Challenge

Students will design and build a robot vehicle to traverse a maze in 30 seconds without touching any sidewalls or going out of bounds.

Materials Needed

- One of these sets:
    - o TETRIX MAX R/C Robotics Set (41990)
    - o TETRIX MAX Dual-Control Robotics Set (43054)
    - o TETRIX PRIME R/C Starter Set (40384)
- Items to create robot maze: painter's tape, blocks, or books of various sizes
- Engineering logbook

Objectives

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

- Create the challenge maze.
- Build a robot within the constraints to meet the challenge.
- Write the steps for the robot to follow that meet the challenge.
- Test and refine the steps the robot follows and its design.
- Demonstrate the effectiveness of the robot to meet the challenge.
- Analyze the scoring formula, calculate the score of their robot, and determine the winning robot.
- Reflect and share on the challenge and its real-world applications.

Activity

Smallest Vehicle R/C Challenge

Difficulty

Intermediate

Class Time

Five 45-minute class periods

Grade Level

- Middle school
- High school

Learning Focus

- Engineering design
- Robot assembly
- Math application

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:
  - o A robot that is too tall and narrow could fall over when it turns. Think about the center of gravity.
  - o Your score will increase with the number of runs, or tests, that your robot executes to complete the maze.
  - o Note the 45° blocks in the two corners.
  - o Note the hallway sizes and the shortcut gap size of the example maze.

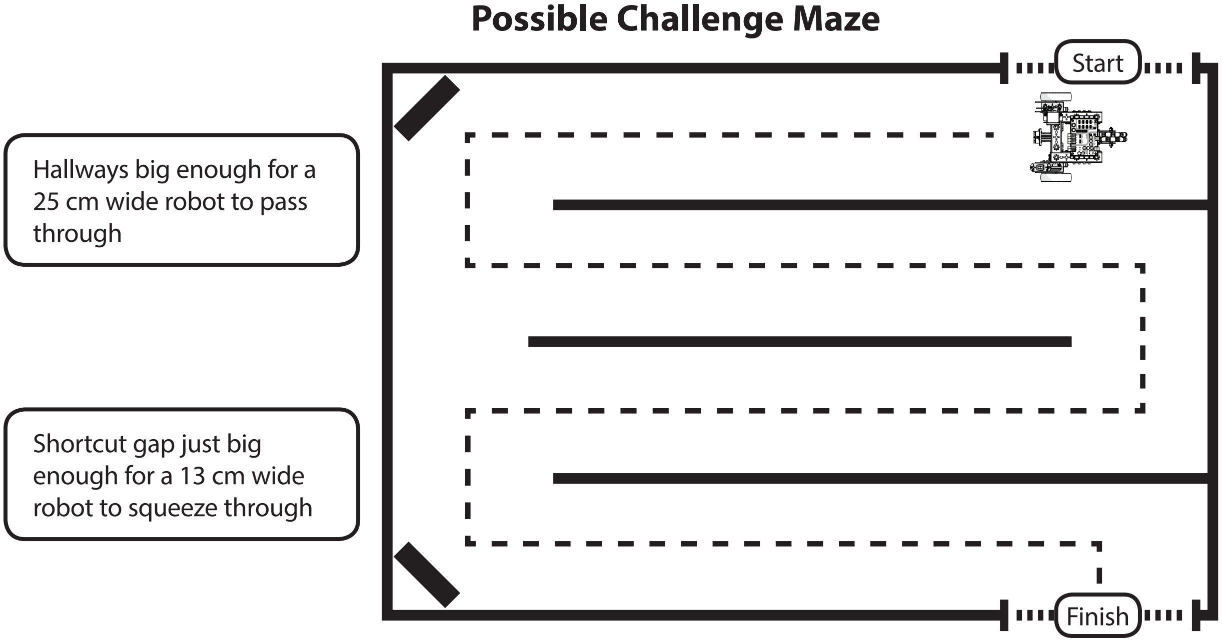
Step 3: Set Up (15 minutes)

- Build the challenge maze following the pictured guide.
  - o It should take 1 m by 1 m of floor space. Use the tape, blocks, and/or books of various sizes.

Constraints

- The team's robot must contain parts from only one set.
- Scoring formula = $10T + P + 5S + 3R + 3W$
  - o T = **time** in seconds' difference from the ideal time of 30 s
  - o P = number of **parts** in the robot, including each connector and wire
  - o S = **size** of robot in cm of the overall length plus width plus height of the theoretical box that the robot would fit into
  - o R = number of **runs** by the robot on the official maze
  - o W = number of times the robot touches a **wall** while inside the maze on its run
- The lowest score wins.

Possible Challenge Maze



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:
  - o Drivetrain for speed and control
  - o Robot chassis for size
  - o Possible solutions given robot size
- Create a detailed sketch of your solution to the challenge. Label the materials you will use. Write a detailed description of how your solution meets the challenge.

Step 5: Create (45 minutes)

- Design and build the robot. Remember to update the solution in the engineering logbook as the design is improved.

Step 6: Write the Steps (15 minutes)

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

Step 7: Test (45 minutes)

- Test the solution. Place the robot into the challenge maze and follow the written steps.
- Refine the solution. Adjust the design and steps as needed. Document any changes in the engineering logbook.

Step 8: Demonstrate (15 minutes)

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

Step 9: 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 steps for the robot to follow, how the solution was implemented, and how this challenge applies to the real world of robot design.

Step 10: Extensions

- Warehouse Parts Robot
  - o The aisles in a warehouse are as narrow as possible so as much material as possible can be stacked onto shelving. Design a warehouse with 25 cm wide aisles and that has parts (small blocks) placed in cordoned-off areas. The robot needs to be able to get to a given part, collect it, and return it to the start area for loading onto a truck.

Sample Steps

1. Go forward until I see a wall 5 cm ahead of me.
2. Turn left 90°.
3. Go forward until I see a wall 5 cm ahead of me.
4. Turn left 90°.
5. Go forward until I see a wall 5 cm ahead of me.
6. Turn right 90°.
7. Go forward until I see a wall 5 cm ahead of me.
8. Turn right 90°.
9. Go forward until I see a wall 5 cm ahead of me.
10. Turn left 90°.
11. Go forward until I see a wall 5 cm ahead of me.
12. Turn left 90°.
13. Go forward until I see a wall 5 cm ahead of me.
14. Turn right 90°.
15. Go forward until I see a black line.
16. Celebrate.

- Warehouse Stocking Robot
    - This is like the previous challenge, but the robot places parts onto the shelves.
- The Real Warehouse
    - Assign each storage shelf coordinates based upon a coordinate system. Have the robot place at least three objects onto shelves and collect three different objects from three other shelves.
- Tunnel Checker
    - Purchase some 15 cm diameter PVC or similar pipe. Have the robot proceed into the pipe until it comes to a restriction, and then count its steps (each rotation of the wheel equals one step) back to the start.
- Mars Explorer
    - Add another variable for weight restriction to any of the previous activities; for example, anything more than a 0.5 kg limit is penalized at $3M$ for each 0.1 kg above that limit. The M variable would represent the mass of the robot. Change the maze to an open field with objects (small wads of paper) to find and bring back to the spaceship.
- Government Purchase
    - Design a cost sheet for each type of part in the robot kit. Add a cost variable (C) to the scoring formula based upon the cost sheet. Adjust the presentation requirements to reflect this new variable by having each team make a sales presentation to an outside audience.