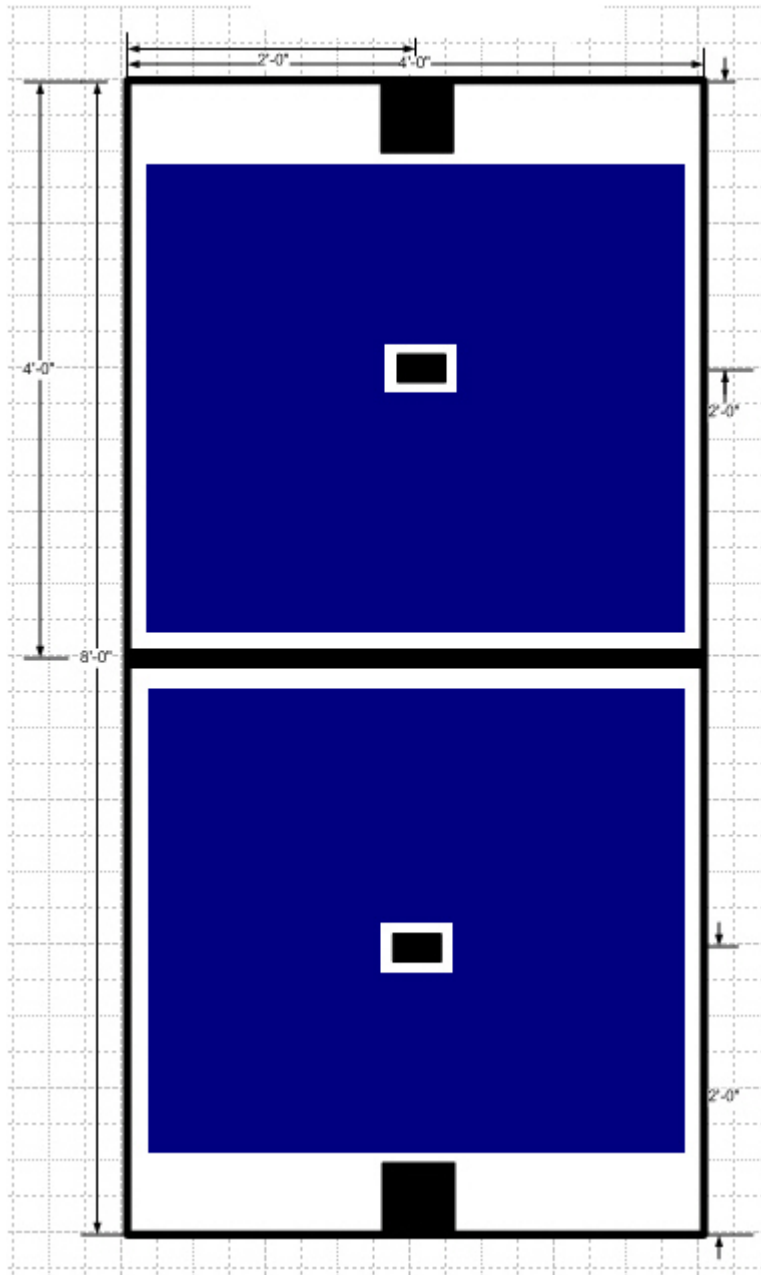


FIGURE #4

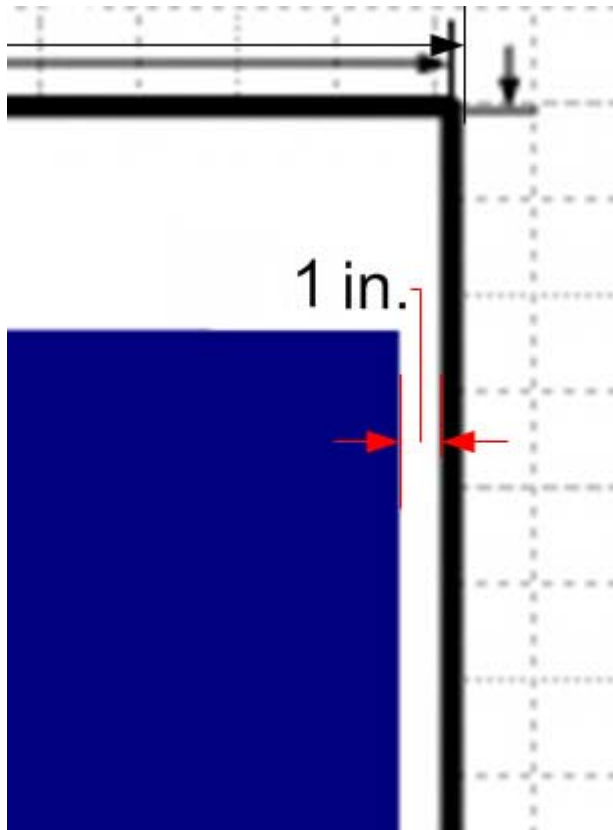


FIGURE #5

6) Stick 1/2 inch flat washer (with a 1-1/4" O.D." - (1) included in the package of balls when you register) in each of the locations (You will have to purchase 9 more of them or just move the one around as you paint). The washer will cover the white paint which will end up being the white ring around each hole.

7) Paint over the blue painters tape and washers using the flat black paint.

8) Before the paint is fully dried remove the blue painters tape and washers. Your board should look something like this (the location of the holes will not be the same).

