Robofest^{SM} 2006 Game Competition Challenge: "Toxic Waste Cleanup"

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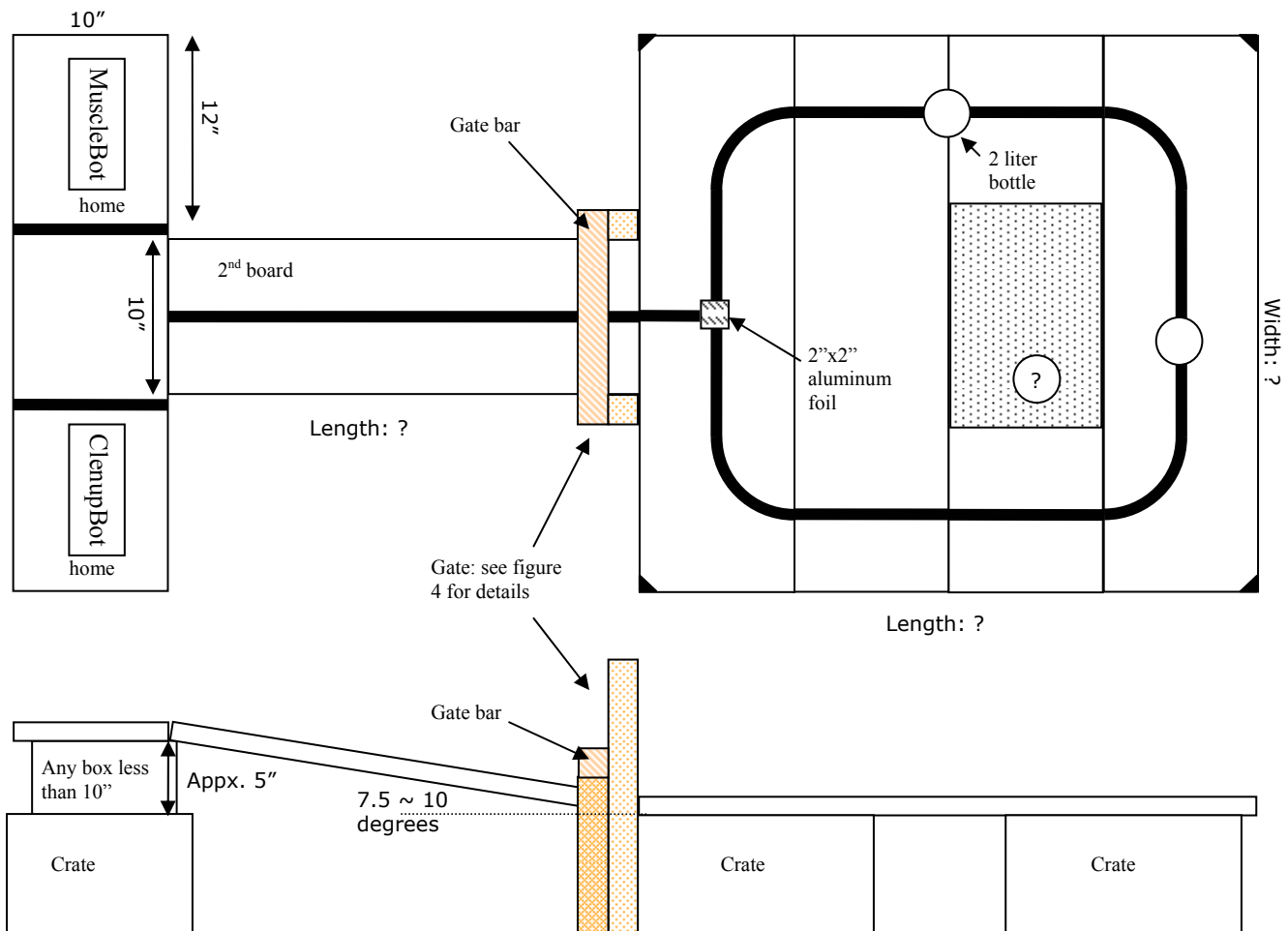
Junior Game Competition Division

Figure 1. Playing field

I. Game Objectives

The learning objectives of this game are to design and program robots to sense and search for objects, communicate with each other, map where the robot itself is located (localization), and navigate through the partially unknown path. In addition, this game requires building the robot to lift/push objects and climb down/up a ramp. Since the lighting condition of the competition area is unknown, it is required that students master the ability to adjust their programs to adapt to an unknown lighting environment.

