

Robofest 2003 Challenges – “Mission Possible”

Lego Robot Competition Division

Game Abstract

This 2003 competition will simulate a situation in which robots will repair the reactor containment structure in a nuclear power plant. The first robot is supposed to carry “radioactive shielding” to the containment structure, place it inside, return back to its starting position and tell the second robot to start. The mission of the second robot is to push a concrete barricade up to the containment structure to shut off possible radioactivity from the reactor. Then the robot must return back to its base and stop. A unique feature of Robofest 2003 is that a part of these missions will be unknown until the day of the competition.

Game Objectives

The main goal of this robot game is to complete the entire course without human aid in the shortest time.

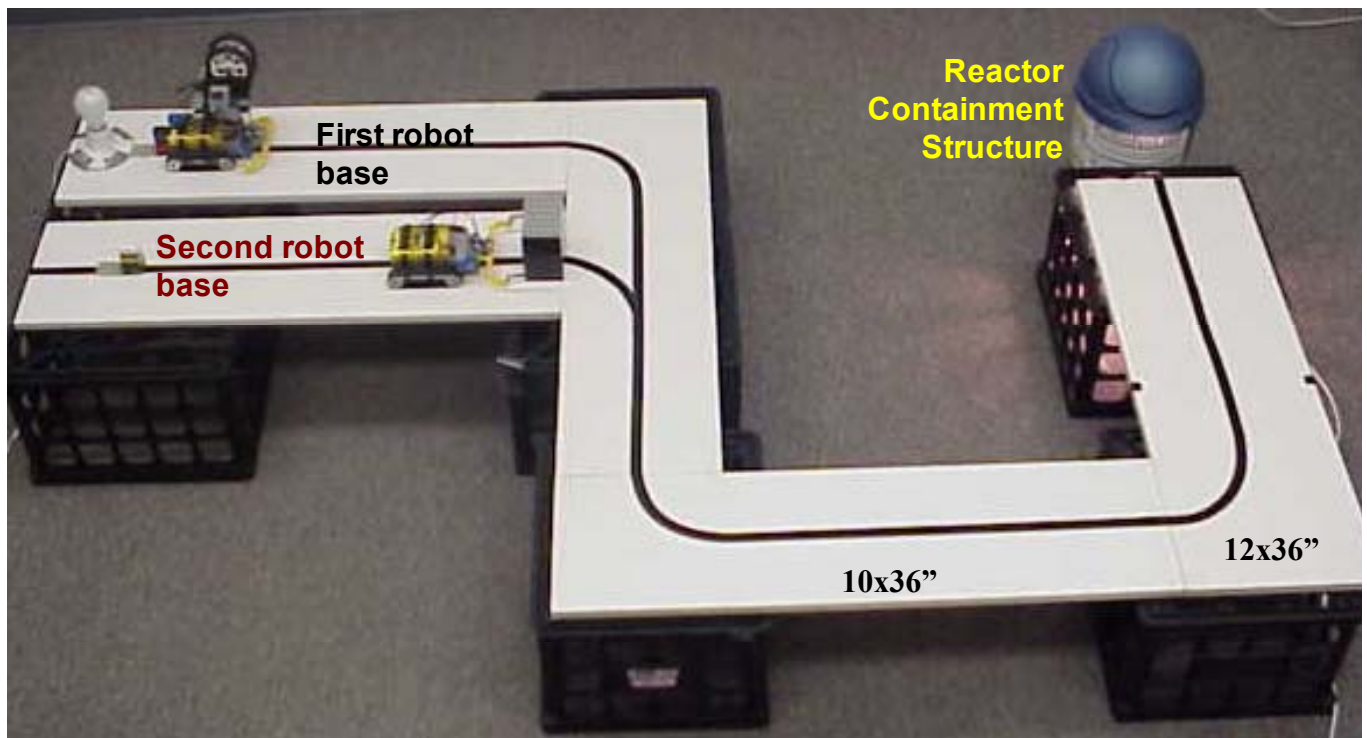


Fig. 1 A Sample Course

Sample Playing Field

Fig. 1 shows a sample playing field. It is constructed of all-purpose white shelves of size 10”x36” and 12”x36”. Crates are used to support shelves and a wastebasket with swing-top will simulate a reactor containment structure in trouble. Please note that the official final shape and length of the playing field for Robofest 2003 will be unknown until the day of competition. One 12”x36” shelf will be used for the track near the reactor containment structure. Details about the playing field construction will be described in the last section.

