

Transfusion Confusion

BEST 2003 Design Contest

Game Specific RULES

Version 1.02

June 29, 2003



1.0 Introduction

Best Robotics Inc (BRI) has decided to branch out from its normal retrieve and rescue missions to enter the field of medical technology. To develop new medical equipment, BRI decided to take the low-risk approach of relying on established radio-controlled robotic technology. The business development plan shows that robots are more reliable than humans and require less pay than certified medical technicians.

So that off-the-shelf components can be used for in-vivo medical procedures, BRI has purchased a second-hand miniaturization machine capable of shrinking a 24-inch robot down to about 24 microns. Unfortunately, the bargain-priced miniaturization machine is based on old technology, so the miniaturization effect is limited to 3 minutes.

Once miniaturized, your machine, and that of three other teams will work to move blood cells from various locations within a sterile field to a Cell Saver used for autologous blood transfusions. There are several blood vessels within the sterile field that contain various types of blood cells and a few green diseased cells. The value of the cell to the transfusion process depends on its type. Since white cells fight infections, they are more valuable than oxygenated red cells. Blue cells, which are actually oxygen-poor red cells, are less valuable than the oxygenated red cells.

Although the miniaturization process sterilizes the robots, each team has a spot decontamination unit that may be switched on to ensure complete sterilization. The spot decontamination unit must be used in the event that one of the diseased cells is accidentally ruptured.

Teams must remember that one of the cardinal rules of medicine is “Above all, do no harm.” Therefore, they should be careful not to damage any of the cells or disturb the vessels.

2.0 Objective

The objective is to design and build a remotely controlled device to safely transport as many blood cells as possible into your portion of a Cell Saver within the 3-minute time limit.

3.0 Field Description

The (sterile) field is approximately 24-foot square (with 3 foot chamfers) and is outlined by 4-inch PVC sewer pipe with an 18-inch high barrier made of orange plastic construction fence. The surface of the field is covered with carpet and the interior of the field contains three arteries, four capillaries and two cell savers. A general layout of the field is shown in Figure 1. The diagonal lines that connect the arteries represent an electrical cord protector.

Detailed dimensions, component specifications, and the locations of the field elements can be found in the separate field drawing document.