II. Game Synopsis

The goal of this game is to complete the entire mission without human assistance in the shortest time.

1. **Wait for the start signal, start successfully, and reach the 2nd board (10 points)**: Two robots, the MuscleBot and CleanupBot, must be waiting for necessary sensor inputs. The start signal

method for the MuscleBot will be unveiled on the day of the competition. It is required for teams to bring an extra **touch** sensor for the qualifying competitions. You may need extra materials to attach the sensor or to build sensor assembly. 10 points will be awarded, if the entire body is moved on to the 2nd board after the successful start. In case the player gives up the automatic start, the player can start the robot manually by pressing a start button on the robot. In this case, 2 points are awarded if the entire body is moved on to the 2nd board. For the qualifying competitions, the unknown mission does **not** require physical interactions between two human players.

2. **Follow the path and touch the gate (5 points)**: The MuscleBot is to follow the path on a white multipurpose board until any part of the robot touches the gate. The length of the ramp is unknown until the competition.

3. **Drop off the gate bar (15 points):** If MuscleBot drops the gate bar off the 2nd board, 15 points are awarded. If the gate bar is removed from the gate assembly, but still on the 2nd board, 2 points are awarded.

4. **Return home and stop (10 points)**: When the MuscleBot returns to home and **stops at least for 2 seconds**, 10 points are awarded. The entirety of the robot must be behind the baseline. While or after returning home, MuscleBot may send a wireless signal (IR, Radio, etc) to let the CleanupBot go. It is possible for CleanupBot to detect the arrival of the MuscleBot using touch, light, or motion sensor. For example, MuscleBot can touch the CleanupBot, while returning home.

If any failure occurs during the above missions, the MuscleBot needs to be restarted from the very beginning with the start signal for full points. (All points earned up to the point of failure are kept, however you cannot get the same points twice.)

5. **Automatic Start of the CleanupBot and reaches the 2nd board (10 points):** After the MuscleBot returns to home and stops, if the CleanupBot starts without human help and the entire body is moved onto the 2nd board 10 points are awarded. *If the CleanupBot starts before the MuscleBot stops at home, it is regarded as a manual start.* However, since it is difficult to precisely determine the time, the team is given the benefit of the doubt when the 2nd robot starts. The team may start the second robot manually without the completion of the 1st robot. In this case, a human player may remove the gate bar and/or place the first robot at its home by hand. If the CleanupBot is started manually and reaches the 2nd board, then 2 points are awarded.

6. **Pass the gate (5 points):** If the entire body of the CleanupBot passes completely through the gate after following the straight path, 5 points are awarded.

7. **Remove the toxic barrels (total 30 points)**: If the robot successfully pushes and drops the barrel (2 liter plastic bottle) on the black line off the board, then **7** points will be awarded for each barrel. The barrel will not be placed on the curve. Only one barrel will be placed on the straight line. No barrel will be placed on the line with the aluminum foil. If the robot successfully pushes and drops the barrel that is inside the dotted rectangle in the circle off the board, then 16 points will be awarded. Two partial points are awarded, if inside bottle is not dropped off but just contacted by the robot. The bottle inside the circle will be in same place for all playing fields for a match.

8. **Unknown mission(s) (10 points)**: After removing the 3 toxic barrels, the CleanupBot should complete some unknown remaining mission(s) for 10 points. The mission will be unveiled on the day of the competition right after the opening ceremony.

If any failure by the CleanupBot, the team may start the first MuscleBot from the beginning with the start signal for perfect score, or they may retry only the CleanupBot by starting it manually. While a robot is in action, touching of robots, gate bars, or bottles by human hands can be regarded as failure.

If all missions are completed in a sequence from the mission No. 1 (not the start of the game) till the end without *any* human help, then additional **5 points** will be given.

