TEACHING CHALLENGE-BASED ROBOTICS

# LINE FOLLOWING CHALLENGE

*Colorado State University Extension with RoboRAVE International*

## OVERVIEW

In the Line Following Challenge, created by RoboRAVE International, robots follow a line to a payload delivery box. There they deliver a ping pong ball payload, before following the line back to the starting position.

**Approximate Challenge Time:** 3 hours (2 ½ hours build/program, 30 minutes competition)

## SUPPLIES

- LEGO Mindstorms EV3 robotics kits (1 per team)
- Delivery box (see specifications below)
- Ping pong balls
- Payload creation materials (see specifications below)
- Line following mat (download & professionally print, or see directions below to create)

### Line Following Mat Supplies

- 6’ x 3’ white butcher paper
- Dark-colored masking or painter’s tape
- Tape measure
- Straight edge
- Marker

### Creating the Line Following Mat

1. Download the mat file for an idea of how to set up this track. To start, select a corner of the mat and place a 4-inch piece of painters tape parallel to the side of the mat, and a few inches in from the edge. This will be your starting line.
2. Create a winding track from this point. Start with a straightway that comes out perpendicular to the center of the start line. Try to include turns to the left and right in your design.
3. Have your track wind to another side of the paper mat. It should come into the side of the mat in a straight line, which is perpendicular to the paper’s edge. The line should end a few inches from the edge. Place another 4-inch piece of tape parallel to the side of the mat at the end of the winding line. This will be your payload delivery area.

4. Label the start and payload areas, and place your payload delivery box in the payload delivery area. Secure the box to the mat with Velcro if available.

**Payload Delivery Box Supplies**

- Box that is between 6 and 8 inches high with an open top, or create your own more challenging box using the RoboRAVE box format.

**Creating the RoboRAVE Payload Box**

1. Use foam board or cardboard pieces and tape to construct a box that is 12 inches long, 8 inches high and 4 inches wide. See the payload box diagram for reference.
2. At the front top of the box, leave a 4 by 4 inch opening for ball delivery.
3. Leave the back end of the box open for delivery of large payloads.
4. Attached a garbage bag to the back of the box to catch delivery payloads, or build a ball catch barrier around the back of the box using pool noodles, cardboard, or other materials.

**Payload Delivery Container Supplies**

- Cardboard
- Chipboard boxes (various sizes)
- Cardstock
- Plastic bottles (various sizes)
- Zip ties
- Tapes (various types)
- Scissors, box cutters and exacto knives

## CHALLENGE INSTRUCTIONS

**Build**

Allow teams approximately 2 ½ hours to build a robot that can follow the line to and from the delivery box, as well as deliver a ping pong ball payload. Teams can use any standard pieces, motors and sensors included in their EV3 kit. They'll need to use the color sensor to follow the line and another sensor like the touch sensor or ultrasonic to stop at the delivery box.

In addition, the teams will each need to create a payload delivery container using whatever materials you provide. Raid your recycle bin to come up with supplies. Kids can build gates, doors, chutes or tipping mechanisms to aid in delivery.

The goal of this challenge is for kids to write a program so that their robot can follow the line, stop at the payload delivery area, deliver payload, and then use a line follow program to return to the start position. Teams will spend a lot of time during the build working on their payload box and mechanics, as well as writing and perfecting their program. During this time, teams should have access to the track and box to test and troubleshoot their program and delivery system.

**Competition**

1. Have each team set up their robot on the starting position and load their payload container with 2-3 ping pong balls.
2. Have teams start their programs, and begin a countdown timer at the same time. Teams should have 3

minutes to complete the challenge.

3. Allow the robots to run their programs. Teams should leave the start area (50 points), use a line follow to go to the payload box and stop (100 points), deliver 1 ping pong ball (100 points), use a line follow program to begin a return trip to the start (50 points), and return to the starting position (100 points). Note completion of these basic line following tasks on the scoresheet.
4. Once teams have completed all of the basic line following tasks (totaling 400 points), they can load up their payload container with as many ping pong balls as possible. These are the bonus balls. Once loaded, teams can reset their robot on the start line and run a line follow and ball delivery program again. Once balls are delivered to the box, teams can pick up their robot, bring it back to the start, reload it with more balls and run the program again. Teams can continue delivering bonus balls until the 3 minute time limit is reached.
5. After time is called, count any bonus balls that were delivered to the payload box. Add these to the score sheet. Teams receive 1 point per bonus ball delivered.
6. Total the line following points and bonus ball points to determine your winners.

If you have a limited number of ping pong balls you can use an alternate scoring method. Based on your supply, and the experience level of your teams, choose a pre-set number of ping pong balls that teams need to deliver. Give teams 3 minutes to try to deliver these balls. Time the runs, and note at which point in the 3 minutes the teams complete the delivery of all of the balls. The team who delivers the balls in the fastest time would be your winner.

This challenge is based on RoboRAVE International's elementary school Line Following Challenge. If you have access to additional color sensors and have more advanced teams, consider upping the difficulty level by using the mats and rules from their middle school and high school levels. The tracks for these levels add junctions, and at the high school level feature a skinnier line. Download information on these challenges on their website.

Consider entering the Line Following Challenge at your local RoboRAVE competition. Visit www.roboquerque.org to find the contest nearest to you and to download their complete challenge rules.