BUGS!

BEST 2011 Design Contest
Game Specific Rules

Version 1.1

1.0 Introduction

A current hot topic of research and development is in the area of biochemical engineering, specifically genetic engineering. In its simplest form, genetic engineering involves manipulating a living cell's inherited material (or genes) to produce an organism with a desired trait.

This concept is not new; "Traditional breeding" goes back centuries. Experiments in the 1880s investigated how to make pea plants produce offspring with specified qualities. However, by 1973 technology had advanced so that DNA from completely different organisms could be spliced. The initial experiments involved bacteria. Since then a variety of different organisms have been modified, including plants, animals, and bugs.

Flies, known to have a very simple genome, were one of the first to be cloned (Rubin & Sparding, 1982, pp. 348-53), and it became common place to use the Drosophila fly model in the laboratory to investigate the role of certain genes. In 2001 the first transgenic housefly was created, (Hediger, Wimmer, & Bopp, 2001, pp. 113-19) which proved helpful to study the effects of toxins on the environment (Cross, Vallacchi, Schock, Wilson, Weber, Eiserich, & Van der Vliet, 2002, pp. S44-50).

Another use of this technology is genetically modifying bugs to eliminate disease. Experiments are underway to genetically alter mosquitoes against transmitting malaria (Corby-Harris, Drexler, Watkins de Jong, Antonova, Pakpour, Ziegler, Ramberg, Lewis, Brown, Luckhart, & Riehle, 2010) and dengue fever (Mahr, 2011). Cockroaches also harbor a variety of diseases and allergens and it may be possible to eliminate their toxicity through genetic engineering.

A certain species of termites has successfully been engineered to introduce genes into another colony that would eliminate their destructiveness (Husseneder, Grace, 2005, pp. 360-7). Termites are also being investigated to potentially transform biomass into ethanol (USC School of Engineering, 2007). In short, bugs are seen to hold promise for eradicating disease, increasing crop yield, as well as basic research.

It is for these reasons that BEST Genetics decided to investigate genetically engineering various types of bugs. They put thousands of man hours and a great deal of capital into creating more advanced bugs. Everything was on track for some major breakthroughs; that is, until yesterday. The containment area on three different habitats failed and some genetically engineered flies, cockroaches, and termites escaped from the laboratory. This could be catastrophic for not only BEST Genetics, but for the environment at large. When introducing a new organism into an environment, there may be unanticipated side effects that could drastically affect human health and the surrounding ecosystem. The FDA has insisted that controlled, longitudinal studies are done before releasing any genetically engineered organisms into the environment ("New Report", 2004) ("Harvest of Fear", 2001). This was the primary reason why AquaBounties genetically engineered salmon were not approved for human consumption (Carollo, 2010). Companies that have not listened to these warnings have been fined and sued. Therefore, it is imperative that BEST Genetics captures and controls these bugs as quickly and safely as possible.

The scientists at BEST Genetics have traced the bugs to an abandoned shed on the far side of the property at a new construction site. However, BEST Genetics is not equipped to handle the bug recovery. They contacted BEST Robotics to rapidly develop a prototype robot to recover the bugs and avert the potential crisis.

Of course, priority one is to salvage as much of the research work as possible. Since four types of bugs escaped, BEST Genetics needs at least one of each bug returned alive. But they are also concerned about the bugs well being, so it is recommended that the bugs be segregated by type. There are also concerns that the bugs have not gotten enough nourishment in the wild, so feeding the bugs should also be a priority.

Due to the potential negative effects the escaped bugs may have on the environment, BEST Genetics needs a robot to promptly recover these bugs and place them in one of three Containment Areas (CA).

BEST Robotics is looking for engineers who are up to the challenge to design and construct robots to recover these priceless bugs.

2.0 Objective

Design and build a robot to safely handle the bugs and/or food. Carefully transport them from their current location to one of three containment areas.

3.0 Bug Zone (BZ)

This BZ is approximately 23 x 23 feet square enclosed by a 1" x 4" wood border. In the center is the shed (see section 3.1). On each of the outside boarders are the three Team Containment Areas (TCA) (see section 3.2). Each trio of containment areas is assigned to a team. There are three orange cones and a “X” shaped barricade in each quadrant of the BZ. The starting position for each robot is located in its team’s respective corner of the BZ. Each robot may traverse the entire floor of the BZ as long as no other rules are broken. Figure 1 shows the BZ layout. Please also see section 6.0 for additional restrictions. The game field drawing package may also be referenced for exact dimensions.

