

# Walking Robot Race

## Objective

A walking robot must autonomously walk from Start/Finish Zone of the race course to the Turn Zone, turn around (180 degree turn), and then walk back to the Start/Finish Zone. The robot with the fastest total round trip time will be the winner.

## Definition of a Walking Robot:

- All legs must operate in a cyclical fashion.
- No wheels or rotary wheel-like appendages will be permitted for locomotion.
  - The ground contact point on the foot can not completely rotate around some point/axle that is in direct contact with the leg during a step cycle. As an example, if the leg is attached to a wheel or an axle and all it does is rotate around in a circle, and when the leg hits the ground it causes the robot to move forward, this is not legal for this contest.
  - If the drive motor continuously rotates in one direction, leg motion must oscillate back and forth through some form of a cam and/or mechanical linkage.
  - The entire weight of the robot must be completely supported by the robot's legs.
  - All legs/appendages that are in contact with the ground must be either used for locomotion or balancing.
  - All legs/appendages that are used to assist in balancing the robot, or locomotion, must separate

(lift/hop/move) off the ground at some point during each walk/step cycle. i.e. they can not slide/roll across the ground.

- If the robot falls over, external appendages (such as arms) can be used to help the robot get back on its feet.

### **Robot Specifications**

Robots must be autonomous.

- Wireless data links to off-board computers are allowed.

- Tethered data links to off-board computers are not permitted, since wire tension could alter the direction of the robot's motion.

- No human-operated remote controls will be permitted except to start and/or stop the robot.

The maximum length, width, height, and weight of a robot are not specified in this contest. The only requirement is that the robot must remain completely on the course during the event. It is the designers' responsibility to design the robot to accomplish this task.

Propulsion must be electrical in nature. No pneumatic, combustion, or other exotic propulsion devices will be permitted. All power must be carried on board the robot.

The race officials shall make the sole decision as to the suitability of a robot for this contest. Robots deemed a hazard to the course, competitors, or spectators will not be permitted to compete. The official's decision on this matter is final and is not subject to dispute.

### **Course Specifications**

The overall dimension of the walking race course is 3 feet wide by 7 feet in length. The course can be made from any material as long as it is flat, smooth, and there are no seams, edges, cracks, etc., that are greater than 0.06 (1/16) inches in height. The entire course is divided into three areas, the starting area, the main track, and the turn area.

### **Start/Finish Area**

This area will consist of the first foot of the seven-foot long course. The entire robot must be placed within or behind this area at the start of the race. This area will be painted Krylon #2327 Fusion Spring Green. (All paint mentioned is currently available at Home Depot, Fred Meyer, and other stores in the Northwest.)

### **Main Track**

The Main Track will be 5 feet in length and 36 inches in width. The Main Track includes the two 2" wide black Track Sides. The main track area will be Polar White in color. The width of the Polar White area will be 32".

### **Turn Area**

This area will consist of the last foot of the track. It will be painted with a Krylon Fusion #2321 Gloss Black. This color is a strong contrast to the white with both IR and visible sensors.

### **Track Sides**

The main track will be bounded on each side with a 2-inch wide strip. This strip can be either painted with the same paint used in the turn area, or it could be composed of black PRO-Pak plumber's tape, available at Home Depot and any plumbing supply. The white printing normally present on this tape will be

removed by wiping it with acetone.

## **Wall**

In addition, a 3 feet wide by 18 inches high wall (that is painted the same white color that is used on the main track) will be provided at the turn end of the course as an aid in navigation. A robot may use this wall as an aid in detecting the proper turn location.

The contestant may position the wall at any distance beyond the turn area.

Additionally a contestant may place any target they desire as an aid to navigation on the wall. The entire wall and any targets must be placed entirely behind the Turn area.

## **External Environment and Course Variations**

The robot must be able to operate in variable lighting conditions that may occur during the event. That is, room lighting and window drapes will be set as desired by the judges and will not be modified for individual contestants. Also, flash photography and IR focusing cameras will be allowed to operate at anytime during the contest. It is the robot's builders responsibility in designing the robot to be able to operate in this environment. If the judges determine that such equipment is being used to intentionally interfere with the robot, the judges will ask the operators of the interfering equipment to stop using it, and may allow the robot a second run on the course.

It is impossible to ensure that all practice arenas built at home will be exactly identical to the contest arena (in geometry, color, texture, and lighting conditions). All contestants must be aware that their robot may perform differently on the official

arena than other arenas. It is the contestant's responsibility to ensure that their robot will operate on the official contest arena. Keep in mind that all robots will run on the same official arena, so all the robots will be running in the same environment. Robots that can adapt to their environment may perform better than robots that can not adapt to their environment.

### **Practice Runs**

Robots will be allowed an opportunity for a "test drive" on the track (or similar official test track construction) for testing and calibration prior to the contest. All test opportunities are on a first-come, first-served basis, one hour before the contest.

### **Race Procedure**

A robot must begin completely in the Start/Finish area, proceed to the Turn area, execute a 180 degree turn, and then return back to the Start/Finish area. At least one of the robot's feet must touch the surface in the Turn area or the run will not count. The run ends when the robot has completely reentered the start area.

### **Setup**

- Five minutes prior to the start of the competition, and "On Deck" call will be made. At the end of the five minute "On Deck" call, all robots must be ready to compete when they are called.

- The entire robot must be behind the front edge of the Start/Finish Area at the start of the contest. The front edge of the Start/Finish Area is defined as the edge between the Start/Finish Area and the Main Track. This is also known as the Start Line.

