**Rolling Platform Driver Challenge**

# Description

In this activity, students will build a basic rolling platform robot that will serve as a chassis for additional activities listed in this module. This activity’s primary mission is to construct a robot that will move forward and backward and turn left and right. The chassis will illustrate key principles of traction, torque and battery power.

Students will conduct this activity in a team environment, develop their capacity for following instructions, make adjustments to improve robot performance and be exposed to concepts and terminology they can use to assess their design.

Novice students may consider constructing the rolling platform using instructions and information available directly from the robot manufacturer’s website. Use the following keywords along with the platform name to search the internet for examples: clawbot, rolling bot or tank.

For intermediate students, consult existing platforms and examples available online first. Next, augment these basic designs to construct a rolling platform that best suits your class’s needs.

# Lesson Outcomes

Students will be able to:

* Construct and operate a robot that is able to make basic manoeuvres
* Follow instructions to complete a complex assembly task
* Understand and apply gear ratios to their design
* Apply design thinking to improve their rolling platform’s performance
* Demonstrate constructive teamwork skills

# Assumptions

Students will have:

* Some knowledge of basic construction techniques
* Formed teams and partnerships within the classroom
* Access to robotics platforms and necessary equipment
* Some knowledge of gear ratios, robots and design
* Some experience with basic mathematics, friction, torque and elementary forces
* Some experience with relevant toys such as LEGO, bicycles, wagons and fictional robots from movies (e.g., R2D2, BB8)



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# Key Terminology

**Center of gravity**: a focal point where an object is standing at its design maximum without falling down.

**Chassis**: a physical structure that connects and holds the various components together to form the basic robot. In most cases it can be the outer shell or the internal skeleton structure.

**Design Thinking**: is an approach to solutions-finding that considers the desired end-result or experience. A Design Thinking approach is often iterative, starting with the definition of a problem, empathetically considering the experience or impact of that problem from multiple

perspectives, considering multiple approaches to potential solutions, then narrowing down the solution through prototyping or experimentation. The chosen approach to the solution is then selected and implemented.

**Friction**: heat caused by opposing forces acting on a surface. **OR** a force that resists motion between two surfaces sliding against each other; strength of the force is determined by their textures.

**Gear ratio**: the science of mechanical advantage using gears.

**Scrub**: the transverse (side-to-side) friction on a wheel in a skid-steer drivetrain.

**Skid steering**: turning a vehicle by driving the left side drive wheels at a different rate than the right drive wheels, similar to a tank or bulldozer.

**Torque**: also known as *moment*. The force of a moving object connected to a single point.

**OR** the measurement of force causing rotation.

**Traction**: the ability to grip a surface.

# Estimated Time

3–4 hours or more (platform dependent)

# Recommended Number of Students

Two to five students per robot, per team (ideal: three students) Two to five teams

# Facilities

Robot testing area: a large table, approximately 120 cm × 240 cm (4 ft. × 8 ft.) Any classroom with tables

Storage space

# Tools

Tools are platform-specific, depending on the robotics platform selected Stopwatch

**Materials**

Storage bins

Robot kits (e.g., VEX EDR, VEX IQ, LEGO Mindstorms)

# Resources

“Simbotics” is also known as Team 1114, former World Champions of FIRST Robotics and one of the most famous high school robotics teams in Canada. They produce some excellent training materials that they share with the robotics community, including this presentation on robot drivetrains. It is, perhaps, more in-depth than needed for presentation to the class, but it

provides excellent background information on drivetrains for the teacher or advanced students in the class:

https://[www.simbotics.org/files/pdf/drivetraindesign.pdf](http://www.simbotics.org/files/pdf/drivetraindesign.pdf)

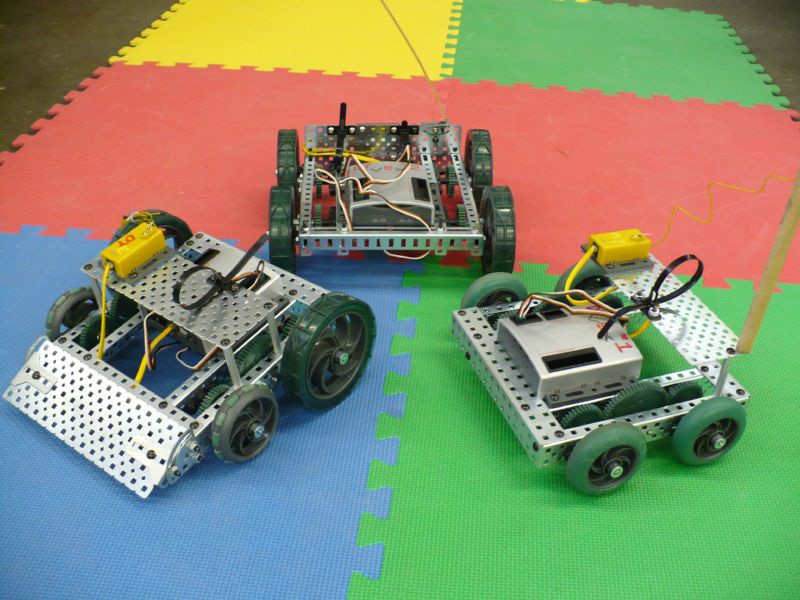
VEX Robotics has curriculum on robot design. This section on drivetrain design is relevant to this activity, particularly the sections on traction, turning and gears. Much of it is written at a high school level.