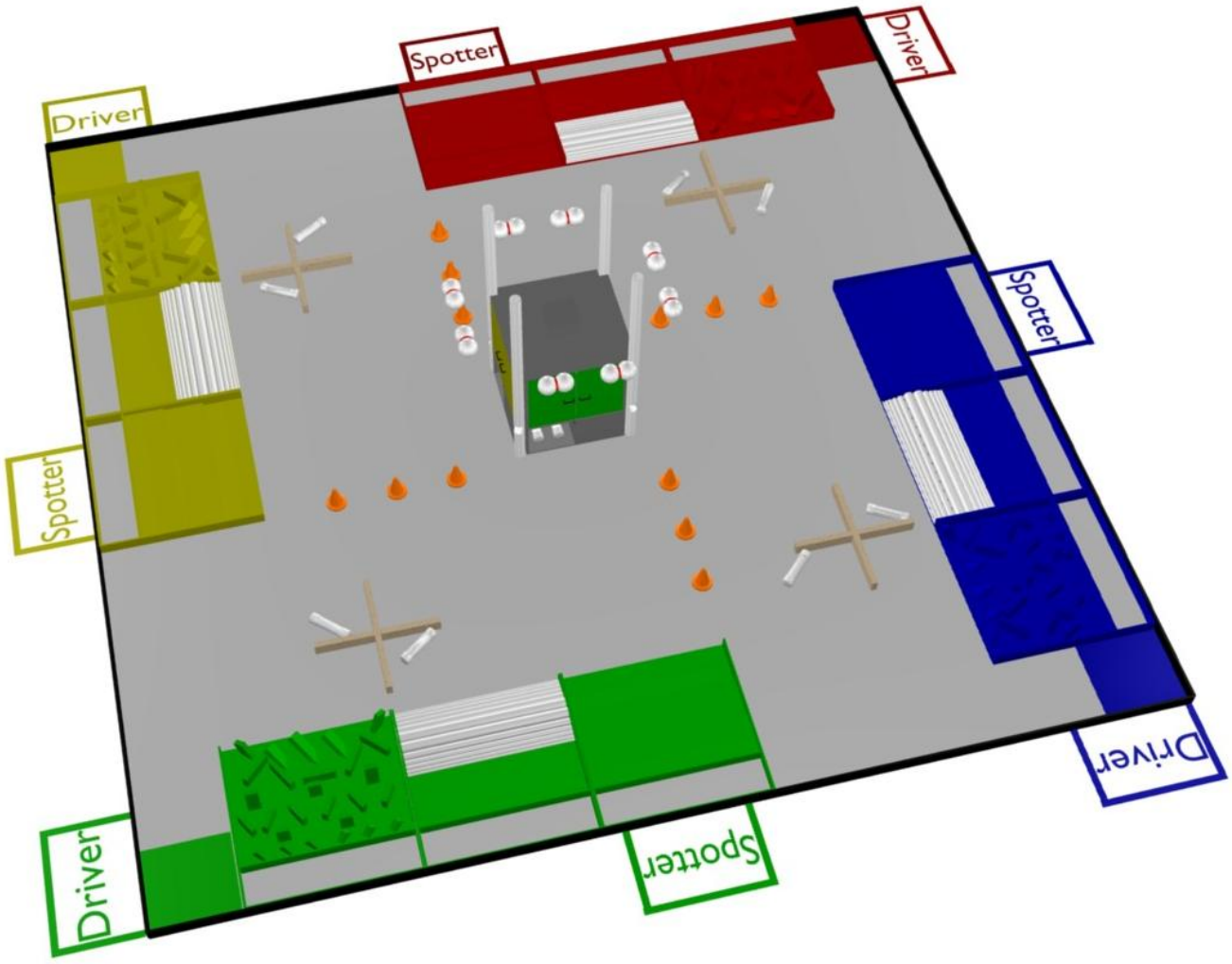


Figure 1: BZ Layout

3.1 The Shed

The shed is located in the center of the BZ. It is 3 feet high and 3 feet wide (not including bug food dispensers on the corners and motor compartment on top). Each of the four sides of the shed has a set of double doors on the upper two thirds that are used to access the cabinet, and recessed compartment on the lower third. The doors are the only access to the cabinet. The opening to the cabinet is approximately 28-3/8 inches wide by 21-1/4 inches high. Each cabinet door is secured with a magnetic latch at the top. The force required to open each door is 2 pounds plus or minus 1 pound. Inside, the cabinet, four flies (see section 4.1) are suspended from a rotating carousel. The four arms of the carousel are 12 inches in radius and rotate at a speed of approximately 0.8 RPM clockwise as viewed from the top. Twelve cockroaches (see section 4.2) are crawling around on the base of the cabinet. Each of the four teams may access the shed from any side, however the doors of the shed determine the tie breaker order based on the door color (see section 5.2 for more details). See section 6.0 for additional restrictions.