Robot Qualifications

- The robot must fit inside a box of dimensions: width 9.5” and length 12” (No height limitation). However, during the game, the robot may extend its dimensions.
- You may use any number/type of sensors
- You may use any number/type of motors
- You may use only standard Lego blocks
- You may *not* tape/glue Lego blocks

Mission Order and Points (total 100 points)

For teams succeeding in completing all missions, the total time taken will be the performance winner-deciding factor.

1. **Waiting for the start signal:** One human player is to position the first robot with “radioactive shielding” (see figure 2) at the first base (see figure 3). This player then presses the “run” button. The robot will wait for the start signal from the lamp bulb. Simultaneously, another human player is to position the concrete worker robot at the second base and press the “run” button (see figure 4). If both robots are not moving after pressing the run buttons, the team will get **5 points**. In case the first robot moves, then the default start method program can be used when the official signal is given. If the second robot moves, then it should be turned off and the default start program is supposed to be used manually when the first robot comes back home. This means that each team may need to develop two programs for each Lego robot, one for the regular start, and the other for the default manual start. A team may declare the use of default start methods in the beginning of the game, if their normal start program is not working. In this case, however, the team will not get the 5 points.
2. **Starting first robot:** How the first robot starts is unknown until the day of competition. The only hint is that the lamp in figure 3 will be used to give the signal to the robot. If the robot starts successfully, the team will get **15 points**. If the robot fails to start, then you may ask the referee to give the start signal again, or you may use the default start program and will get **2 points**.
3. **Passing the junction:** When the robot starts, the robot is supposed to follow the line. If the robot successfully passes the junction shown in Figure 8, **5 points** will be awarded. If not, then the robot needs to be restarted either using regular method or default method.
4. **Reaching the reactor:** If the robot reaches the reactor (see figure 5), which is the edge of the last board, then **2 points** are awarded. The edge of the shelf near the structure can be easily identified because a lamp under the shelf is on. If the robot fails to reach the edge, it needs to be restarted either using regular method or default method.
5. **Dumping:** The robot then must drop “radioactive shielding” inside the reactor containment structure. If it is successfully dumped into the basket, then **20 points** will be recorded. If the robot dumps the shielding anywhere except inside the structure (the shielding must not remain on the robot), then **5 points** will be given. The team may restart from the beginning, if they want to get the full 20 points (however, they will lose time...)
6. **Passing the junction:** Now the robot is supposed to come back to its first base. If the robot travels back past the junction successfully, then the team will get **2 points**. If it fails, then the team may have two choices: either restart the first robot from the beginning or give up the rest

of the first robot's missions and start the second robot manually using the default method program.

7. **Coming back to the first base:** If the robot comes back home and touches the line-end block then **2 points** will be awarded. The first robot does not need to stop, but must send an IR message(s) to the second robot to trigger the start of the second robot. Since there will be many robots in the gym, the robot needs to send a secret code to the second robot.
8. **Starting second robot: 20 points** will be awarded if the second robot begins to push the concrete barricade (see figure 9) after decoding the signal from the first robot (see figure 4). The two robots must not touch each other. In case the second robot does not start properly, the only option is to start it manually by using the default start program.
9. **Passing the junction:** If the second robot passes the junction with the barricade, **6 points** will be awarded. If it fails, it may restart from step 8.
10. **Placing barricade:** If the robot places the barricade 'entirely' into the zone as shown in figure 10, then **13 points** will be given. The zone is marked with two out-lines as shown in figure 10. If any part of the barricade is located outside the zone, but on the last board as shown in figure 11, then **5 points** will be awarded. It is possible to use time (dead-reckoning) to decide where to stop pushing, but it is highly recommended to use a rotation sensor for better accuracy. If the whole barricade was not placed on the last board, then the team may restart from mission no. 8.
11. **Passing the junction:** If the second robot passes the junction and following the line to it home, then **5 points** will be marked. If unsuccessful, the robot may be restarted from step 8.
12. **Coming back home of second robot:** The entire mission is completed when the second robot returns back to its home and touches the home base end-of-line block (see fig. 12). The robot does not need to stop. (**2 points**)

