Below are the 2008 SoutheastCon Hardware Competition Rules. While a lot of attention has been given to developing these rules, we realize that they may need further clarification. We invite your questions, comments, and suggestions. Please see the Robot Competition FAQ for rule interpretations and ancillary information. We will make every attempt to provide prompt responses to your questions and concerns (our goal is four business days).

**Modification History**

**November 17, 2007**
1. Attachment B, Playing Field Blocks. RFID Tag alternate sourcing.

**August 7, 2007**
1. VII. Judging & Scoring. Remove points awarded for returning to home square.

**July 31, 2007**
1. Re-modify Zone 2 sand and paint mixture ratio (1 quart of sand to 1 quart of WHITE paint).
2. Eliminate painting pea pebbles RED.
3. Hoarding Penalty clarification.
4. Modify Blocking Penalty and Bumper Violation rules (Section VII, numbers 6 and 8).
5. Added points for robot mobility – leaving and returning to base.
6. Modify Attachment F – Playoff Round Ladder
7. Modify Playoff Round procedures.

**July 23, 2007**
1. Blocks must be picked up, not pushed across the surface, to score.
2. Specify Zone 2 paint and sand mixture ratio (1 ½ parts sand to one part WHITE paint).
3. Paint pea pebbles RED.

**June 13, 2007**
1. Increase competition time from four to six minutes
2. Change orientation of RFID tags from facing up to facing front of playing field.
3. Give each block a unique RFID number.
4. Increase number of IR LED’s per beacon from three to six.
5. Change Zone 2 and 3 of playing field from White Marble Chips and Lava Rock to sand mixed with paint, and pea pebbles. The marble chips are no longer carried by Home Depot and the Lava Rock is difficult to maneuver over.
7. Attachment F – Playoff Round Ladder
8. Various clarification wording throughout.

October 11, 2007

1. Corrected playoff seeding order (Attachment F).
I. Objective
To find, retrieve and return to home base, 2-inch cube, wooden blocks with attached RFID tags within the competition time limit of six (13 June) minutes. The block point values are determined by their color and numbers encoded on attached RFID tags.

II. Introduction
In the not-too-distance future, mankind has returned to the moon, whereupon valuable mineral deposits have been discovered. Exploration and development of this resource has been licensed to private enterprises. Many organizations, perhaps yours, have decided to enter into a competition to harvest the mineral deposits and return them to Earth. The process is arduous and expensive, and international regulations only permit unmanned, autonomous prospecting robots on the moon. The color and magnetic properties of the mineral deposits are correlated with their worth. Good luck in your venture.

III. Playing Field
1. The playing field (see Attachment A) will be based on a 6-foot by 6-foot plywood deck surrounded by walls that extend 8-inches above the playing field surface. The walls will be attached to the outside edge of the plywood deck.

2. The playing field will be divided into three zones plus robot home bases. Zone 1 will be painted BLUE, except for the home bases, which will be painted WHITE; Zone 2 will be covered with sandy WHITE paint; Zone 3 will be covered with pea pebbles. The rocky surface will be bonded to the plywood base with tile adhesive. The playing field walls will be painted flat BLACK.

3. One navigation aid will be placed in each of the playing field home base corners. Each navigation aid will consist of one quarter section of an 8-inch-tall, 4.5-inch-diameter, schedule 40 PVC cylinder into which six (13 June) LEDs have been placed (see Attachment C). The navigation aid on the right (as viewed from the robot home base side of the playing field) will flash its LEDs at 4.0 kilohertz, while the navigation aid on the left will flash its LEDs at 2.5 kilohertz. Both navigation beacons will use a square waveform.

4. The 12 1/2-inch-square robot home bases will be located in separate corners on the same side of the playing field. The bases will be painted WHITE (see Attachment A).

5. The playing field will contain seven wooden blocks 2” on each side. The layout pattern will have bilateral symmetry with respect to a line dividing the playing field in half between the robot bases (see Attachment D for the block specification; Attachment E gives the block layout pattern). Each block will have a round, passive RFID tag attached to one (13 June) surface and the block will be painted according to its point value. The RFID tag will be positioned to face the front (home base side) of the playing field (13 June). See Section V for more information on the blocks.
6. The playing field environment lighting is not specified except that it will be well lit. Flash photography and infrared range finders on cameras and camcorders are permitted. Intentional interference with the operation of the robots is not allowed, and may result in sanctions.