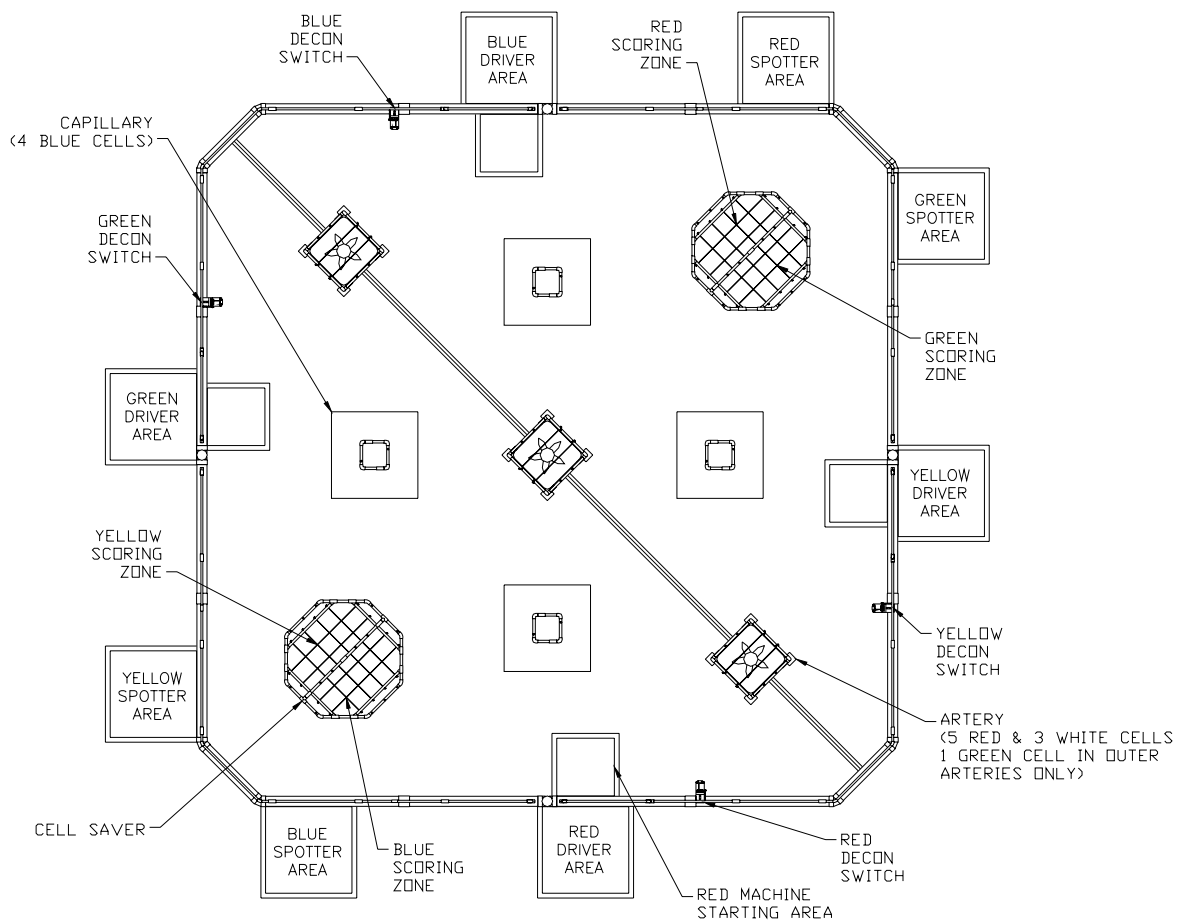


Figure 1 – Field Layout

3.1 Artery

Each artery consists of a 20-inch box fan, turned to blow air upwards, housed in a frame constructed from 3/4-inch PVC pipe fittings and 3/16-inch diameter nylon-cased shock cord. The arteries are approximately 48 inches high and 24 inches across as shown in Figure 2. The shock cords are spaced on 7-inch centers. Two shock cords across the opening at the top are spaced on 8-inch centers. The base is held in place on the carpet with the hook side of hook-and-loop fastener.

3.2 Capillary

The capillaries are also constructed from 3/4-inch PVC pipe fittings and 3/16-inch diameter nylon-cased shock cord. As shown in Figure 3, the capillary is approximately 36 inches high. The PVC assembly is fastened to a 3-foot wide square piece of 1/8-inch thick hardboard. The hardboard is mounted with the smooth side up and is attached to the carpet with the hook side of hook-and-loop fastener.

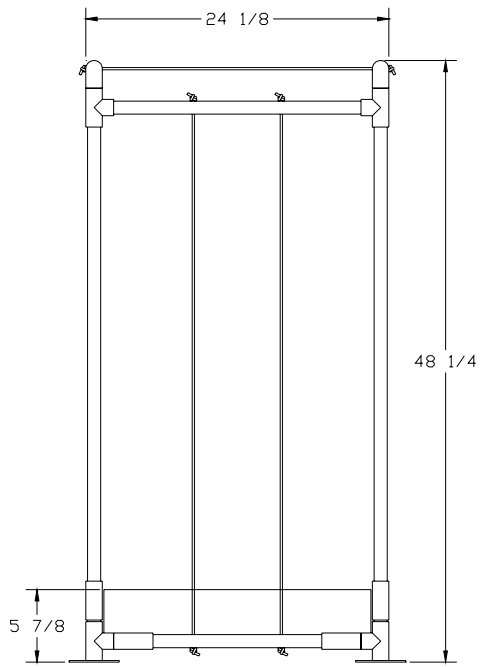


Figure 2 – Artery

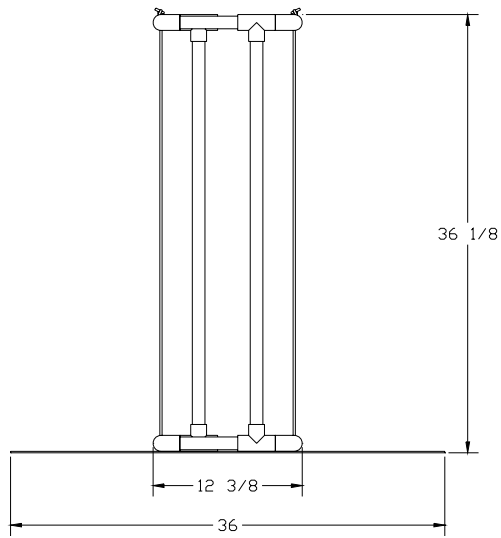


Figure 3 – Capillary

3.3 Cell Saver

The configuration of the cell saver is shown in Figure 4. The cell savers are constructed of the same size PVC and shock cord material as the other field pieces. A horizontal plane and a vertical plane divide each cell saver into four zones. The vertical plane separates the scoring area for two teams and the horizontal plane separates the high and low score areas. The shock cord spacing is nominally 7 to 7 1/2 inches.