If each mission is restarted, the score earned before cannot be re-earned. However, the team does not lose the points previously earned. Please note that once the concrete barricade is moved and placed in the barricade zone, it cannot be removed by human's hand. A possible flow chart for this game is shown in figure 13.

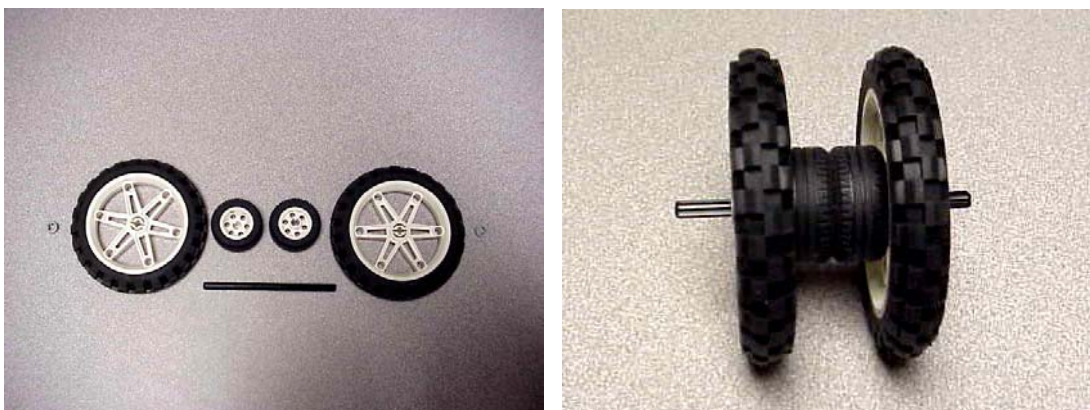


Fig. 2 Radioactive Shielding. Size of the axle is Lego "10"

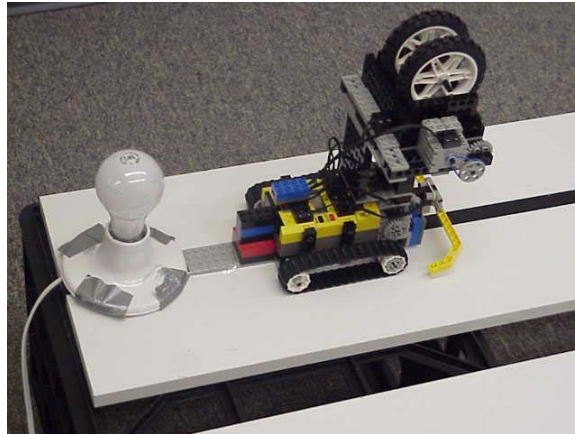


Fig. 3 Start signal lamp and the first robot position. The back of the robot must touch the line-end block

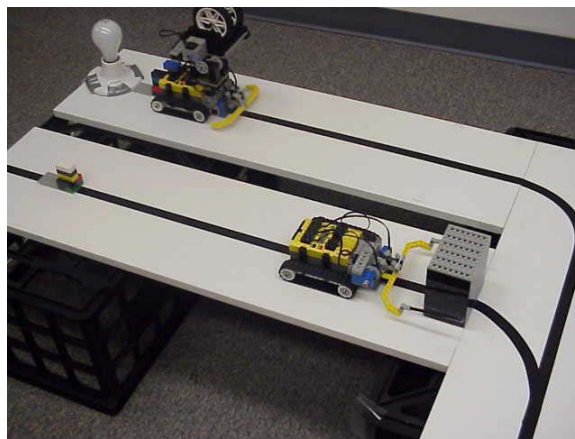


Fig. 4 Second Robot Position. Any part of the second robot cannot pass the edge of the second base shelf