Two additional flies can be found hovering over each side of the cabinet. They are approximately 4 feet off the ground and approximately 1 foot from the face of the cabinet suspended by a piece of piano wire. Their exact location will vary based on the flexible nature of the piano wire.

The lower third of the shed is vertically divided into two equal sections. The left section has an opening of approximately 13-7/8 inches wide by 11-1/2 inches tall and 17-1/2 inches deep, and contains two termites (see section 4.3). The right section is enclosed by a wall.

On each corner of the shed are bug food dispensers. Each dispenser holds four pieces of bug food. The dispenser is activated by a switch just inside the opening that contains the termites. The switch is approximately 11 inches off the floor, see figure 2 and the game field construction document for more details. The switch activates the dispenser to the left. Food will dispense until the switch is released or until empty. Any team may use any food dispenser. Please reference the layout of the shed in figure 2 and game field construction drawings for more details.

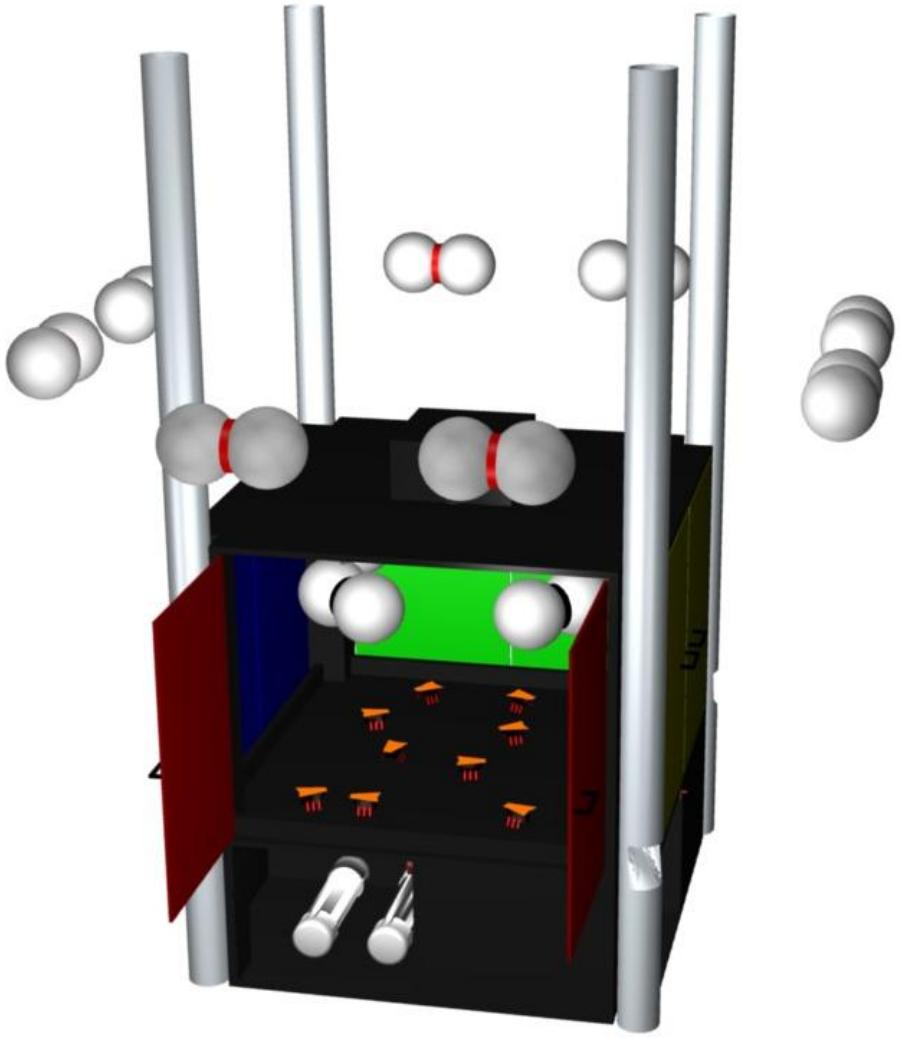


Figure 2: The Shed

3.2 TCA

Each team has 3 CAs. Each CA is 1 foot deep by 4 feet wide. In front of each CA is an obstacle, approximately 3 feet deep by 4 feet wide. The CA closest to the driver is called the Wood Pile Containment Area (WPCA) (see section 3.2.3). Next to the WPCA is the Pipe Containment Area (PCA) (see section 3.2.2). Furthest from the driver is the Stepped Containment Area (SCA) (see section 3.2.1). The robot must reach over, navigate through or drive over the obstacle in order to reach the containment area. Points are scored by placing bugs and food in the team's containment areas. See section 5.0 for details on scoring points. The field drawing package has more details on the physical dimensions of the containment areas, and Figure 3 shows the layout of the TCA. Section 6.0 has additional restrictions regarding the containment areas.