III. Game Rules

- The brightness of the competition area is unknown. Students should be able to adjust their programs or write programs to self-adjust on the fly for possible light changes.
- 2 minutes per game are given.
- 2 chances (rounds) are given for each team before the final.
- To encourage teams to try early in the *first* round, the first match teams will get 2 *flash* extra points. (If there are two official playing fields, then two teams will get the extra points). The second match teams will get 1 *flash* extra point. Teams are not allowed to "hold" a place in line; the team in line must have two robots; laptop computers are not allowed in the waiting line.
- Only two players are allowed in the official playing field. One minute will be allowed for setup before each round. Team members are responsible for catching the robot if it falls off the course.
- Average of the two scores from two rounds will be used to determine finalists. Tiebreaker is the average of the completion times. 2nd tiebreaker is the best time.
- The game competition winner will be decided by the results from the average of the best 2 runs.
- LEGO remote controls seen anywhere at the competition site will be confiscated.
- Anything not specified in this rule can be decided by the Game Judges.

IV. Robot Qualifications

	Length	Width	Height	Weight
MuscleBot	≤12″	any	any	any
CleanupBot	≤12″	≤10″ *	≤7.5″	any

(*) Note that if more than 10", then the robot cannot pass through the gate! During the game, the CleanupBot may extend its dimensions such as arms maximum up to total **15**".

- You must use only one (8 bit micro-processor based) robot controller for each robot. For example, the Lego RCX brick uses an 8 bit Hitachi H8/3292 micro-controller.
- You may use any number of sensors / sensor types.
- You may use any number/type of motors/servo motors.
- You may use any material to construct your robot. You may use tape, glue, bolts and nuts, etc.
- You may use any programming language; we recommend an icon-based graphical programming language for the Junior division.

V. Instructions for Playing Field Construction

As shown in figure 1 and 2, several multipurpose white shelves will be used for the path and the toxic field. The dimension of the white boards is unknown except for the start board which is 10"x36". The width of the 2nd board is 10", but the length is unknown. The size of the toxic barrel area is also unknown. The angle of the ramp is between 7.5 and 10 degrees.

Note that the actual width of the bookshelves you can buy from local stores in the USA is slightly less than the specified size. The thickness of the bookshelves is about 5/8". Standard black electrical tape (width of 0.75") will be taped approximately in the middle for the shelves shown in Figure 1 and 2.

The dimension for the curve shape is shown in figure 3. Also, the corners will be covered with black electrical tape.
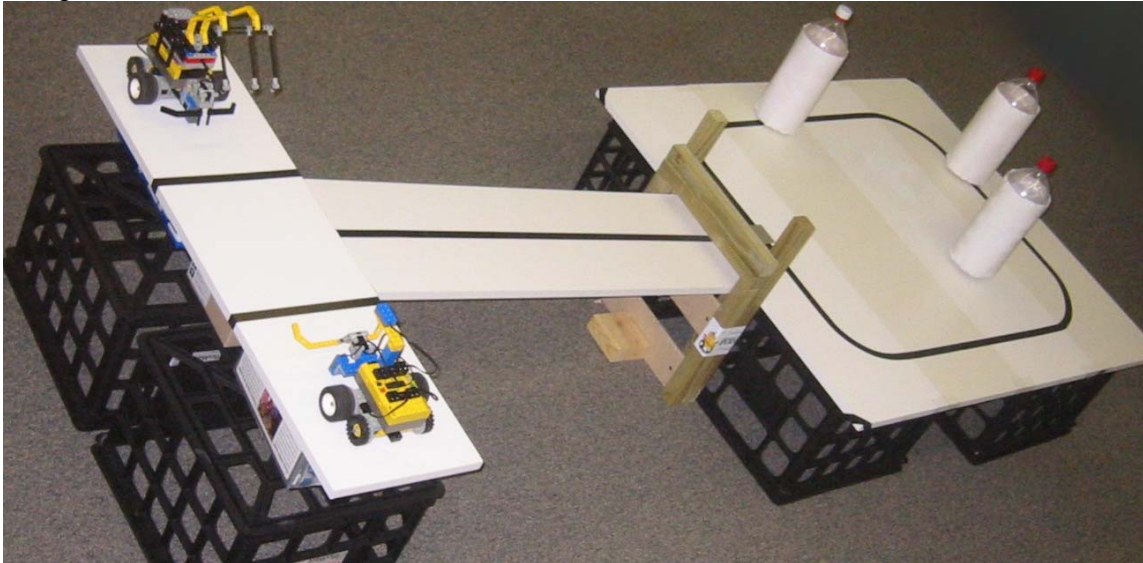