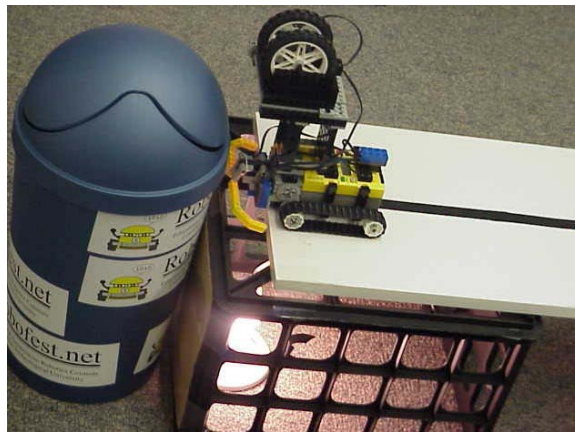


Figure. 5 Reactor Containment Structure. The first robot is about to dump the radioactive shielding.

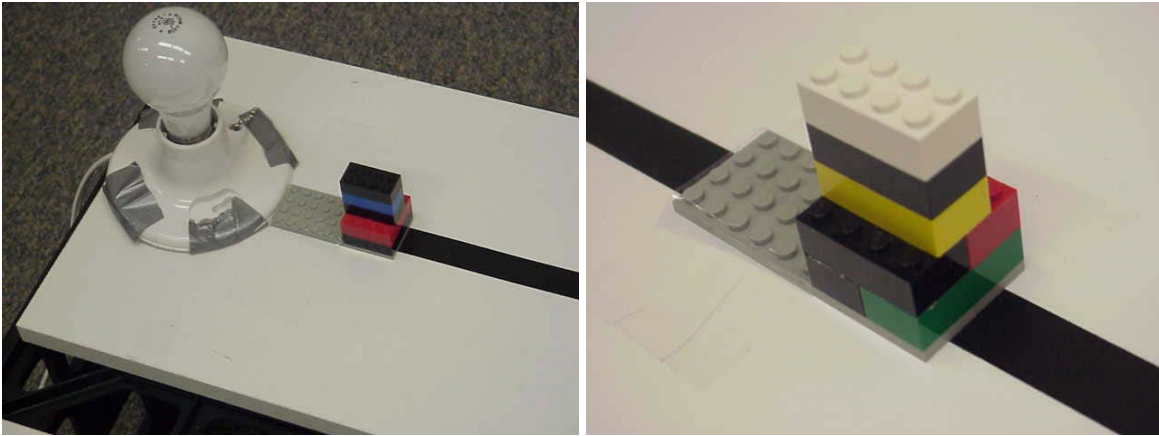


Fig. 6 Line-end Blocks (Taped on the shelf)

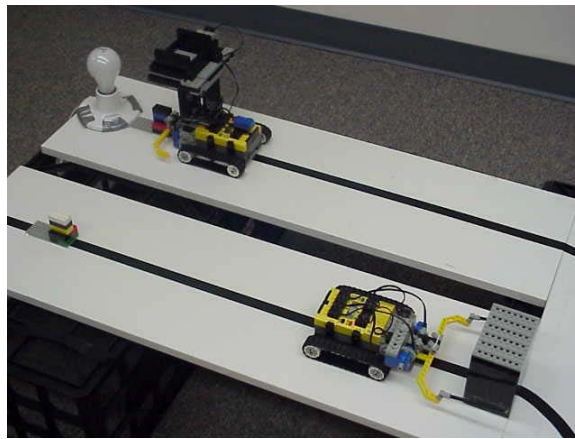


Fig. 7 First robot returns home base and sends a message to the second robot, when it touches the line-end block. The gap between the first robot base and second robot base is unknown until the day of competition.



Fig. 8 A junction from the second base. A concrete barrier is located at the edge of the board. Any part of the second robot cannot pass the edge.