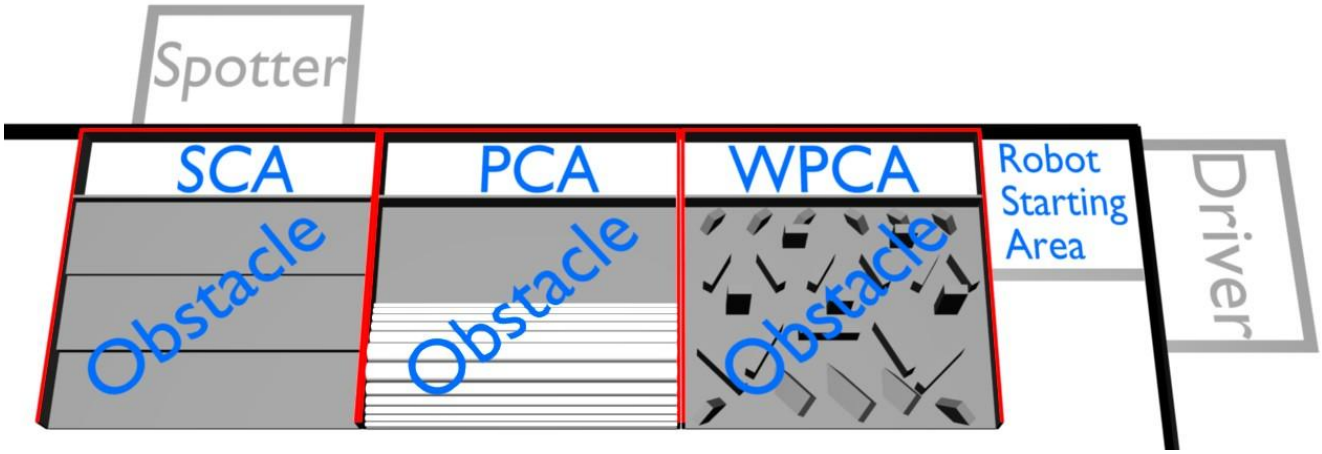


Figure 3: Team Containment Areas

3.2.1 SCA

The SCA is located furthest from the driver. The obstacle in front is made up of a set of three steps. Each step will be increasingly taller than the last starting at the smallest rise of 1/2 inch to the largest rise of 2-1/2 inch. See the game field drawings for exact dimensions.

3.2.2 PCA

The PCA is located between the SCA and the WPCA. The obstacle in front is made of PVC pipe of different sizes and laid out in a pyramid design. Starting and ending with 3/4 inch, with 3 inches in the middle. All pipes are schedule 40. The pipes are secured to the side of the PCA and have a tendency to shift and roll in place. See the game field drawings for exact dimensions.

3.2.3 WPCA

The WPCA is located closest to the driver. The obstacle in front consists of fixed wooden blocks of various sizes arranged at various angles. See the game field drawings for exact dimensions.

3.3 Obstacles

There are two different types of obstacles in the BZ. There are three orange cones in each quadrant of the BZ. The cones are approximately 9 to 10 inches tall. The exact shape, including any openings, in the cone may vary. Under each cone is one piece of bug food. There is also an "X" shaped barricade located in each quadrant. The barricade is made of two 2 foot pieces of 2x4 lumber mated at a 90º in the center. Teams are allowed to move the cones and barricade as long as no other rules are broken. See Figure 1 and 4 and the game field drawings for more details.