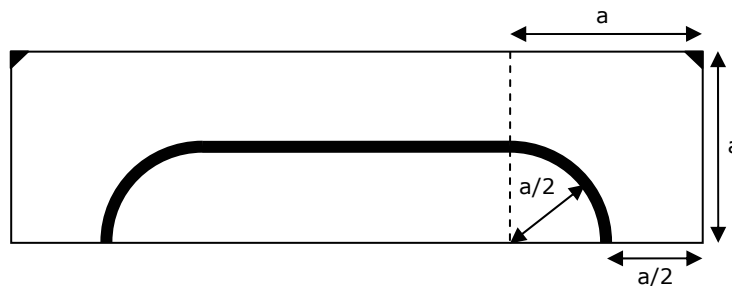**Figure 2. A sample playing field for Junior Division**


Figure 3. Curves

For imitating toxic barrels, standard 2 liter soda bottles (Coke, Pepsi, etc.) filled with around 7 fl oz (200 ml) water will be used. They are covered with a white legal size (8.5"x14") paper. Two bottles will be placed on the straight lines, not on the curves. The location of the bottle inside the circle is unknown and placed in the dotted rectangle area in figure 1 after the game starts by the judge.

The 2x2" aluminum foil square will be located on the black line almost in the center of the gate. The shiny side of the foil will be up. Double sided tape must be used from the bottom of the aluminum foil.

The gate is made of a 2x2 wood bar as shown in figure 4. The gate pillar is attached to the crate with packaging tape (or you could make a structure not to fall down, for example, using L shape brackets, etc.). The weight of the gate bar is approximately 4.3 oz (121.9 grams).

The color of the crates under the first board shall be dark. The color of the floor where the shelves will be placed should be dark, but unknown. (For example, Lawrence Tech site's floor color is dark blue). You may use this knowledge for your path following and navigation method.

There will be a 20"x30" black foam board which team players may use to prevent from detecting inappropriate light sources, if they want to use.

6"

12.5"

12.5"

10 7/16" (*)

Board

(*) or height of the object to support the boards
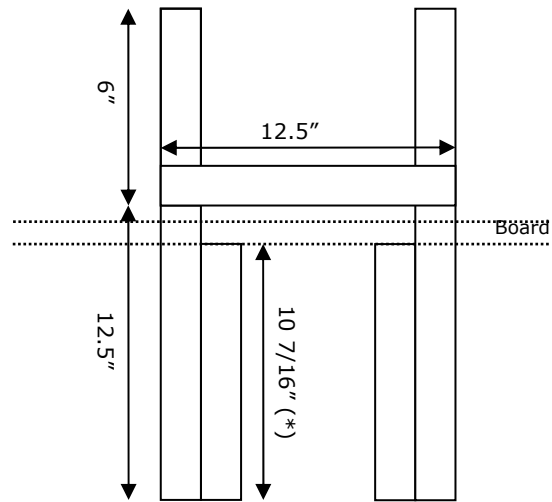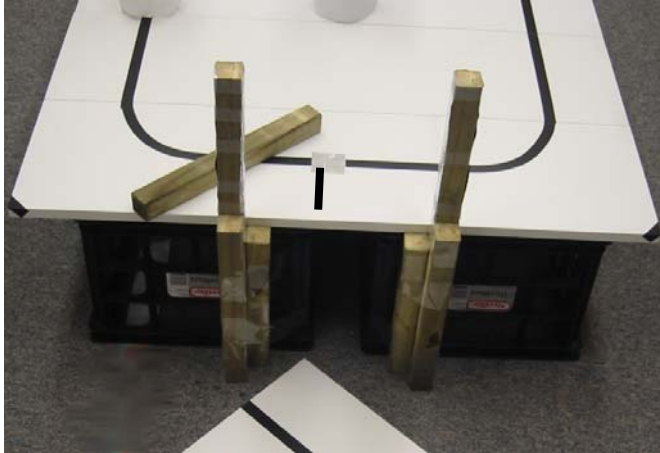
Figure 4. How to make the gate

Suggested method to make the ramp is depicted in figure 5 shown on the right. Three boxes of empty or full 12 fl oz. (355ml) soda cans, with a height of about 5", are placed under the 1st board. Note that no part of the boxes should be seen from above.

