

## Lesson 12

## Peak Performance

*Suggested Time*

One 60-minute session

*Lesson Overview*

Students will build and program a LEGO car that uses gears or sensors to travel quickly across a flat surface, but is also able to climb a steep hill. The settings of the cars can only be switched by a quick adjustment and not a new building component. Students can use gears to keep traction between the wheels and the table or use sensors in their program to determine the speed of their car.

- Class discussion of different building and programming methods.
- Building of sturdy car with gears.
- Overview of programming the car with and without sensors.
- Car testing on flat surface and incline.
- Recording design and test results in Engineering Journal.

*Learning Objectives*

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

- Define WeDo programming terms.
- Be familiar with the WeDo programming language.
- Be familiar with gears and sensors.
- Define engineering design as the process of creating solutions to human problems through creativity and the application of math and science knowledge.

*Teacher Background****Introduction to Programming***

**Start Block:**

This is the initiation of the program. This is needed to make the program go or commence.

**Wait Statements:**

This is used to stall the program in the state that it is currently in. This activity will use the wait statement to keep the motor running for a specific amount of time.

**Power Levels:**

When the motor is running, different levels of power, that relate to motor speed can be selected. The higher power level relates to a higher speed.

**Motor “This Way” or “That Way”:**

The direction of the motor is controlled by the direction of the arrow on the motor programming block. The best way for students to determine

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the forward direction is to test it.

Loop:

Loops are used to repeat a section of programming. This is useful in the acceleration and deceleration challenge in that it repeats the motor forward code, but adds or subtracts to the speed for each loop.

### ***Engineering Design***

Engineers typically work together to solve the problems that face society. Engineering design is the process of creating solutions to human problems through creativity and the application of math and science knowledge. The basic steps within the design process include:

- i. Identifying a problem** – Observing a problem and seeing a need for a solution.
- ii. Researching possible solutions** – Coming up with ideas to address the problem.
- iii. Picking the best solution** – Determining which idea best addresses the problem. This decision may involve monetary, practicality, material, and property concerns.
- iv. Building a prototype** – Build a working model of the chosen design
- v. Testing the prototype** – Be sure the working model solves the problem and holds up to any important material property tests.
- vi. Repeating any steps needed to improve the design** – The engineering design process is not always a step-by-step process, as engineers often repeat steps or go back and forth between the other five steps.

### ***Vocabulary***

**Engineering** – the process of creating solutions to human problems through creativity and the application of math and science knowledge.

**Gearing Down** – a small gear to a big gear. This results in the follower rotating much slower than the driver.

**Start Block** – the start block is used to begin or start the program.

**Speed** – the distance traveled over a specific time.  $V = d/t$

**Motor Statement** – turn the motor on in a specific direction. Other motor commands include: Motor On For Block, Motor Power Block, and Motor Off Block.

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**Power Level** – the power level is the speed at which the motor will spin. This is used with the Motor Power Block

**Wait Statement** – this causes the program to continue in its current state until a specified time has elapsed.

**Loop Statement** – this repeats a section of code. Use this when you are going to need to do the same thing over and over again.

**Add or Subtract Block** – add or subtract numbers to the current display number. This is useful when increasing or decreasing power levels or changing wait statement times.

**Tilt Block** – this is used to base a decision statement on the direction of the tilt sensor.

**Motion Sensor Input** – this block references the value of the motion/proximity sensor. This can be used to tell how close you are to an object.

*Materials***For each student**

- Engineer's Journal Part 1

**For each student pair**

- WeDo kit

**For the class**

- Handout with program terminology of the programming blocks.