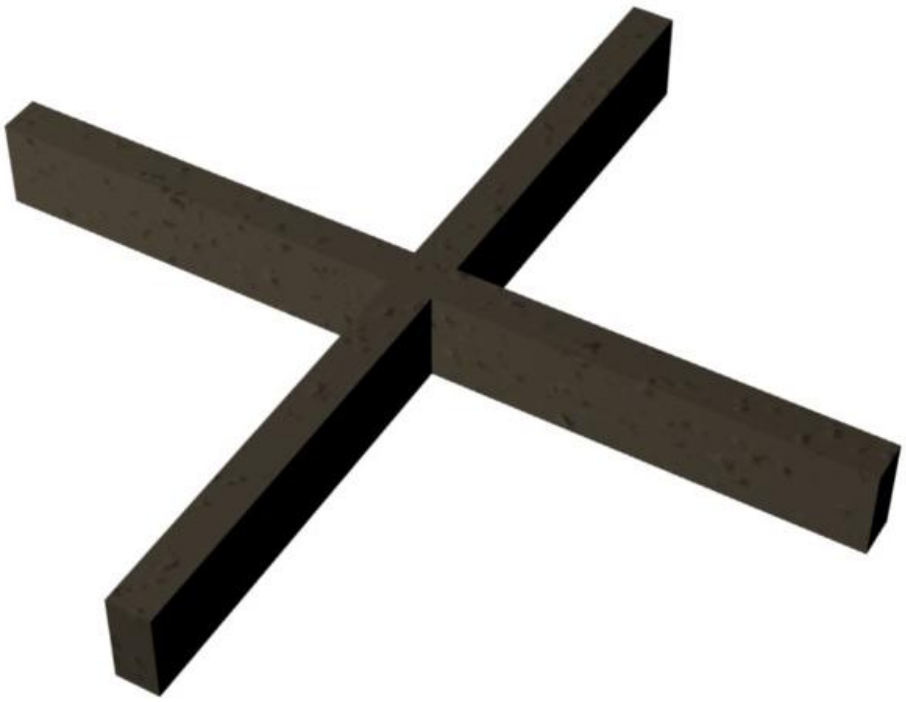


Figure 4: "X" Shaped Barricade

3.4 Driver and Spotter Boxes

The driver and spotter boxes are located on the outer perimeter of the BZ. Each is 2 foot by 3 foot and measured to the outer boarder of the tape. The driver boxes are located on the outer corner of the BZ. The spotter boxes are centered on the outer perimeter of the BZ. For detailed location and orientation information please reference Figure 2 and Figure 3. Please reference the generic game rules for additional regulations regarding the driver and spotter boxes.

3.5 Robot Starting Box

A robot starting box is located in each corner of the BZ. The size of the robot starting box is 2 feet by 2 feet (reference Figure 2 and Figure 3) and measured to the outer boarder of the tape. Please reference the generic game rules for additional rules regarding the robot starting box.

4.0 Bugs and Food
All bugs and food are available to each team during a match.

4.1 Flies
There are a total of twelve flies in the BZ. The flies are created from a pair of approximately 5 inch diameter Styrofoam® spheres glued together. Wrapped around each set of spheres is a piece of ribbon with Velcro® attached. The Velcro® is used to suspend the fly from its hanger in the BZ. The four flies suspended from the carousel have special genetic markers that make them more valuable. They are identified by a black ribbon. The remaining eight flies are found hovering near each door of the shed and identified by red ribbon.

4.2 Cockroaches
There are a total of twelve cockroaches in the shed. Cockroaches are simulated with IFC hex bug nanos. Each weighs approximately 0.25 ounces. The cockroach's starting location is the base of the cabinet. However, given the mobile nature of the cockroaches, their exact position will be random.

4.3 Termites
There are a total of sixteen termites in the BZ. They are constructed from a tube of Tyvek® material with 1 lb of red kidney beans inside. Each end of the tube is secured with a 2 inch PVC cap. Each termite weighs approximately 1 lbs 8 oz. Based on their construction, the length will vary from 12.25 to 14.25 inches.

There are two termites located in each of the four recessed areas at the base of the shed. The exact orientation and location in the recessed area will be unknown. Two more termites are located near each "X" barricade. Their orientation and exact location will be unknown, but they will be touching the barricade.

4.4 Bug Food
There are a total of twenty-eight pieces of bug food in the BZ, four in each dispenser and one under each orange cone. Each piece of bug food will be simulated by a standard size tennis ball.

5.0 Scoring
Scores will be determined at the moment the match is over. The score for each match will be a combination of the containment area subtotals plus bonus points subtotal. The score for each match will be added to the previous match to create a cumulative score.

5.1 Scoring Requirements
The inside plane of the CA walls create a vertical virtual boundary that reaches up to infinity. If any part of a bug or food crosses, or is completely outside the CA virtual boundary then the scoring object (bug or food) does not count toward the final score for the match.

Insects in the CA contained by robot, subassemblies, Detached Assemblies (DA) or any game components (other than bugs and food) at the end of the match will score no points.

5.2 Tie Breaker
The tie breaker will be determined by the order the shed doors were opened. Either the right or left door will activate the tie breaker. In the event of a tied score at the end of the match, the tie breaker order may be used to determine the winning team. The tie breaker doors face the team's containment area and are identified by the team's assigned color (Red, Green, Blue, or Yellow).

5.3 Basic Scoring of Bugs and Food
Each bug and piece of food that is located in a team's containment area (see section 5.1) at the end of the match will score points for that team. See table 1 for point values.