All the edges (not the center area) of the shelves will be taped together using transparent packaging tape (2" width). If your robot is using skids, make sure they can slide over the tape.

This document is using inches as measurement unit for length by default.

Figure 5. How to make the ramp

VI. Suggested purchase list for one practice playing field

Item	Spec. / Description	Quantity	Estimated Unit Price	Estimated Price
All purpose white shelf *1	5/8 thick, Approx. 10"x 36"	6	$6.50	$39
2x2-8' wood *2	SYP EE, treated, for outdoor deck	1	$2.50	$2.50
Storage Crate*, *3	Sterilite, 15 1/4"L x 13 3/4"W x 10 1/2"H, 1692, www.sterilite.com	6	$4	$24
Standard electrical tape *2	Black, PVC tape	1	$1.50	$1.50
Scotch double sided tape	Permanent	1	$3	$3
Scotch Packaging tape	Clear, 3750	1	$3	$3
Coke cans	12 FL OZ (355ml) H: 12.2cm	36	*4	
2 liter bottle		3 or 4	*4	
Aluminum foil		1	*4	
White paper	Letter (8.5x11) or Legal (8.5x14)	2 or 1	*4	
			Total	**$73**

*1- Found at Meijer, Home Depot, or ACE Hardware   *2- Home Depot (Not Lowes)
*3- Meijer or go to www.sterilite.com/stores.html   *4- recycled ones

<u>Senior Game Competition Division</u>

The game rules of the Senior Division are the same as that of the Junior Division except the differences summarized in the following table.

	Junior	Senior
Recommended programming language	Icon-based graphical language such as RCX code or RoboLab	Text-based high-level language such as C, C++, PBasic, or Java
CPU of the controller	8-bit micro processor based	Any
The line on the 2nd board	Solid line	Dashed line (length of the gaps and lines unknown)
Number and location of the bottles	Three; Two on the line and one inside the circle	Four; Two on the line and two inside the circle. The distance between the inside two barrels will be at least 5".
Points for bottle(s) inside circle	16 or 2 (in case just contacted)	8 for each
Number of gate bars	1	2 (They are stacked. If only one is dropped off, 8 points will be awarded. No partial points)
Unknown missions	Simple	More challenging. It may require missions for both robots
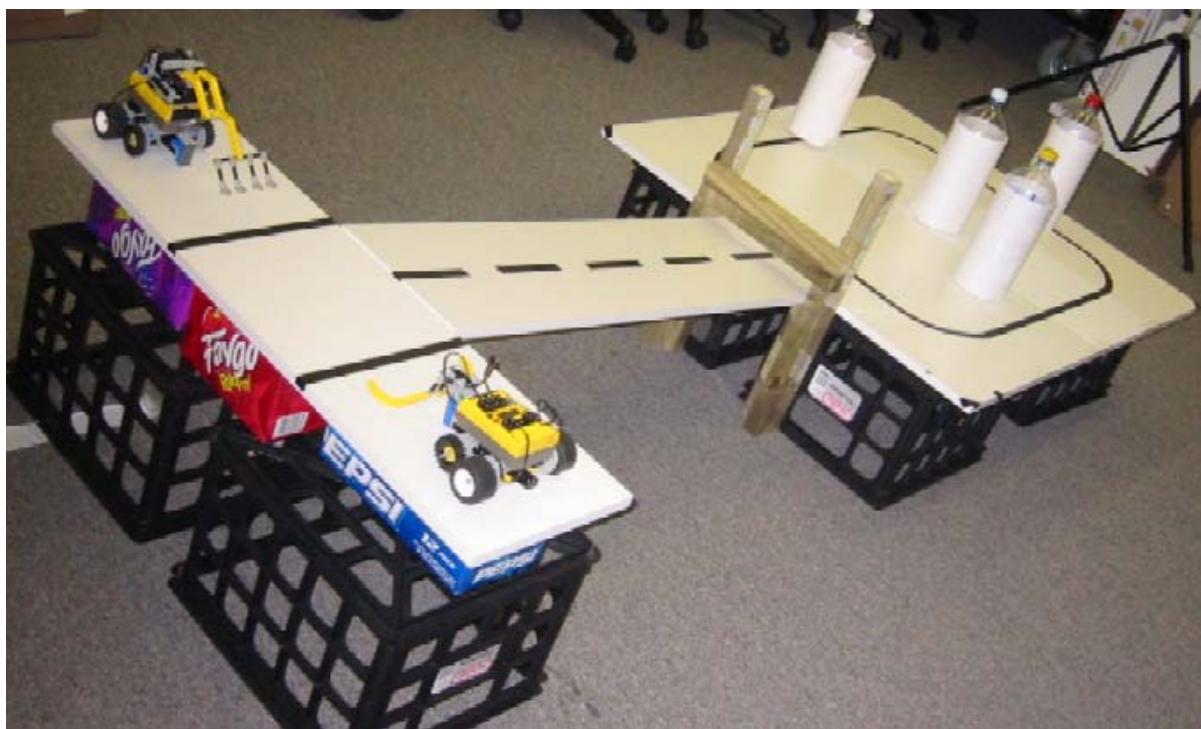
Figure 6. A sample playing field for Senior competition division