IV. Robot
1. The robot must operate completely autonomously once started and be entirely self contained, including any power source. Robots that do not meet this requirement will not qualify.

2. The maximum size is 10 inches by 10 inches by 11 inches tall. This maximum size applies when the robot is in the starting square at the start of a match or is in motion on any part of the playing field. When not in motion, the robot may extend a maximum of six inches by six inches in any one direction at a time. The extension must be physically connected to the main robot at all times.

3. There is no weight limit or construction material restriction except that anything that is deemed by contest officials to be dangerous or injurious to the participants, audience, staff, playing field or surroundings will result in disqualification. If in doubt, ask in advance. Pyrotechnics, compressed gas, toxic or corrosive materials are not allowed.

4. A robot may not operate in a manner that excessively damages the landscape. The rocky surface may become littered with loose rocks during the course of play (such is the nature of the lunar surface). This is expected and considered normal wear and tear, and operating conditions.

5. Each robot must have a bumper that surrounds a minimum of 80% of its perimeter in a continuous stretch. This bumper must be the outermost structure at all times when the robot is moving. The bumper must present a vertical surface at least 1” high and cover, at a minimum, the space from 1 ½ to 2 ½ inches above the playing field. The bumper may be of any shape around the robot and need not be outwardly convex on all surfaces but must not have any radius of curvature less than ½ inch. The bumper must be included in the maximum 10 by 10 inch by 11 inch tall overall size.

6. A robot must have a button or switch somewhere on its top surface to start the robot in play.

7. In addition to meeting safe operation requirements, a robot must fit inside a 10 ¼ inch by 10 ¾ inch by 11 ¼ inch box to qualify for the competition. The qualification inspection will be available prior to the first round of play.

8. Robots may be modified physically, reprogrammed, and/or recharged between each match. However, any physical modification will require a re-inspection for safety and overall size compliance.
V. Playing Field Objects
1. Wooden blocks will be used to represent mineral-bearing rocks on the moon. The blocks will be cubes measuring 2 inches on each side (see Attachment D).

2. There will be a total of seven blocks. Two of the blocks will be colored RED, two will be colored WHITE, two will be colored BLUE, and one will be colored BLACK.

3. One passive RFID tag will be attached to each block. The tags will have numbers encoded in them. Each block will have a unique number (13 June).

4. Seven RFID tags with the same numbers as those to be used in the competition will be mailed to each registered team. The tags are 50 mm in diameter.

5. RED blocks have a 15-point value, WHITE blocks have a 20-point value, BLUE blocks have a 25-point value, and the BLACK block has a 30-point value.

6. The color of a block and the color of the playing field on which it resides are not necessarily the same.

VI. Rules of Play
1. During the first three rounds, there will be only one robot on the playing field (13 June).

2. During the playoff rounds (see Appendix F), two robots will compete on a single playing field at the same time (13 June).

3. Prior to the beginning of play, the next team(s) to play will be announced. They must present their robots and place them on a robot home base within one minute of the announcement. Missing this deadline will result in disqualification for the missing team(s) for that match. For the playoff rounds, home base assignments will be decided by the flip of a coin by one of the contest officials (13 June).

4. A hands-off period will follow the placement of a robot on the playing field. During this time, seven wooden blocks with RFID tags will be placed on the playing field in a symmetrical pattern with respect to each robot home base. This pattern will be randomly drawn from a set of unique patterns established prior to play. The blocks will be placed with the RFID tags facing toward the front (home base side) of the playing field (13 June).

5. After the blocks have been placed on the playing field, a contest official will give a verbal start command. A team member may then manually start the robot by pressing a button or flipping a switch on the top of the robot. The start button or switch must be indicated to a contest official prior to the start command. No further interaction between the robot and a person may then take place until the six-minute match ends or a team decides to terminate its participation. Any points scored until early play termination for a team will count towards the final point tally for that match.
6. The end of a match will be indicated by a buzzer.

7. The blocks must be picked up off of the field and transported to the home square to score. Blocks that are pushed across the surface will not score (23 July). A robot may transport any number of blocks at a time.