Insects and Food	Point Value (PV)	Total number in the BZ
Flies – with Black Ribbon	9	4
Flies – With Red Ribbon	7	8
Cockroaches	5	12
Termites	3	16
Bug food	1	28

Table 1: Scoring Pieces Point Summary

5.4 Containment Area Multipliers (CAM)
All bugs and bug food in scoring position will have their point value multiplied by the CAM. SCA (described in section 3.2.1) has a scoring multiplier of 1 times. The PCA is (described in section 3.2.2) has a scoring multiplier of 3 times. The WPCA (described in section 3.2.3) has a scoring multiplier of 5 times.

5.5 Bonuses
Bonuses will be issued per team per match using the following criteria.

5.5.1 Food Bonus
A bonus of 25 points will be awarded for each CA that is occupied by both insects and food.

5.5.2 Separation Bonus
A bonus of 50 points will be awarded if any of the individual teams CAs contain bugs and if each of those CAs have exactly one type of bug. For the purpose of the separation bonus, the flies with red ribbons and black ribbons are considered the same.

5.5.3 Full Recovery Bonus
A bonus of 100 points will be awarded if the team collects at least one of each type of insect. This collection can be in any combination of the team's CA. For the purpose of the full recovery bonus the flies with red ribbons and black ribbons are considered the same.

5.6 Scoring Examples

5.6.1 Example 1

CONTAINMENT AREA CONTENTS

SCA Contains: .....1 Terminate
PCA Contains: .....1 Cockroach
WPCA Contains: .....1 Red Fly and 1 Black Fly

CONTAINMENT AREA SCORE

SCA Subtotal

Item	Count	PV	Subtotal	CAM	SCA Subtotal
Fly-Black	0	x 9	= 0		
Fly-Red	0	x 7	= 0		
Cockroach	0	x 5	= 0		
Termite	1	x3	= 3		
Food	0	x1	= 0		
Subtotal / Score			= 3	x 1	= **3**

PCA Subtotal

Item	Count	PV	Subtotal	CAM	PCA Subtotal
Fly-Black	0	x 9	= 0		
Fly-Red	0	x 7	= 0		
Cockroach	1	x 5	= 5		
Termite	0	x 3	= 0		
Food	0	x 1	= 0		
Subtotal / Score			= 5	x 3	= **15**

WPCA Subtotal

Item	Count	PV	Subtotal	CAM	WPCA Subtotal
Fly-Black	1	x 9	= 9		
Fly-Red	1	x 7	= 7		
Cockroach	0	x 5	= 0		
Termite	0	x 3	= 0		
Food	0	x 1	= 0		
Subtotal / Score			= 16	x 5	= **80**

BONUS SCORE

Food Bonus 0
Separation Bonus.....50
Full Recovery Bonus.....100
Bonus Subtotal.....**150**

TOTAL SCORE

SCA Subtotal.....3
PCA Subtotal.....15
WPCA Subtotal 80
Bonus Subtotal 150

Total Score.....248

5.6.2 Example 2

INSECT CONTAINMENT AREA CONTENTS

SCA Contains .....1 Termite and 1 Piece of Food
PCA Contains: .....6 Cockroaches and 1 Black Fly
WPCA Contains: .....1 Black Fly and 1 Piece of food

CONTAINMENT AREA SCORE

SCA Subtotal

Item	Count	PV	Subtotal	CAM	SCA Subtotal
Fly-Black	0	x 9	= 0		
Fly-Red	0	x 7	= 0		
Cockroach	0	x 5	= 0		
Termite	1	x 3	= 3		
Food	1	x 1	= 1		
Subtotal / Score			= 4	x 1	= **4**

PCA Subtotal

Item	Count	PV	Subtotal	CAM	PCA Subtotal
Fly-Black	1	x 9	= 9		
Fly-Red	0	x 7	= 0		
Cockroach	6	x 5	= 30		
Termite	0	x 3	= 0		
Food	0	x 1	= 0		
Subtotal / Score			= 39	x 3	= **117**

WPCA Subtotal

Item	Count	PV	Subtotal	CAM	WPCA Subtotal
Fly-Black	1	x 9	= 9		
Fly-Red	0	x 7	= 0		
Cockroach	0	x 5	= 0		
Termite	0	x 3	= 0		
Food	1	x 1	= 1		
Subtotal / Score			= 10	x 5	= **50**

BONUS SCORE

Food Bonus .....50 (2 TCAs x 25 points)
Separation Bonus.....0
Full Recovery Bonus.....100
Bonus Subtotal.....**150**