- The robot (or portions of the entire robot) may extend behind the 12 inch depth of the Start/Finish Area.
- No part of the robot is allowed to extend past (outside) the 36 inch width of the Start/Finish Area.

### **Race Procedures**

The following are the race procedures

- Contestants start their own robot.
- The time clock will begin when the forward most part/edge of the first leg or foot, that crosses the Starting Line. Any other part of the robot (such as: arms, body, head, etc) that crosses Start Line before the first leg will not start the time clock.
  - Once the time clock has started; no contestant or official may touch the track, the robot, assist, or interfere with the robot in any way.
  - At least one foot of the robot must touch the surface inside the Turn area before returning to the start area.
  - The time clock will stop when the rear most part/edge of the last leg or foot, that crosses the Start/Finish Line at the end of the race. Any other part of the robot (such as: arms, body, head, etc) that crosses Start/Finish line after the last leg will not be used to stop the time clock.
  - The robot must remain on the course at all times.
  - If any part of the robot touches the ground on either side of the course, the race is ended, and the time clock is stopped. The total distance robot traveled will be recorded. If the robot went towards the turn area and then went out of bounds, then the distance from the start area, to the turn area,

then to the point where the robot went out of bounds will be recorded. This robot will be classified as NOT completing the course.

- If any part of the robot touches the ground on either side of the entire course or behind the Turn area, the race is ended, and the time clock is stopped. The total distance the robot traveled will be recorded. If the robot went out of bounds after reaching the Turn area and turned around and was returning back to the Start/Finish line, then the distance from the Start/Finish area, to the Turn area, and then to the point where the robot went out of bounds will be recorded.

### **Termination**

The robot's operator can terminate the race at any time.

Termination includes physically touching the robot.

- If the operator terminates the robot's run prior to the starting of the time clock, then the robot will be allowed to restart the race.

- If the robot's operator terminates the robot's run after the start of the time clock, then the robot's run is terminated. The clock stops, and the distance the robot traveled at that point is recorded.

- The robot's operator is allowed to turn off the robot after it has returned back to the Start/Finish Area, or after it has gone out of bounds.

### **Restarts**

The robot will be allowed to restart the race under the following conditions:

Interference by another competitor.

Interference by a spectator.

Interference by an official.

Flaws in the arena where the officials believe that it will have a negative effect on multiple robots. All flaws must be in violation of the course specification rules.

External forces that cause the robot to change its course. i.e. earthquakes, tornadoes, floods, acts of war, etc.

Robots will NOT be allowed to restart a run if they have any electrical, optical, acoustic, mechanical, or software failures after the start of the time clock.

### **Final Scoring/Ranking**

This is very simple, the robot with the fastest (i.e. shortest) time wins the race. All other robots will be ranked based on time. The fastest is awarded 1st place, 2nd place goes to the next fastest robot, and so on.

There are times when not all robots complete the course.

Ranking for these robots will be based on the total distance traveled, not on time. The robot that traveled the furthest will be ranked higher than the robot that traveled a shorter distance. All robots that have completed the race will be ranked higher than robots that have not completed the course. Any robot that failed to complete the 180 degree turn will forfeit any distance accumulated past the Turn area.

### **Additional Races**

Additional races may be conducted at the discretion of the race officials. Additional races will not be conducted if there is not sufficient time for all of the robots to complete the additional races. If additional races are conducted, the robot's best

overall score will be used in the final ranking.

### **Violations and Penalties**

Any contestant violating any of the rules in this race will be disqualified.

### **Notes about Future Races**

As robots improve in performance, handicapping rules may be added so that different classes of robots would be able to compete on equal grounds. The handicapping may be in the form of geometrical measurements. As the number of robots competing in this event, different classes will be added, such as bi-peds, quadra-peds, hexapods, polypods, etc. Obstacles may be added, and the length of the course will change. The goal of this event is to encourage people to build different styles of walking robots, and future rule changes will be based on increasing the number of the robots entering the event, and increasing the interest in this event.

### **Rules Committee**

The event committee, rules committee, and race officials reserve the right to clarify, augment, or modify these rules in the interests of fair play. Changes should be published prior to the event. But in some rare circumstances a change in the rules may be implemented during event if it is found that someone is trying to violate the spirit of the rules by using a technicality in the rules that was unforeseen by the rules committee. Any changes will be made in the interest of fair play for all of the contestants.

All decisions by the race officials are final.

The rules committee should be consulted prior to the event if a

robot has some unique feature that might be questionable according to the published rules. All inquiries will be kept confidential. The rules committee will provide an answer if the unique feature is permitted to be used, guidance in the design of the unique feature to remain in compliance of the rules, or in some cases, changes in the written rules to specifically address the unique feature.

## **History**

The rules presented here are based on the original walking robot race that was developed by the Portland Area Robotics Society ([www.portlandrobotics.org](http://www.portlandrobotics.org)) annual robotics event known as the PDXBot event. The original walking robot race at PDXBot event occurred in May 2003. The original rules had a handicapping method that was based on leg geometry.

Rev. A. Added a lot of clarification to robot geometry and execution of the event along with scoring data sheets.

Rev B. Added additional robot clarification. Dropped the handicapping method because there was no evidence that the original handicapping method actually provided any useful handicapping. Added ranking system based on time and distance traveled (for robots that did not complete the race). Made the 180 degree turn at the Turn area mandatory.