8. Destructive Interference: A team may not take any action that purposely interferes with the course of play or causes damage to the playing field or competing robot. The penalty for destructive interference is disqualification for that match.

9. A match is six minutes (13 June) from the point that the verbal start command is given. A buzzer will sound the end of a match and no further points will be scored.

VII. Judging & Scoring

1. Points are scored by placing blocks in a robot’s home base. “In a robot’s home base” will be interpreted as meaning that any portion of a block is within the boundary of the home base square. If a block is placed wholly or partially on another block in the home base square, it will count as being in the home base square.

2. Ten points are awarded to a robot that completely leaves the starting square.

3. If a robot carrying blocks is in any part of the home square at the end of play, all the blocks it carries, up to the maximum number allowed, will score.

4. During the first three rounds, a block will only score if placed in the robot’s home square (13 June). If a block is placed in an opponent’s home square (during the playoff rounds), its value will score points for the owner of that square (13 June).

5. The contest’s judge decision is final regarding whether a block is in scoring position or not.

6. Hoarding Penalty: Due to limitations in transporting mass back to earth, a robot may only score (31 July) a maximum of four blocks. If more than four blocks are placed in home base, points will only be scored for the four lowest value blocks. During the playoff rounds (13 June), any blocks in excess of the four lowest scoring (31 July) will be scored for the opponent team.

7. Blocking Penalty: A robot may not persistently position itself near a competitor’s home base so as to block it from reaching its home base. If this situation occurs, the blocked robot will score all the blocks it possesses or deposits in the vicinity of its home base. A stalled (doesn’t move for one minute), blocking robot will be removed from the playing field.

8. Poaching Penalty: Disturbing or removing blocks from an opponent’s square, whether intentional or not, will not decrease the score of the “poachee” nor increase the score of the poacher and MAY be considered grounds for disqualification. If disqualified, the offending robot will be removed from the playing field and play will continue.
9. Extending a portion of the robot beyond the bumper while the robot is in motion will result in a penalty of one point per second of violation.

VIII. Tournament Format
1. There will be three preliminary rounds of play for all robots, and playoff rounds for the eight highest scoring robots (13 June).

2. Each team will play three preliminary rounds in which only one robot will be on the playing field (13 June).

3. The final score for a team will be the sum of points accumulated in the three preliminary rounds. A team’s pre-playoff rank will be determined by its final score. The highest scores will determine the top eight teams. In case of ties, i.e. more than eight teams qualify for the playoffs, the time taken for the last block scored, will be used as a tie breaker (31 July). If more than eight teams still qualify, additional, single robot matches will be held for the tied teams.

4. The top eight teams will play each other in head-to-head competition, with two robots competing for blocks on the same playing field, during the playoff rounds. The two winners of the semi-final playoff will play each other for first and second place honors (13 June). The two other semi-final teams will play each other for third place honors (31 July). The play-off elimination ladder is shown in Attachment F.

5. IEEE student membership is required of all team members participating in the competition. Only one entry is allowed per school and the school must be in Region 3 (southeast) and have registered by March 7, 2008 (31 July). Team registration form is located elsewhere on the web site (31 July).

6. All judges’ decisions are final.

IX. Tolerances
All materials, sizes, and construction techniques and tolerances are given in the appropriate attachments.

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Playing Field Materials

1. Plywood Base
The base is constructed from two pieces of 3’ x 6’ 1/2” thick plywood. The competition playing field will use A grade plywood, although B/C plywood is useable, since 2/3 of the surface area is covered by coarse material.
2. **Wall Material**
An eight-inch-high wall of 1/2-inch thick plywood painted flat black will completely surround the plywood playing field base. The top of the wall will be 8 inches from the top of the playing field and is attached to the outside edge of the plywood base so that the interior of the base measures six feet by six feet.

3. **LED Beacons**
There are two LED navigation beacons, one in each of the home base corners. Each is constructed from a PVC housing, six (13 June) IR LEDs and current limiting resistors. A square wave-driving circuit powers the beacons. The housing is cut from 4.5-inch diameter, schedule 40 PVC. The PVC is cut into an eight-inch high section and then cut into quarters lengthwise. One piece is used for each beacon. Details are in Attachment C.

4. **Paint Specifications**
Four paint colors are used: flat black, flat white, gloss red (23 July), and gloss blue. Paint product specification is given in Attachment B.