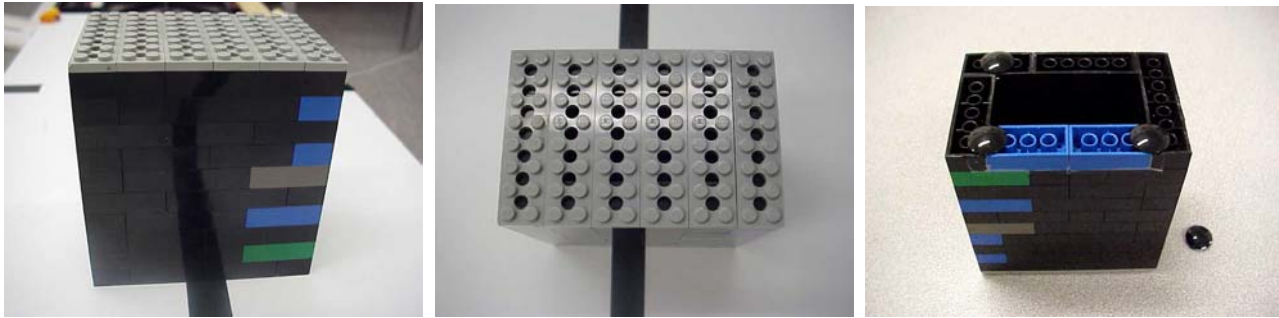


Fig. 9 A concrete block with 4 skids

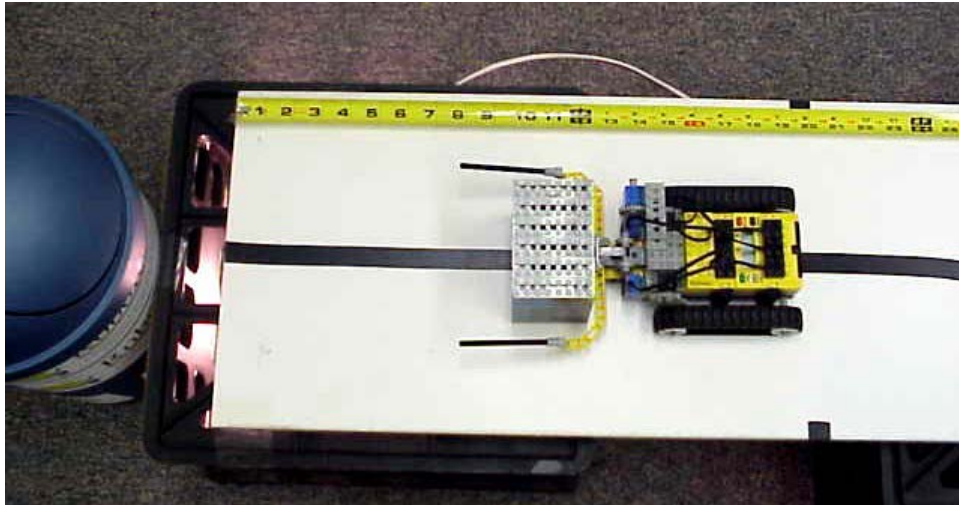


Fig. 10 Reactor containment structure, located 2.5" from the end of the shelf. Two out-lines are located 20" from the end of the shelf. Second robot places the barricade in the safe zone. 13 points will be awarded

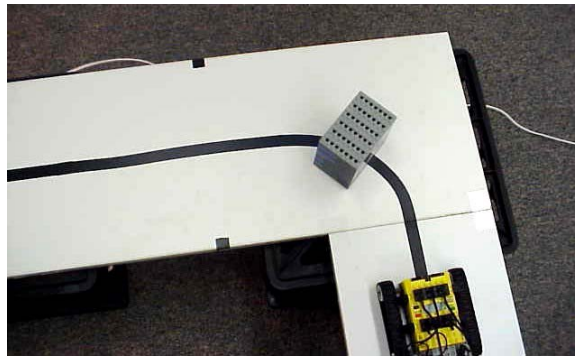


Fig. 11 The barricade is not placed in the safe zone, but placed on the last board by the second robot. 5 points will be awarded