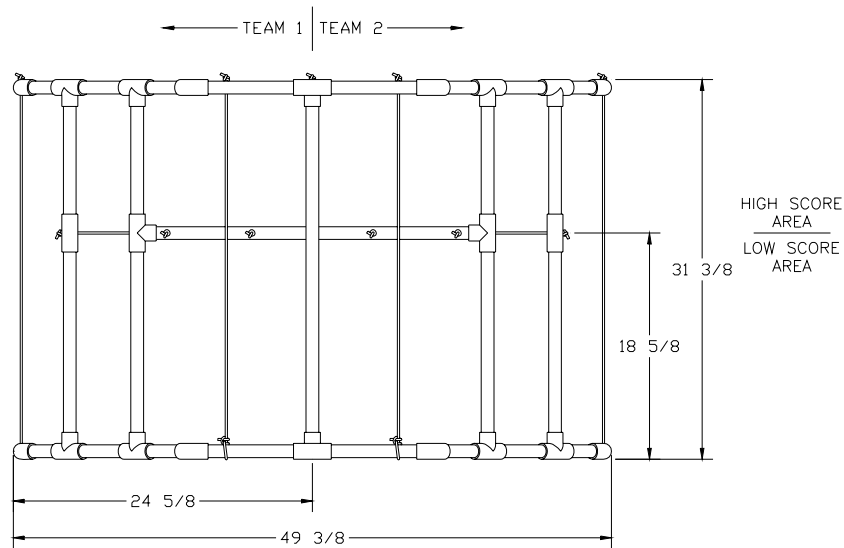


Figure 4 – Cell Saver (Picture shown without the colored panels on the carpet that indicate the team assignments)

3.4 Decontamination Switch

The decontamination switch (shown in Figure 5) is constructed from a 16-inch long piece of standard 1x4 lumber, and pivots on a hinge. The top of the switch tilts towards the inside of the field and is returned to that position with 3/16 shock cord connected near the bottom of the paddle. The switch is activated when the pivoting portion of the switch is moved such that the bottom edge is roughly 1/4-inch away from its initial position. When the switch is activated, the light at the top of the switch will turn off. The switch is connected to the electronic tiebreaker system that automatically determines if the switch has been activated.