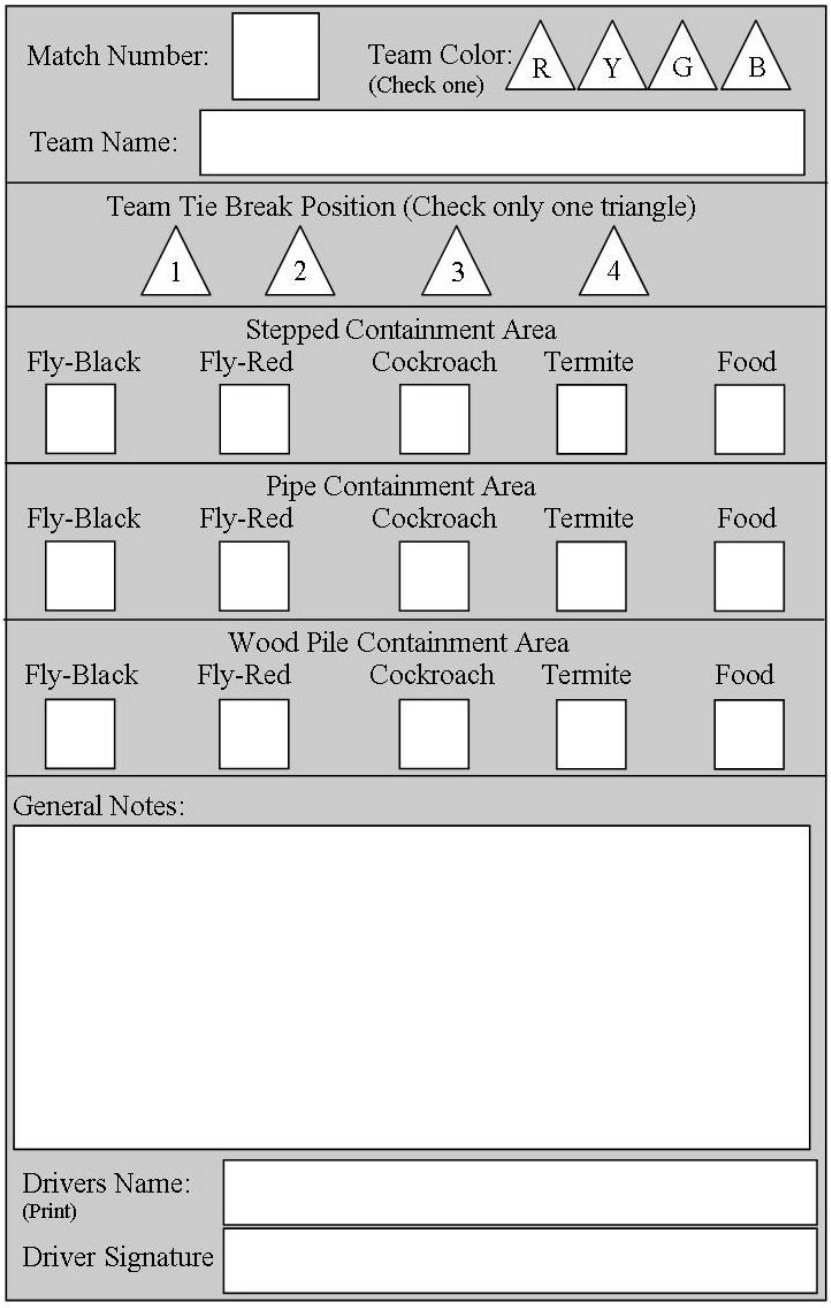
TOTAL SCORE

SCA Subtotal.....4
PCA Subtotal.....117
WPCA Subtotal 50
Bonus Subtotal 150

Total Score.....321

5.7 Sample Score Card

This is an example score card that will be used during the competition. Place a "✓"or an "x" on areas indicated by a triangle. Numbers are entered in areas indicated by squares and words are entered in areas indicated by rectangles.



6.0 Additional Restrictions

6.1 Interference rules
No interference is allowed. This includes, but is not limited to, blocking other teams, maliciously attacking other robots, as well as driving in other teams CAs or the preceding obstacle. Blocking is defined as intentionally restricting other robots movement both on the ground and in the shed.

Offending teams will be asked to drive to a non interference area and the remote control will be confiscated by the referee for the remainder of the match. The offending team will receive zero points.

6.2 TCA Rules
The insects and food may not cross or travel along the containment area boundaries (indicated by the red line in figure 3). In addition the robot may not reach or drive over any of the containment area boundaries with the intent of directly or indirectly placing insects or food in the CA.

If these rules are violated the insects and/or food that were illegally placed will not score any points.

6.3 BZ Boundary
Teams may not retrieve or use any game pieces or robot subassemblies that have touched the floor outside of the BZ boundary. The game pieces as well as any part of the robot may break the vertical boundary of the BZ but may not touch or come in contact with any object (including the floor or person) outside the BZ. The outside surface of the wood is the virtual boundary for the BZ. The top edge of the wood is inside the BZ. For the first offense teams will have their remote control confiscated by the referee for 20 seconds. Teams will be disqualified for the match and receive zero points on the second offense.