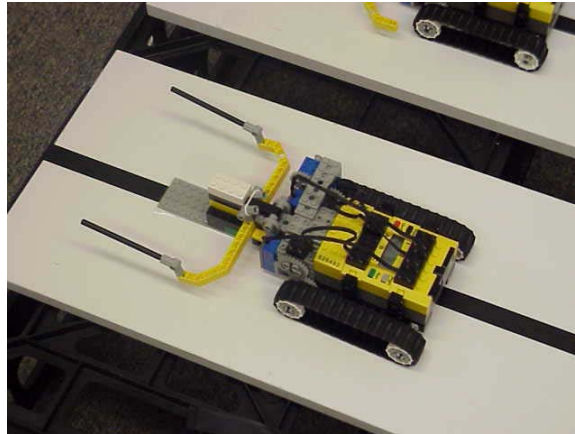


Fig. 12 The last mission: second robot comes back home and touch the line end block

Game Rules

- The missing part of the game rule will be handed out right after the opening ceremony in the morning of the Robofest day.
- Suggested way to implement the missing part is to (1) copy the default start method program for the first robot to another file name, (2) add the parts for the regular start, and then (3) download the new program to another program slot.
- If a team feels they are ready to go before the first round begins, they may compete for a Special Award. They must have included the missing part of the mission in their program. When they are ready, two team members should come forward with their two robots into the waiting area and list their team ID on the sign-up sheet. Since every team has only two chances to compete before semi-finals, this will take the place of their first round. A final call for the Judge's Award will be announced 10 minutes prior to the start of the first round. After the Special Award is announced, the first round will begin and will include every team that did not attempt the Special Award round in their predetermined order. The second round will include all teams in their predetermined order. The predetermined order will be announced in the morning when teams check-in.
- If any mission fails or a violation is noted by a referee, then the robot must be restarted according to the order of missions explained in the previous section and figure 13. In case of failures, the decision to restart or not must be made by team members given that the missions have to be completed within 2 minutes.
- The top 8 teams, based on performance the average of two scores, will advance to the semi-finals. The tie breaker in this decision will be (1) the average total time taken, (2) whether they succeeded in a preliminary match, and (3) the best total time out of two runs.
- There will be two semi-final matches. Based on the results of two semi-finals, the best four teams will advance to the final match.
- The final match will decide the champion team.