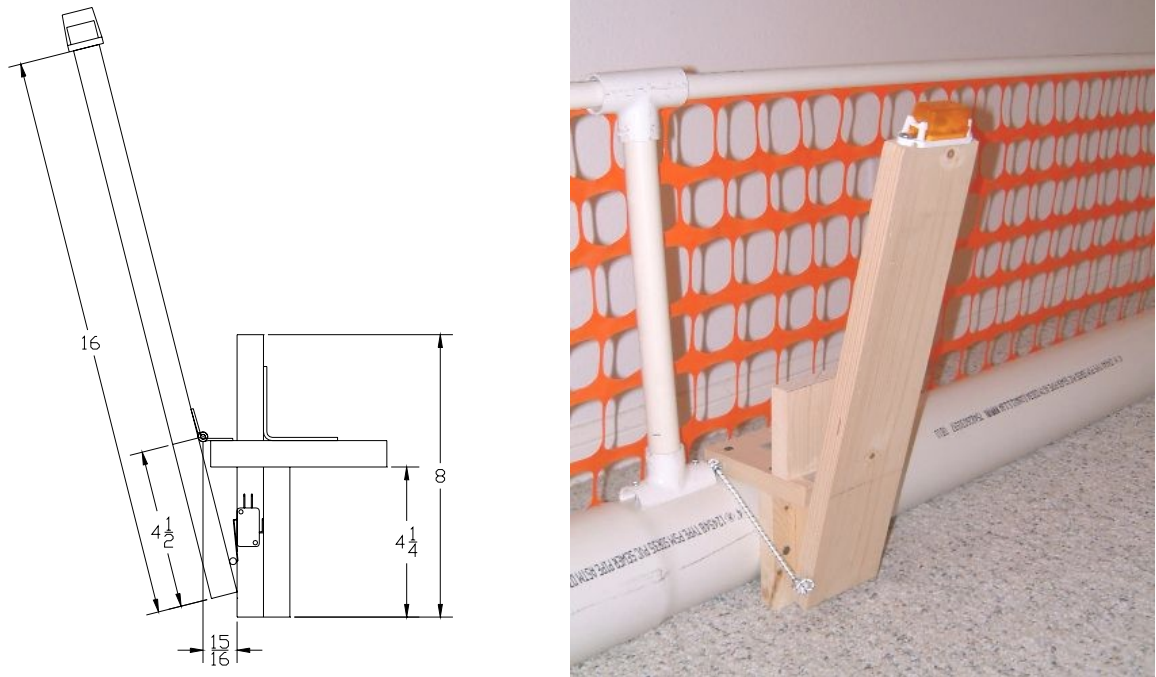


Figure 5 – Decontamination Switch. The field border is visible in the background.

3.5 Field Restrictions

1. It is illegal to intentionally tip over or move any portion of the field (you wouldn't want to hurt the patient, right?). A team that intentionally violates this rule will be disqualified from the match.
2. Devices intended to alter or block the flow of air from the fan may not be deposited on (or under) the fan (this could cause a stroke).
3. Machines may not attempt to stop the rotation of the fan blades.
4. Machines may not drive on the horizontal surface of the fan grill (the tissue is sensitive).
5. A referee will untangle machines that become entangled with part of the field for more than 10 seconds or that appear to be damaging the field because of the entanglement.
6. Machines that touch the floor outside of the sterile area must immediately proceed to their decontamination location and flip the switch (regardless of whether or not the switch was previously flipped).

4.0 Game Pieces

The blood cells are actually “11-inch” Qualatex® brand balloons filled with air. The balloons are filled such that the diameter is between 8-1/4 and 8-3/4 inches (i.e. 8-1/2 inches \pm 1/4 inch). The balloon length is not controlled, but is nominally 10 inches. The balloons should be tied such that there is a 1/2 to 1-inch “tail” at the tied end of the balloon.

5.0 Scoring

Each cell saver serves as the scoring location for two teams. As was previously mentioned, there is a vertical plane (shown in Figure 4) that divides the scoring areas for two teams and a horizontal plane that divides the lower and upper portion of the cell saver. Therefore, each cell saver contains four scoring zones. For purposes of scoring cells within the cell saver, the position of the blood cell is established by the center of the quasi-spherical portion of that individual blood cell (as determined by the referee). The outer edge of the scoring area is defined by the centerline of the PVC pipe that makes up the outer octagonal shape of the cell saver. The horizontal plane that defines the upper/lower scoring areas is defined by the center of the PVC pipe to which the shock cord is mounted (it is not determined by the position of shock cord which may stretch up or down). The upper scoring area extends infinitely upwards.

Scoring is determined by the position of the individual blood cells at the end of each match. Only complete (un-damaged) blood cells will be counted.

5.1 Red, White and Blue Cells

Each blood cell type (color) has a point value. The value of the cell is doubled if it scored in the upper area of the cell saver. It does not matter which team places a cell in a specific goal, the points are awarded to the team (color) assigned to the goal. The following table summarizes the value of a blood cell scored in the cell saver.

Table 1 – Point values by blood cell type and scoring area

Blood Cell Type	Lower Area Point Value	Upper Area Point Value
Blue (1 point)	1	2
Red (2 points)	2	4
White (3 points)	3	6

5.2 Diseased Cells

There are two ways of using the green diseased blood cells: the cell scores when it is removed from the sterile field (i.e. deposited outside of the playing field), or the cell nullifies the score in the specific zone of the cell saver where it is located.

Each diseased blood cell removed from the field scores 8 points for all teams participating in the match. To score, the diseased blood cell must not be in contact with a machine, and must be

located completely outside the field. The outer boundary of the field extends vertically without limit and is defined by the outer edge of the orange fence material. Once a diseased blood cell has been removed from the field, it is out of play, and cannot be brought back onto the field.

To nullify a zone of the cell saver (e.g., the upper scoring area of the yellow team), the diseased blood cell must be located within that zone subject to the same location criteria as the red, white and blue blood cells. The diseased blood cell does not affect the blood cells contained in any of the other zones of the cell saver.

5.3 Decontamination Switch

Activating the decontamination switch scores 3 points for the team assigned to the switch. The switch only scores points the first time it is activated. Since the switch automatically returns to its initial position, the score is not affected by subsequent changes in the switch position. The order in which the decontamination switches are activated is used to resolve ties as described in the competition protocol section of this document. As was previously mentioned, the decontamination switches are electronically monitored to determine both the scoring status and switch order.

