

Challenge

Students will design and build a robot that acts as a dump truck. The robot must be able to carry as much weight as possible, deliver the load to a specified location, and dump the load into a bin.

Materials Needed

Each pair of students will create one robot.

- Use one of these sets:
 - TETRIX® MAX R/C Robotics Set (41990)
 - TETRIX MAX Dual-Control Robotics Set (43054)
- Items to create challenge field:
 - Painter's tape
 - Meterstick
 - Dumping bin – a wide bin with short walls
 - Paint roller trays, short boxes, or under-the-bed storage bins work well.
- Scale to measure mass
- Weighted material such as sand or gravel
- Engineering logbook

Objectives

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

- Build a challenge field.
- Write the steps for the robot to follow to complete the challenge.
- Design and build a robot that meets the criteria and constraints of the challenge.
- Test, analyze, and refine the robot to improve its performance.
- Demonstrate the robot's effectiveness at meeting the challenge.
- Reflect on and discuss the challenge including its real-world applications.

Activity

Dump Truck Challenge

Difficulty

Beginner to intermediate

Class Time

Seven or more 45-minute class periods

Grade Level

- Middle school
- High school

Learning Focus

- Servo torque
- Engineering problem-solving
- Robot assembly

Step 4: Formulate a Solution (20 minutes)

- Consider the ideas you brainstormed in Step 2. Which of these ideas do you think will have the most success on the challenge field?
- Turn your best ideas into a design for your robot.
- In your engineering logbook:
 - Create a detailed sketch of your chosen solution to the challenge.
 - List materials you will use.
 - Write a detailed description of how your solution meets the challenge criteria and constraints.

Step 5: Prototype the Solution (135 minutes)

- Build the robot according to the designs you created in Step 4. If you modify the design as you build your robot prototype, remember to change the design in your engineering logbook.
 - **Note:** The creation of the robot could take longer depending on the complexity of the robot solution.

Step 6: Develop a Process (10 minutes)

- Robotic challenges often require robots to complete a series of tasks in a certain order. This series of steps is called a process. Think through the process your robot needs to complete to be successful in the challenge. Planning this series of steps is sometimes referred to as creating pseudocode for your robot.
 - Record your robot's process in your engineering logbook. Use this process as a guide when operating the robot and completing the challenge.

Step 7: Test and Analyze (15 minutes)

- Test your robotic solution. Place the robot in your challenge field and follow the process you wrote in Step 6.
- As you test your robot, record observations and data in your engineering logbook.

Step 8: Redesign or Improve the Solution (45 minutes)

- Refine your challenge solution. Adjust the robot design and process as needed. Document any changes in the engineering logbook.
- Make the physical changes to your prototype robot according to your design modifications.

Step 9: Demonstrate (15 minutes)

- When the robot has been tested and successfully completes the challenge, demonstrate its performance in a final test.
 - Measure the amount of material moved with the scale.

Sample Process for Robotic Dump Truck

1. Load the robot in the loading zone.
2. Drive forward and turn right.
3. Drive forward and turn right.
4. Drive forward and turn left.
5. Drive forward and turn left.
6. Drive forward, turn right, and stop.
7. Back up to the bin and stop.
8. Raise the bed of the robot to dump the load.
9. Lower the bed of the robot.

Step 10: Reflect and Share (15 minutes)

- Reflect on the changes your robot went through from original idea to final design.
- Reflect on the results of the challenge. What elements of your robot design brought you success or failure?
- Discuss the roles and responsibilities each team member fulfilled. How did teamwork and collaboration help you complete the challenge?
- Discuss how this challenge relates to robot design in the real world.

Step 11: Extensions

- Robotic Loader
 - Create a robotic front loader to load the robotic dump truck. Make loading the truck part of the competition.
- Transport Competition
 - See whose robotic dump truck can transport and dump the most material in a given time limit. Robots can make multiple trips between the loading zone and dumping bin to move as much material as possible. Use a scale to measure the amount of material used.
- Mining Operation
 - Simulate a mining operation by having multiple robotic dump trucks transport material from the loading zone to the dumping bin.
 - Determine the most efficient system for transporting the maximum amount of material. Consider the following:
 - Number of trucks in operation at one time
 - Amount of material each truck should transport
 - Loading time of a truck
 - Transport time of a truck
 - Dumping time of a truck
 - Route back to the loading zone
- Autonomous Dump Trucks
 - Add a PRIZM® controller to the dump truck and program the dump truck to transport the load from the loading zone to the dumping bin, dump the load, and return to the loading zone. Incorporate sensors to detect the environment and help the truck complete the challenge.