5. **Rock Specifications**
Two types of coarse materials are used to cover portions of the base: sand mixed with paint and pea pebbles (13 June). Material product specifications are given in Attachment B, construction details below.

6. **Adhesive Specifications**
The sand will be mixed with white paint for Zone 2 and an adhesive is used to bond the pea pebbles to the plywood base. Adhesive product specification is given in Attachment B.

**Construction Details and Suggestions**

1. **Cut Base.** Cut each 4 x 8 sheet of ½ inch plywood into a 3- by 6-foot piece. These two pieces will form the entire playing field base.

2. **Establish Zones.** Temporarily put the two plywood pieces together to form a 6’ by 6’ base. From the middle of the long edge of one piece draw two circular arcs, one 30 inches in radius and one 48 inches in radius on the plywood surface, as illustrated in the Figure above. The area enclosed by the 30-inch arc is Zone 3; the area between the 30 and 48 inch arcs is Zone 2. Outline a 12 1/2”-by-12 1/2” square in each corner opposite Zones 2 and 3. The area outside the arcs and bases is Zone 1.

3. **Prepare Coarse Material.** Mix one quart of sand with one quart of white paint (31 July) to paint Zone 2. First wash the pebbles in water to remove all the fine, gritty material (23 July). Remove the rocks from the gritty material by passing a cat litter scooper through the washed pea pebbles. Keep all the rocks and dispose of the grit. Process enough of the pea pebbles to cover Zone 3. You will need a little less than one bag (23 July) of sorted pea pebbles to cover Zone 3.
4. Prepare Zone 3. Spread the entire bucket of gray adhesive evenly over Zone 3. You may use a wide-bladed putty knife or a tiling trowel to smooth the adhesive. Spread the pea pebbles fairly evenly over the area and press **firmly** into the adhesive. Let set for at least 48 hours at room temperature. When the adhesive is set, tip the upper half of the playing field to remove all the loose rock that did not bind to the adhesive. A few **good** taps to the bottom of the plywood will help shake off the loose material.

5. Prepare Zone 2. Paint Zone 2 with the sand and paint mixture.

6. Prepare Zone 1. Before painting Zone 1 blue, paint the white home base squares. Use two coats of paint and when dry mask off with painters masking tape. Then apply a coat of blue paint to Zone 1.

7. Prepare Walls. Cut the remaining 1/2-inch plywood into 8 ½” strips and paint flat black. When dry, affix the walls to the plywood base on all sides in any manner that is sturdy. The official playing fields will have the walls nailed and glued to the edge of the base and have 2” L-shaped, steel brackets on the outside connecting the walls to the base. Brackets will also be used on the outside of the corners.

8. Assemble Playing Field. In order to get the two halves of the base to meet, you may need to use a putty knife to remove excess material from the inner edges of the plywood halves. The official playing field will use metal brackets on the outside of the walls to join together the two playing field halves. Affix the IR Beacon PVC housing by gluing or screwing to the walls (attaching with #4 wood screws will allow easy removal for modification or repair. Pre-drill screw holes with an 1/8” twist bit).

**Dimensional Tolerances**

The overall playing field size will have a size tolerance of +/- one-half inch. We will strive for quarter-inch tolerance, but wood is not a precise medium and the size is also subject to humidity changes. The texture of the rocky surface can not be specified accurately, as is appropriate to the nature of a lunar surface model. Some areas will have more material than others, and although we will attempt to make the surface level, irregularities will exist.
SUBJECT TO CHANGE
17 November 2007
ATTACHMENT B

Shopping List

Trading Field

1. Base. Two, 4’ x 8’ by ½” thick plywood panels. The main property required is flatness. You may also use OSB panels or plywood sheathing used for roofing. The choice depends on how much you want to spend. The official playing field will use 1/2 ” thick, grade A plywood.

