Challenge

Students will design, program, and build a robot that crosses a canyon, picks up its bridge afterward, and then follows a road to cross the next canyon. Canyons will be represented by gaps between tables.

Materials Needed

- Use one of these sets:
  - TETRIX® PRIME Programmable Robotics Set (44321)
  - TETRIX PRIME Dual-Control Robotics Set (44322)
- Items to create challenge field: painter's tape, soft items, tables
- Engineering logbook

Objectives

By the end of the lesson, students will be able to:

- Design and build a challenge field.
- Build a robot within the constraints to meet the challenge.
- Write the steps and create a program for the robot that meets the challenge.
- Test and refine the robot program and design.
- Demonstrate the effectiveness of the robot to meet the challenge.
- Reflect and share on the challenge and its real-world applications.

Activity

Canyon Bridger Challenge

Difficulty

Intermediate

Class Time

Six or more 45-minute class periods

Grade Level

- Middle school
- High school

Learning Focus

- Engineering problem-solving
- Robot assembly
- Computer science

Step 1: Introduce (15 minutes)

- Share, define, and refine the challenge. Document this information in the engineering logbook.
- Write the challenge in your own words. Record the constraints you should follow, the materials that can be used for the solution, and what the testing field will look like. Discuss the constraints and materials that are allowed.

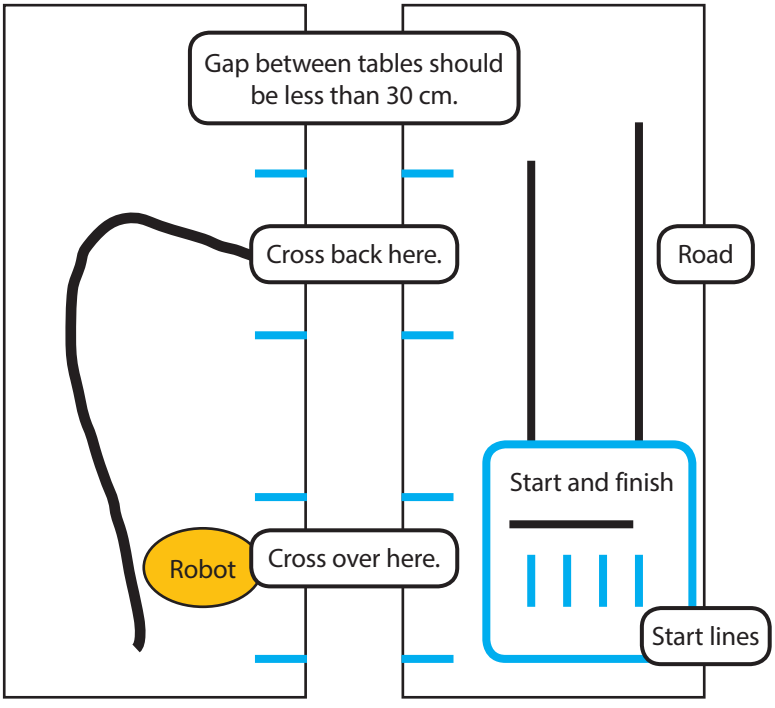
Step 2: Brainstorm (30 minutes)

- Brainstorm ideas to solve the challenge. Create quick sketches and describe solutions to the challenge.
- Considerations for your design:
  - Think about the center of gravity of your robot. A robot that is too tall and narrow, or too short, could fall over when it tries to lift its bridge.
  - Use the Ultrasonic Sensor pointing down to tell where the canyon starts.
  - Use the Line Finder Sensor pointing down to follow the road.
  - There is nothing in this challenge to prevent the bridge from being attached to the robot.

Step 3: Set Up (15 minutes)

- Build the challenge field following the pictured guide.
  - Mark areas on the tables as shown in the sample challenge field.
  - Two tables should be placed an agreed-upon distance apart, with a pillow or similar soft material at the bottom of the canyon.

Possible Challenge Field



Constraints

The team's robot must:

- Contain parts from only one set.
- Measure less than 30 cm x 40 cm x 40 cm.
- Be able to lift and carry its own bridge and never leave it behind.
- Start from one of the randomly assigned start lines inside the start area.
- Follow the road (the black tape lines) back to the start area.

Step 4: Plan (30 minutes)

- Before building, think about the potential design of the robot and draw or record ideas in the engineering logbook. Consider the following:
  - Drivetrain for speed and control
  - Robot chassis for size
  - Bridge and its ability to carry the robot
  - Gearing for the robot to be able to lift the bridge
  - Location and orientation of the Line Finder Sensor
  - Location and orientation of the Ultrasonic Sensor
- Create a detailed sketch of your selected solution to the challenge. Label the materials you will use. Write a detailed description of how your solution meets the challenge, constraints, and criteria.

Step 5: Create (45 minutes)

- Design and build the robot. Remember to update the solution in the engineering logbook as the design is improved.
  - **Note:** The creation of the robot could take longer depending on the complexity of the robot solution.

Step 6: Write the Steps (15 minutes)

- Think through the steps or series of actions that the robot will have to complete to meet the challenge. Planning this series of steps is sometimes referred to as creating pseudocode for your robot.
  - Record these steps in the engineering logbook and use them as a guide when operating the robot. Notice that the steps are like writing code for the robot to follow. Make sure the robot performs all the steps required in the challenge.