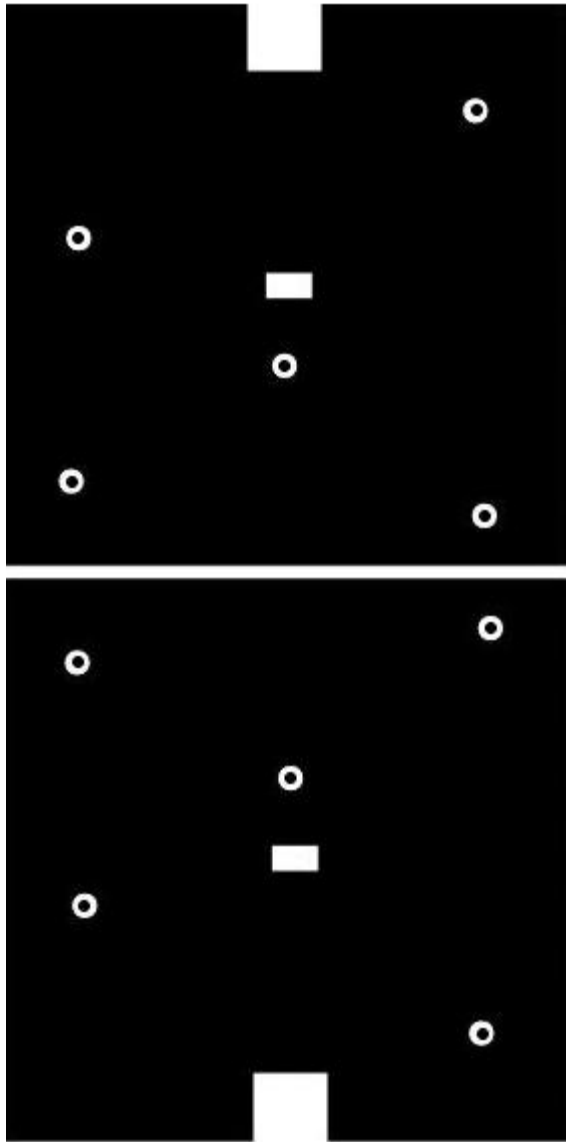


FIGURE #6

Note: The sides are symmetric : having similarity in size, shape, and relative position of corresponding parts.

9) With the 3/4 inch Forstner Bit drill out the centers for each ball location. In the example above the locations to drill out are in RED below. Drill completely through the plywood and then attach using glue, tape, etc. a piece of BLACK construction paper to the underside of the plywood at each drilled location.

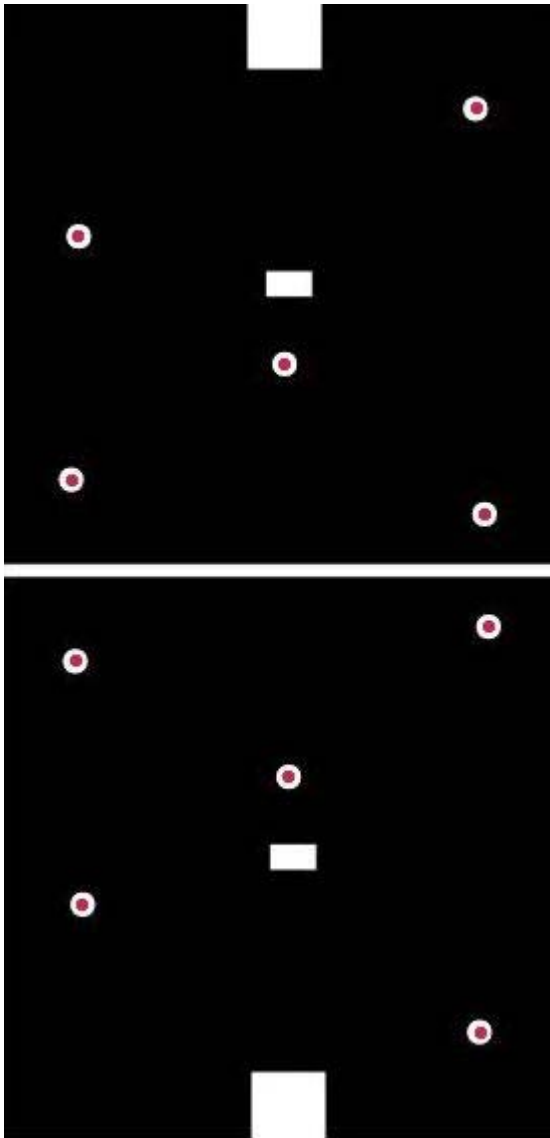


FIGURE #7

10) The holes in the board should be deburred with sandpaper and that the inside walls of the holes be painted black.

11) At this point your board is complete except for the hole for the LED. Purchase two (one for each side) High-Output Infrared LED Brand: RadioShack Catalog #: 276-143



FIGURE #8

Specifications for the 276-143C are as follows:

- Radiant Intensity (mw) 7.368

- Peak Wavelength (nm) 940
- Forward Voltage (V) 1.28
- Half View Angle (Degrees) 36.36

Drill the hole so that the top of the LED is flush with the plywood. The wires should come out under the plywood and then be connected to the switch & battery. The hole for the LED should be in the center of the 6 X 6 starting square (3 X 3 location).

12) At the competition the playing surface will be laying flat on a carpeted floor. The practice area has pergo floors.

Example images from Western Kentucky University.