2. Walls. One 4’x8’ panel, 1/2” thick.

Paint

1. WHITE. Rust-Oleum, Painter’s Touch, Flat White, 1 quart. Home Depot SKU 359-339

2. BLACK. Rust-Oleum, Painter’s Touch, Flat Black, 1 quart. Home Depot SKU 217-927

3. BLUE. Rust-Oleum, Protective Enamel, Gloss Royal Blue, 1 quart. Home Depot SKU 527-117


Rocks


2. Pea Pebbles. Vigoro Decorative Stone, 0.5 cubic foot, Home Depot SKU 440-773

Adhesive

1. GRAY. Tile Perfect, Gray Premixed Thinset, 1 gallon. Home Depot SKU 699-006

Infrared Beacon

1. IR LED. High Output, 5 mm, twelve (13 June). Radio Shack 276-143.

2. PVC Pipe. 4.5 inch diameter, schedule 40. Home Depot SKU 295-112 (This commonly comes in 5 and 10 foot lengths.)
Playing Field Blocks


2. RFID Tags, World Tag 50 mm, S2048. We supply seven tags to registered teams. These tags will be identical to those used during the competition.

Parts and Tools (suggested, not required)

1. Adhesive Spreader. 3” wide blade putty knife or a notched tiling trowel, about 4 ½ “ by 9 ½” (notched edge not used) makes the job a lot easier
2. Buzzer. Radio Shack, TBD.
Navigation Beacons

Navigation Beacon Materials

1. PVC Pipe
   Four-and-a-half-inch diameter, schedule 40 PVC pipe will be used.

2. IR LEDs.
   Six (13 June) IR LEDs per beacon will be connected in series with an appropriate current
   limiting resistor to operate the LEDs at 100 ma.

3. Timer Circuit.
   The timing circuit will flash the left beacon LEDs with a 2.5 kHz (plus or minus 5%), 50%
   duty cycle square wave, and will flash the right beacon with a 4.0 kHz (plus or minus 5%),
   50% duty cycle square wave.

Construction

1. Beacon Housing. Cut off a eight-inch long section of the PVC pipe. Slice this section
   lengthwise in quarters. Drill six (13 June) one-quarter-inch diameter holes equally spaced
   along two horizontal, parallel lines located one third and two thirds of the way between the
   ends of the pipe (13 June). Countersink the holes on the convex side to provide the LEDs
   with a wider angle of illumination (31 July). Do this for both beacon housings. Paint the
   convex side flat black, the same as the playing field walls.
2. LED Assembly. Fit the LEDs into the beacon housing holes and fix in place (we used hot glue over the back of the LEDs). Solder the LED leads in series, anode to cathode. Choose a current-limiting resistor, of appropriate wattage, according to the power supply voltage you choose. It is suggested that you wire a polarized, locking connector to the LED assembly and wire a visible LED in parallel with the IR LEDs to visually verify when power is applied.
ATTACHMENT D

Playing Field Blocks

Playing Field Blocks Construction

1. Seven Wooden Cubes. Make or purchase seven, wooden cubes two inches on a side. Two blocks are painted RED, two WHITE, two BLUE and one BLACK.

2. Affix the RFID Tags. RFID tags will be sent to each school team that registers for the hardware competition. The RFID tags will be affixed to one face of each block. Each block will have a unique number (13 June). These ID numbers will be furnished along with the tags.

RFID Tags

The committee will supply RFID tags to registered teams.

Dimensional Tolerances

The blocks will have a size tolerance of 1/8-inch on each side.
RED, WHITE, and BLUE blocks will be placed in the center of 10-inch squares (position of dots in diagram), arranged in the grid pattern below (neither grid nor dots nor x’s will appear on the playing field). Each block of the same color will be placed symmetrically about the vertical center line in the figure below. Areas around the home bases and adjacent walls will be excluded, as shown below, 6-inches from the walls and 3 1/2-inches from the inner base boundaries.

1. One RED, one WHITE, and one BLUE block will be placed on one side of the center vertical line and another of each color placed symmetrically on the other side of the central vertical line.

2. The BLACK block will be placed on the intersection of the center line and one of the horizontal lines, but not along an edge (position of X’s in diagram below).

3. Blocks may be placed in adjacent squares, except no block will be placed within one square of the BLACK block.

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**Diagram**

[Diagram of block layout pattern showing RED, WHITE, and BLUE blocks arranged symmetrically about the vertical center line, with areas around the home bases and adjacent walls excluded.]
Playoff Round Ladder

1st Rank Team

8th Rank Team

4th Rank Team

5th Rank Team

2nd Rank Team

7th Rank Team

3rd Rank Team

6th Rank Team