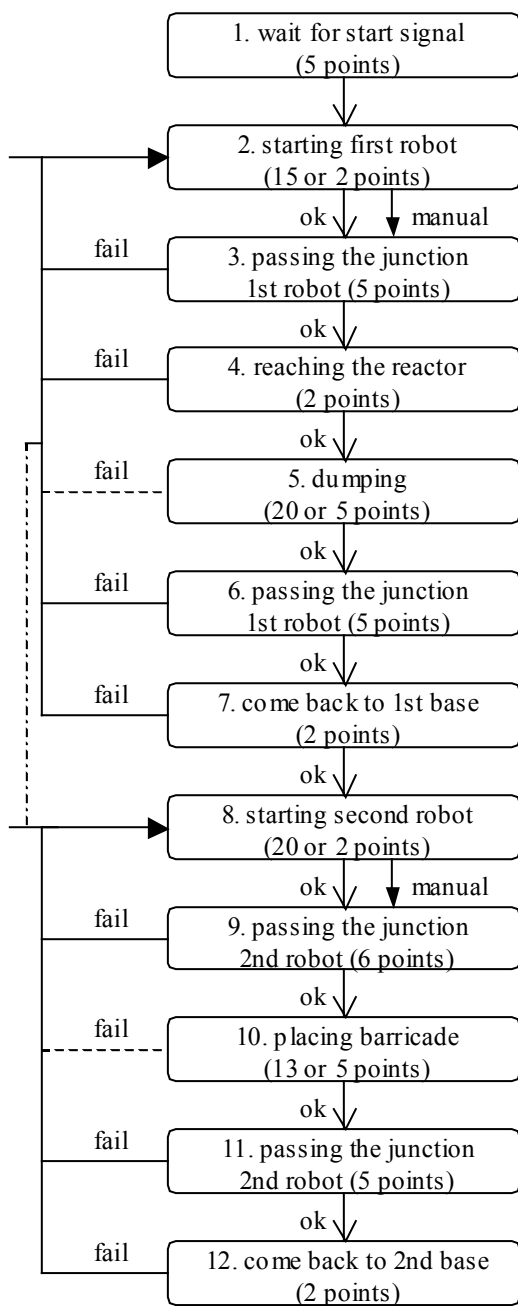


Fig. 13 Flow chart of game order

Advanced Robot Competition Division

Qualifications

- You can build robots using robotics controllers such as Handy Board, Handy Cricket, or similar controllers.
- You may program Lego RCX robots using a high-level language such as Java, C++, VB, or NQC.
- This division is recommended for High school students (grades 8-12).

Game rules

- Exactly the same rules as the Lego robot division described above. However, the way to start will be different and more difficult. It is needed to use variables.
- Teams are required to submit a diskette and hard copy of the source code to the judge immediately upon checking-in.

Tips for Handy Board Robots

A manual start program using a touch sensor may be necessary for the default start method.

Handy Board can send and receive IR signals. However, the default configuration of the Handy Board only has a built-in IR Receiver. In order to transmit IR messages with the Handy Board, you would have to attach an IR Transmitter to the Handy Board IR transmitter port. Fred Martin's book has a detailed description of IR communications with the Handy Board.

“Robotic Explorations: A Hands-on Introduction to Engineering”, Fred G. Martin, MIT Media Labs, ISBN: 0-13-089568-7, Publisher: Prentice Hall
Check out: vig.prenhall.com/catalog/academic/product/1,4096,0130895687,00.html

Also, it is also possible to do RF communications between Handy Boards: See www.leang.com/robotics/info/articles/serialcom/serialcom.html

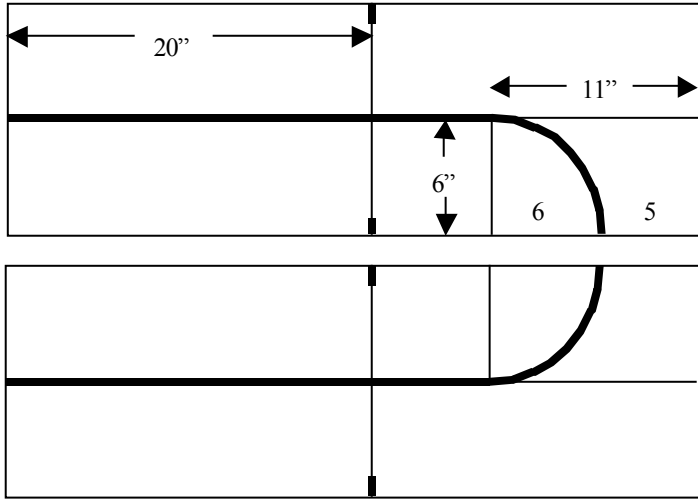
Handy Cricket has built in IR sender and receiver.