Start Block



Start On Key Press Block



Start On Message Block

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Motor This Way Block



Motor That Way Block



Motor Power Block



Motor On For Block



Motor Off Block



Play Sound Block



Display Block



Add to Display Block



Subtract from Display Block



Multiply by Display Block



Divide by Display Block



Display Background Block

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-  Send Message Block
-  Wait For Block
-  Repeat Block
-  Text Input
-  Number Input
-  Random Input

 Record Stop Play

-  Motion Sensor Input
-  Tilt Sensor Input
-  Tilt Up
-  Tilt Down
-  Tilt This Way
-  Tilt That Way
-  Any Tilt
-  Sound Sensor Input

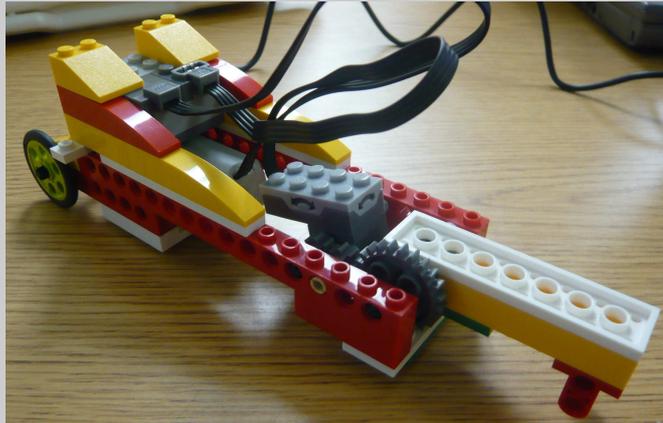
-  Display Input
-  Bubble

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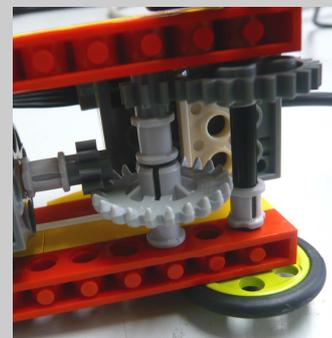
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***Preparation***

- Distribute Engineering Journals
- Prepare an example car and program

***Instructions for Teachers*****Peak Performance**

This design uses the tilt sensor to determine the speed of the car. If the tilt sensor is straight (on a flat surface), the car travels fast and if the tilt sensor is tilted (on a hill), the car will slow down.

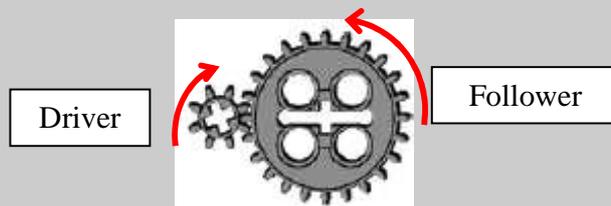


Gearing down will make the car travel slower up an incline. The direction of the gears can be switched to make the car travel faster across a flat surface.

1. Begin with a class discussion about gearing down. Remind them of the Exploring Gears lesson where they discovered that gearing down results in a slower motion of the follower gear.

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2. Tell the class that they will be building and programming a car that can travel quickly across a table but is also able to climb a steep hill. Show them your example car and how you used gears or a sensor. Explain that they can only do a quick adjustment to change the speed of their cars. Suggest using gears or sensors to make the switch between different speeds.
3. Allow 10 minutes for student pairs to build their cars. Students may use gears, friction, or any other strategies they think of, to design their cars.
4. Tell students to use the same program they used for the “Going the Distance” lesson. They can add to this program to change the speed or if they want to use sensors.
5. Have student pairs demonstrate their cars one at a time. Have them show you how they switch between speeds.
6. Afterwards, gather students to discuss their design methods. Bring up any problems students came across, and how they changed their design or programs. Show students your car. Explain how you designed it and show them your program.
7. Allow time for students to record their design and test results in their Engineering Journals.



This program can be used to accelerate the car up the ramp. Starting from rest creates enough traction to stop the car from slipping.



This program uses the motion sensor to determine the speed of the car. If the tilt sensor is tilted upwards, the car will slow down and if the tilt sensor is flat, the car will travel faster.

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