6.4 Game Piece / Field Destruction
It is considered damaging to the game pieces to use a mechanism that penetrates their surface. See generic game rules.

6.5 Dropping and Throwing of Insects and Food
Insects and food may not be forcibly launched or thrown through the air by the robot, any of its subassemblies, or detached assemblies. Game pieces (bugs and food) may be dropped by the robot, subassemblies, or detached assemblies as long as there is minimal horizontal movement (as determined by the referee) of the insects and food. The insects and food must not be significantly damaged (as determined by the referee).

All pieces released from a robot with more than minimal horizontal movement will not score any points. If bugs or food are damaged during the dropping or throwing action the team will receive zero points for the match.

Pieces of food that exit the food dispenser are exempt from this rule.

6.6 Theft
Robots may not add to or remove game pieces already in possession of another team's robot or another team's containment area.

The offending team will receive zero points for the match and any pieces removed from the victim's containment area will be replaced. Any pieces added will be removed.

6.7 DA Ownership
As soon as a piece of a robot is no longer attached to the robot by any item on the returnable or consumable list it is defined as a DA. DAs are no longer owned by the designing team. Instead the DA becomes public domain to be used by any team. If the DA is picked up then it is owned by the possessing team until it is set down. This process is repeated until the end of the match when the DA must be returned to the original designing team.

6.8 Hook Loop Fastener (Velcro®)
Velcro® may not be used for attachment to game pieces. Offending teams will receive zero points for the match.

6.9 Shed / Food Dispenser Interference
Robots should not interfere with the electrical and mechanical mechanisms of the shed and food dispensers. Anything placed on top of the shed, intentionally or not, is out of play and should only be retrieved by a referee at the end of the match.

If the interference is deemed intentional, the offending team will have their remote control confiscated by the referee for 20 seconds. For the second offence the team will be disqualified for the match and receive zero points.

7.0 Match Protocol
Each match shall be three minutes long and is played with four teams if possible. The scoring software will assign teams to a match and will determine the team's starting locations relative to the BZ.

7.1 Competition Protocol

7.1.1 Driver Spotter Rotation
Drivers must rotate from match to match. Spotter rotation is left to the team's discretion. Please reference the Generic Game Rules.

7.1.2 Game Day Flow
There will be four phases to the competition – a seeding round, wild card match, semi-final round, and a final round. The flow for hub level competitions is listed below. Regional events will follow a similar schedule and will be announced as soon as possible. The world championships will likewise follow a similar schedule, but will be announced as soon as possible.

7.1.3 Seeding Round

The seeding competition will consist of round robin competition with eight matches (or six depending upon time) for each team. The top seven teams ranked by score will advance to the semi-finals.

7.1.4 Wildcard Match

The wildcard match consists of one match between the four teams with the highest scoring notebooks that are not already ranked in the top seven teams from the seeding round. No previous match scores will be included nor will any scores from this match be added to any other phase of the competition. The winner of this match will move on to the semi-finals. Tie breakers for this match will be played as already indicated.

7.1.5 Semi-final Round

The semi-final round will also consist of a round robin competition. The top seven scoring teams from the seeding round plus the winner of the wildcard match will play in the semi-final round. Each team will play three matches. Scores will be reset before the semi-final round. Semi-final round rankings will be based on cumulative scores from the three matches of the semi-final round. The top four ranking teams will move on to the final round. See table 2 for seeding information.

Semi-final Round Match Number	Starting Position Color / Team Seeding Round Ranking			
	Red	Green	Blue	Yellow
1	4	1	5	8
2	2	8	3	7
3	6	4	7	1
4	3	2	4	5
5	5	7	8	6
6	1	3	6	2

Table 2: Semi-final Round Seeding

7.1.6 Final Round

The top four ranking teams from the semi-finals will play three final matches. Scores will be reset from previous phases of the competition. Teams will be ranked based on cumulative scores from the three matches of the final round. The winner will be the team with the most points accumulated in the final round. See Table 3 for more information.

Final Round Match Number	Starting Position Color / Team Semifinal Ranking			
	Red	Green	Blue	Yellow
1	1	2	3	4
2	4	3	2	1
3	3	1	4	2

Table 3: Final Round Seeding

8.0 Acronyms

BZ .....Bug Zone
CA.....Containment Area
CAM .....Containment Area Multiplier
DA.....Detached Assembly
PCA.....Pipe Containment Area
PV .....Point Value
SCA.....Stepped Containment Area
TCA.....Team Containment Area
WPCA.....Wood Pile Containment Area

9.0 References

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