<http://curriculum.vexrobotics.com/curriculum/drivetrain-design>

As important as it is for robots to be able to turn, it is also important to get them to go straight. This 15-minute video discusses how to get a LEGO robot to travel in a straight line. It also demonstrates good scientific practice in measuring and recording performance. https://[www.youtube.com/watch?v=OlAO9Ho-N58](http://www.youtube.com/watch?v=OlAO9Ho-N58)

# Demonstration

Ideally the teacher will have access to a working robot drivetrain to demonstrate how it works. Particular emphasis should be placed on the importance of keeping the centre of mass over the drive wheels, and dealing with “scrub” or “skid,” the sideways force acting on the front and rear wheels when a “tank style” or “skid steer” drive train changes direction (see Figure 1). It is also important to reference the relationship between drive wheel diameter, gear ratio and motor torque. In the event that a demonstration robot is not available, some of the videos below will help cover the relevant topics.



**Figure 1—**Three simple VEX-based “rolling chassis” using “skid” steering. The left-hand robot uses omni wheels on the front axle to help reduce “scrub” and make turning easier.

The following videos will provide an understanding of gear ratios. It is recommended that teachers preview the following videos before showing them to their students in class. Note that these are the same videos linked as a resource in Activity 3, “Essential Principles of Robotics.” Students who have completed that activity may already be familiar with this content.

### Gear Ratios - Part 1

https://[www.youtube.com/watch?v=B4j2VPHVm6o](http://www.youtube.com/watch?v=B4j2VPHVm6o)

### Gear Ratios - Part 2

https://[www.youtube.com/watch?v=h1vfR9YvjMA](http://www.youtube.com/watch?v=h1vfR9YvjMA)

### Gear Ratios - Part 3

https://[www.youtube.com/watch?v=-q5FmanzCw4](http://www.youtube.com/watch?v=-q5FmanzCw4)

The following videos will provide an understanding of speed vs. strength (torque):

**Understanding Gears: Speed Vs. Torque**: a two-minute demo of simple gear ratios https://[www.youtube.com/watch?v=UUfZnZ\_0Cb8](http://www.youtube.com/watch?v=UUfZnZ_0Cb8)

### LEGO Technic - Torque, Speed, Gearing

https://[www.youtube.com/watch?v=KKQHqPIuEVc](http://www.youtube.com/watch?v=KKQHqPIuEVc)

Also, discuss centre of gravity as a concept and how it affects the construction and operation of your rolling platform.

# Procedure

1. Students build their rolling platform. They may follow these reference materials to build the basic rolling platforms:

### VEX IQ (animated instructions)

<http://www.vexrobotics.com/vexiq/animated-build/clawbot-iq#1>

### VEX IQ (build instruction PDF)

<http://www.vexrobotics.com/vexiq/explore/robot-builds/>

### VEX EDR (build instruction PDF)

<http://content.vexrobotics.com/docs/instructions/276-2600-CLAWBOT-INST-0512.pdf>

### LEGO Mindstorms/EV3 (build instruction PDF)

<http://www.lego.com/en-us/mindstorms/build-a-robot>

1. After constructing the rolling platform, students should test their rolling platform to see if it performs according to plan.
2. Introduce the following activity as a competitive challenge to get students accustomed to the arena of competitive robotics challenges. Be sure to have a stopwatch on hand to keep time.

**Testing Your Robot Challenge—Navigate the Maze**

The object of this challenge is to remotely control the rolling platform to travel from one side of the maze to the next. This activity is scored by a stopwatch.

The rolling platform starts in contact with the wall on one side of the maze, then crosses to the other side to touch the destination wall, at which point the timer is stopped. The rolling platform cannot simply climb over the wall(s) to get to the other side. The team with the shortest time wins the challenge.

Figure 2 shows one possible “maze” configuration. Slalom courses and “head-to-head” racing on parallel tracks also make for exciting activities.

**Figure 2—**One possible maze layout

# Extension Activities

Extension activities may be found at the following website under Classroom Challenges at the bottom of the page:

### Jr. Robotics: a place for teachers, students and parents:

https://vsbrobotics.wordpress.com/

# Assessment

The evaluation of this lesson is based on the learning outcomes outlined above.

Prior to teachers using the evaluation grid it is recommended that students perform some form of peer-assessment and self-assessment.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Outcome To Be Assessed** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| **Outcome 1** | **Robot Construction** |  | | | | | | |
| **1.1** | Construction of robot to specifications. |  |  |  |  |  |  |  |
| **1.2** | Understands and applies gear ratios to the design. |  |  |  |  |  |  |  |
| **1.3** | Follows instructions to complete a complex assembly task. |  |  |  |  |  |  |  |
| **Outcome 2** | **Perform the Technical Challenge** |  | | | | | | |
| **2.1** | Robot successfully navigates the maze(s). |  |  |  |  |  |  |  |
| **2.2** | Applies design thinking to improve their rolling platform’s performance. |  |  |  |  |  |  |  |
| **Outcome 3** | **Teamwork** |  | | | | | | |
| **3.1** | Able to resolve challenges when encountered. |  |  |  |  |  |  |  |
| **3.2** | Equitable division of work. |  |  |  |  |  |  |  |
| **Outcome 4** | **Understanding Key Terminology** |  | | | | | | |
| **4.1** | Demonstrates the use of Key Terminology. |  |  |  |  |  |  |  |
| **4.2** | Applies terminology appropriately. |  |  |  |  |  |  |  |

## Total Points:

|  |  |  |
| --- | --- | --- |
| 6 | Completed successfully at the exceptional level | Exemplary |
| 5 | Completed successfully at higher than the expected level | Accomplished |
| 4 | Completed successfully to the expected level | Emerging |
| 3 | Attempted successfully at the minimum level | Developing |
| 2 | Attempted - Unsuccessful - Close to Successful | Beginning |
| 1 | Attempted - Unsuccessful | Basic |
| 0 | Not Attempted | N/A |

**Comments:**