Step 7: Create the Program (45 minutes)

- When you have completed this process, you are ready to begin programming using your steps as a guide. Remember to track changes in the engineering logbook.
  - When you are coding your robot, it is recommended that you write the code using functions so that each task can be tested and adjusted before it is incorporated into the final program.
- Prepare functions to control your robot, depending upon your solution plan.
- Check each function as you write it to make sure it works as you intend.
- Now, write a test sketch to try them all out.

Step 8: Test (45 minutes)

- Test the solution. Place the robot into the challenge field and press the Start button to execute the code.
- Refine the solution. Adjust the design and code as needed. Document any changes in the engineering logbook.

Sample Steps

1. Go forward until I see the canyon.
2. Lower my bridge.
3. Drive over the bridge.
4. Pick up the bridge.
5. Go forward until I see a black line.
6. Follow the black line until I see another canyon.
7. Lower my bridge.
8. Drive over the bridge.
9. Pick up the bridge.
10. Go forward until I see a black line.
11. Go forward a little farther.
12. Turn right 90^{o}.
13. Go forward until I see a black line.
14. Celebrate.

Step 9: Demonstrate (15 minutes)

- When the robot has been tested and successfully navigates the challenge field, demonstrate its performance in a final test.

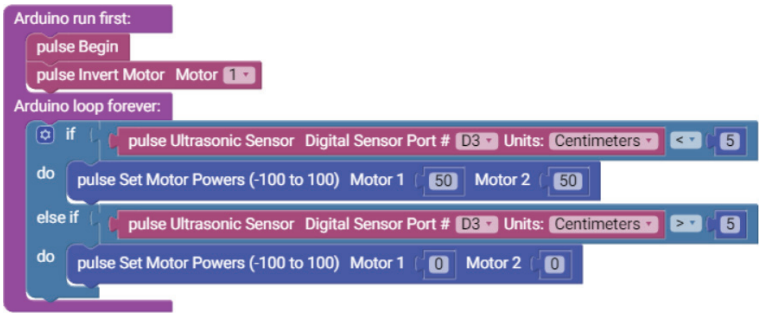
Step 10: Reflect and Share (15 minutes)

- Look back at the prototype. How does it compare to the final design?
- Look back at the original steps. How do they compare to the final steps?
- Discuss the original prototype, the final robot code, the solution as implemented, and how this challenge applies to the real world of robot design and programming.

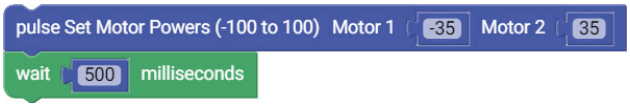
Step 11: Extensions

- Mars Buggy Racer
    - Design a course that requires several canyon crossings and has several turns with a start and finish. The shortest time to complete the course wins the title of ruler of Mars.
- Seabees
    - This is a team challenge. The robots form a line. As the lead robot comes to a canyon, it lowers its bridge. All the robots cross the bridge, and the next one in line becomes the leader. It is OK to leave the bridges behind, but it is not required. Use black tape lines to assist with navigation.
- Minesweeper
    - In a field of about 2 m x 2 m, randomly place about ten 3 cm x 3 cm squares of contrasting tape to represent landmines. Each robot carries three mine markers to place over mines when found. The robot uses a search pattern to locate mines and mark them by dropping mine markers onto the tape squares. Robots can work individually or in teams to complete the task.
- Government Purchase
    - Design a cost sheet for each type of part in the robot base kit. Total the cost of the canyon bridger. Adjust the presentation requirements to reflect the costs of the robots by having each team make a sales presentation to an outside audience.

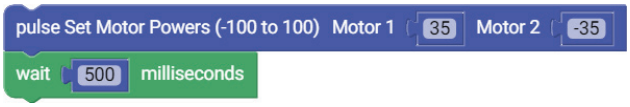
To get you started, here are some sample codes from the PULSE™ controller with the *TETRIX Ardublockly* software.



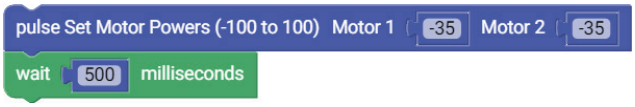
In this set of blocks, the motors will drive forward if the Ultrasonic Sensor detects an object less than 5 cm from it. This would represent the robot driving on the table. If the Ultrasonic Sensor doesn't detect an object more than 5 cm from it, the robot will stop.



Turn left

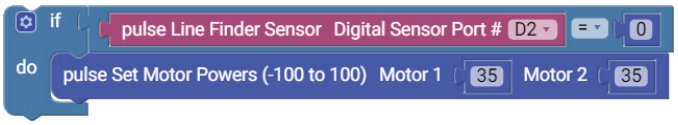


Turn right

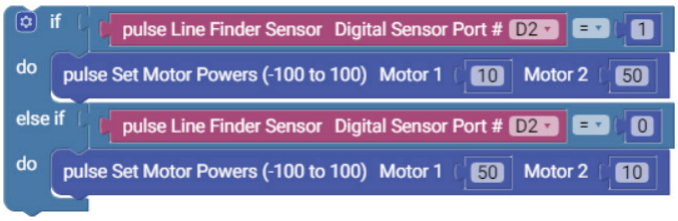


Go backward

Go forward



In this set of blocks, the motors will drive forward as long as the Line Finder Sensor doesn't detect a black line.



In this set of blocks, the robot will follow a black line.