5.4 Scoring Penalties

Intentionally damaging (i.e. popping) cells is not an acceptable strategy. The referee may disqualify from the match a machine that he or she feels is intentionally damaging blood cells. When blood cells are damaged, the team or teams involved with the damage are assessed a scoring penalty. When the penalty applies to multiple teams, each team receives the entire penalty value; the penalty is not split between the teams. Although it is legal to remove (steal) cells from another team, a team damaging any blood cell in a scoring position will receive a 10-point penalty. A team otherwise damaging any cell will receive a 4-point penalty. If a team intentionally damages cells that are in a scoring position, that team will be disqualified as previously mentioned, and the points for the damaged cells will be awarded to the team that would have received the points if not for the actions of the disqualified team.

If a green diseased blood cell is damaged, in addition to receiving the point penalty described in the previous paragraph, the team or teams involved must immediately proceed to their decontamination location and activate the decontamination switch to re-sterilize their machine (regardless of whether or not the switch was previously flipped). A team that ignores the referee's direction to proceed to the decontamination switch will be disqualified. Should match time run out prior to the team activating the switch, there will be no disqualification, as long as the referee observes that the team is making a good-faith effort to reach the switch.

At the end of the match, if a team's total score is negative, that team will receive zero points for the match. A disqualified team automatically receives zero points for the match.

6.0 Match Protocol

Each match is 3 minutes long and is played with 4 teams. If necessary, matches may also be played with less than 4 teams. The scoring software will assign teams to a match and will determine teams starting locations.

6.1 Starting Locations

At the start of each match, Drivers and Spotters must be in their respective areas and the machine must be positioned completely inside the 24-inch square starting area. Refer to Figure 1 for an overview of these locations.

At the start of each match, each capillary contains four blue blood cells (oxygen poor red cells), and each artery contains five red blood cells and three white blood cells. In addition, the outer two arteries each contain a single green diseased blood cell.

7.0 Competition Protocol

There will be three phases to the competition: a seeding competition, a semi-final competition, and a final competition.

During the seeding competition, each team will play up to eight matches against randomly selected opponents. Less than eight matches per team may be played when time limitations exist, but all teams must play the same number of matches. The team ranking for the seeding competition will be based on the average of the points scored during the seeding matches excluding the team's lowest scoring match.

The top eight teams from the seeding competition will advance to the semi-final competition. Regional and other competitions with a team count greater than 32 may choose to advance more teams for the semi-final. During the semi-final competition, each team will play a total of three matches based on the rotation shown in the table below. The team ranking for the semi-finals will be based on the total points the team accumulates during the three semi-final matches (i.e. no scores are dropped, and the results of the seeding matches are not included.)

Table 2 – Semi-final match rotation

Semi-Final Match	Starting Position			
	Yellow	Blue	Red	Green
1	Seed 1	Seed 2	Seed 7	Seed 8
2	Seed 5	Seed 4	Seed 3	Seed 6
3	Seed 8	Seed 1	Seed 4	Seed 5
4	Seed 6	Seed 3	Seed 2	Seed 7
5	Seed 3	Seed 8	Seed 6	Seed 1
6	Seed 2	Seed 7	Seed 5	Seed 4

The four top ranked teams from the semi-final will advance to the final competition where they will play three additional matches in the field starting positions shown in the following table. The final team ranking will be based on the total points scored during the three final matches.

Table 3 – Final match rotation

Final Match	Starting Position			
	Yellow	Blue	Red	Green
1	Semi 1	Semi 2	Semi 3	Semi 4
2	Semi 4	Semi 1	Semi 2	Semi 3
3	Semi 3	Semi 4	Semi 1	Semi 2

7.1 Tiebreaker

The average tiebreaker position will be included in the team position calculation for each phase of the competition. The tiebreaker position is determined by the order in which the decontamination switches are activated. The tiebreaker position includes only those matches played during a particular phase of the competition. For the seeding matches, the tiebreaker position of a team’s lowest scoring match will be dropped (along with the score). If the average tiebreaker position does not resolve a tie, the tiebreaker positions of the tied teams will be compared starting with the most recent match and proceeding to earlier matches (within a competition phase) until a difference is found. The team that activates the decontamination switch first will place before the other team(s).