Robofest 2003 Playing Field Instructions and Purchase List

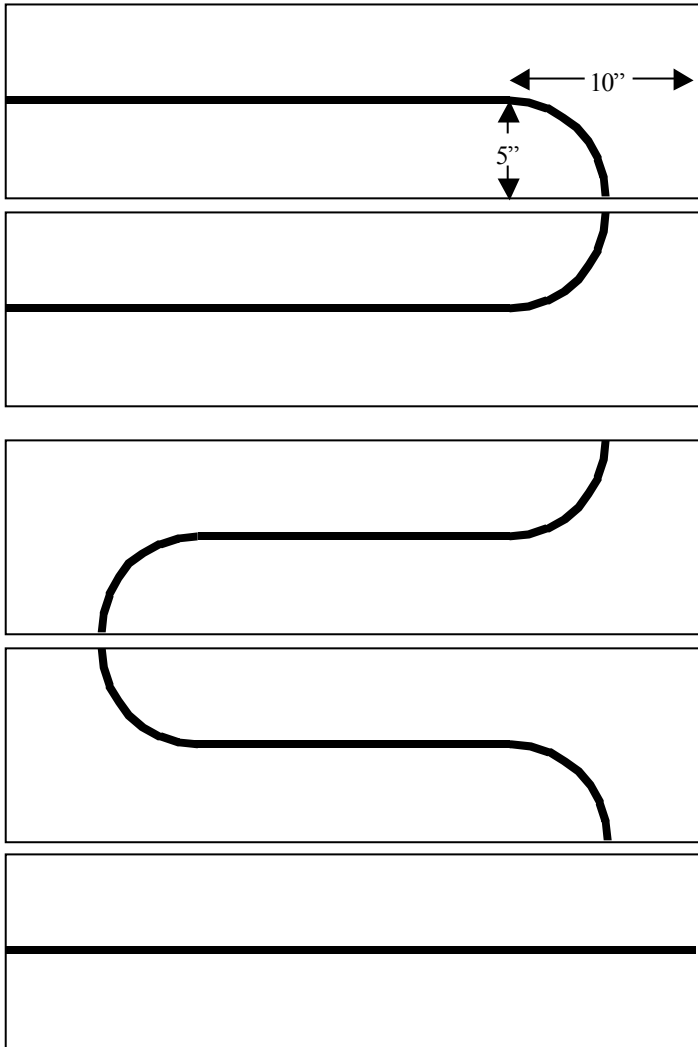
Tracks

Multipurpose white shelves with black line as shown below are to be used. Note that the actual width of the 10"x36" bookshelves you can buy from local stores is slightly less than the specified size. The thickness of the bookshelves is about 5/8". Black standard electrical tape (width of 0.75") will be taped approximately in the middle of each shelf. The length of the tape outline for the “barricade zone” is 0.5 inches.

One of the following 12x36”s for the shelf on the crates:



Four or five from the following four 10x36" shapes are to be used for the area before the ramp. Note that this means the length of the total path is unknown. The junction from the second base will be made using the same idea for the curves on the shapes below.



All the edges of the shelves will be taped together using transparent packaging tape. If your robot is using Lego skids, make sure they can slide over the tape.

The color of the floor where the shelves will be placed is dark (dark blue). You may use this knowledge for your navigation method. Team members are responsible for catching the robot if it falls off.

Purchase list for Lego Robot Division

Item	Spec / Description	Quantity	Estimated Unit Price	Estimated Price
Plastic pull chain lamp holder **	Leviton	2	\$2.96	\$5.92
Easy-to-wire plug **	Leviton	2	\$1.87	\$3.74
Electrical wire **		20ft	\$0.13	\$2.60
All purpose white shelf*	5/8 thick, Approx. 10"x36"	4 (or 5)	\$6.29	\$25.16
All purpose white shelf*	5/8 thick, Approx. 12"x36"	1	\$7.39	\$7.39
Storage Crate* (You may purchase another one as long as height is same)	Sterilite, 15 1/4"L x 13 3/4"W x 10 1/2"H, 1692, www.sterilite.com	6	\$2.00	\$12.00
40W Bulb **	GE Softwhite x 4	1	\$1.48	\$1.48
Standard electrical tape *	Black, PVC tape	1	\$1.19	\$1.19
Wastebasket *	12 Quart Rnd Swing-Top Wastebasket, 1083 9 1/2"Dia x 18 3/8"H, White or Glacier www.sterilite.com	1	\$3.99	\$3.99
			<u>Total</u>	\$63.47

* purchased at Meijer

** purchased at HomeDepot

The following Lego items may be needed

- One extra 9V geared motor (Lego item number: 775225, \$16.25) for the first robot.
- Extra Light Sensors (Lego item number: 779758, \$14.99) for the better performance (however, programming becomes harder).
- Additional Lego Pieces
- Rotation (angle) sensor for the second robot (Lego item number: 979891, \$16.99)

Where to purchase Lego parts

- <http://www.pitsco-legodacta.com/>
- <http://shop.lego.com/>
- Lego Dacta: 1-800-362-4308
- Lego Shop: 1-800-453-4652