Official scoring sheets for the two divisions are attached.

Robofest 2006 "Toxic Barrel Cleanup" Challenge Scoring Sheet for
<u>Junior</u> Division
(Bring this form to the On-deck circle, Staging Area)

Team School (Organization) Name: _____ Team Number: _____

Round: *Practice*   *First*   *Second*   *Final*   Race Track No: _____

Match No: _____

	MISSIONS		Point Value	Score Earned
1		Start successfully and reach the 2nd board	10	
		Start manually and reach the 2nd board	2	
2	Muscle Bot (40 pts)	Follow the path and touch the gate	5	
3		Drop gate bar off the 2nd board. If it is on the board, 2 partial points. (robot must stay on the board)	15 or 2	
4		Return home (entire body passes the base line) and **stop** (and let the CleanupBot start automatically)	10	
5		Start automatically and reach the 2nd board, after No. 4 mission above is completed	10	
		Start manually and reach the 2nd board	2	
6	Cleanup Bot (55 pts)	Pass the gate (human player may open/remove the gate, in case the first robot did not accomplish the no. 3 task)	5	
7		Remove two toxic barrels on the line (7 points each) and inside the circle (16 pts). Two points, if inside bottle is just contacted by the robot.	7	
			7	
			16 (2)	
8		Unknown mission	10	
	Absolutely no human help was given during the entire span of a game		5	
If the mission is restarted, the score previously earned will not be lost. (Even if a team fails on a particular mission during the second try in a round, they will get the points for the mission **if they succeeded** the first time)			*Flash Extra Points* (*)	
			Total Score Max. 100+2	
			Time if score is 100 w/o Flash Extra Points	(sec.xx)

(*) 1st perfect score team: 2 points, 2nd perfect score team: 1point

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<u>Senior</u> Division
(Bring this form to the On-deck circle, Staging Area)

Team School (Organization) Name: _____ Team Number: _____

Round: *Practice*   *First*   *Second*   *Final*   Race Track No: _____

Match No: _____

MISSIONS			Point Value	Score Earned
1	Muscle Bot (40 pts)	Start successfully and reach the 2nd board	**10**	
		Start manually and reach the 2nd board	2	
2		Follow the path and touch the gate	**5**	
3		Drop 2 gate bars off the 2nd board. If only one bar is dropped off, 8 points. (robot must stay on the board)	**15 or 8**	
4		Return home (entire body passes the base line) and stop (and let the CleanupBot start automatically)	**10**	
5	Cleanup Bot (55 pts)	Start automatically and reach the 2nd board, after No. 4 mission above is completed	**10**	
		Start manually and reach the 2nd board	2	
6		Pass the gate (human player may open/remove the gate, in case the first robot did not accomplish the no. 3 task)	**5**	
7		Remove two toxic barrels on the line (7 points each) and inside the circle (8 each).	**7**	
			7	
			8	
			8	
8		Unknown mission	**10**	
Absolutely no human help was given during the entire span of a game			**5**	
If the mission is restarted, the score previously earned will not be lost. (Even if a team fails on a particular mission during the second try in a round, they will get the points for the mission **if they succeeded** the first time)			*Flash Extra Points* (*)	
			Total Score Max. 100+2	
			Time if score is 100 w/o Flash Extra Points	(sec.xx)

(*) 1st perfect score team: 2 points, 2nd perfect score team: 1point