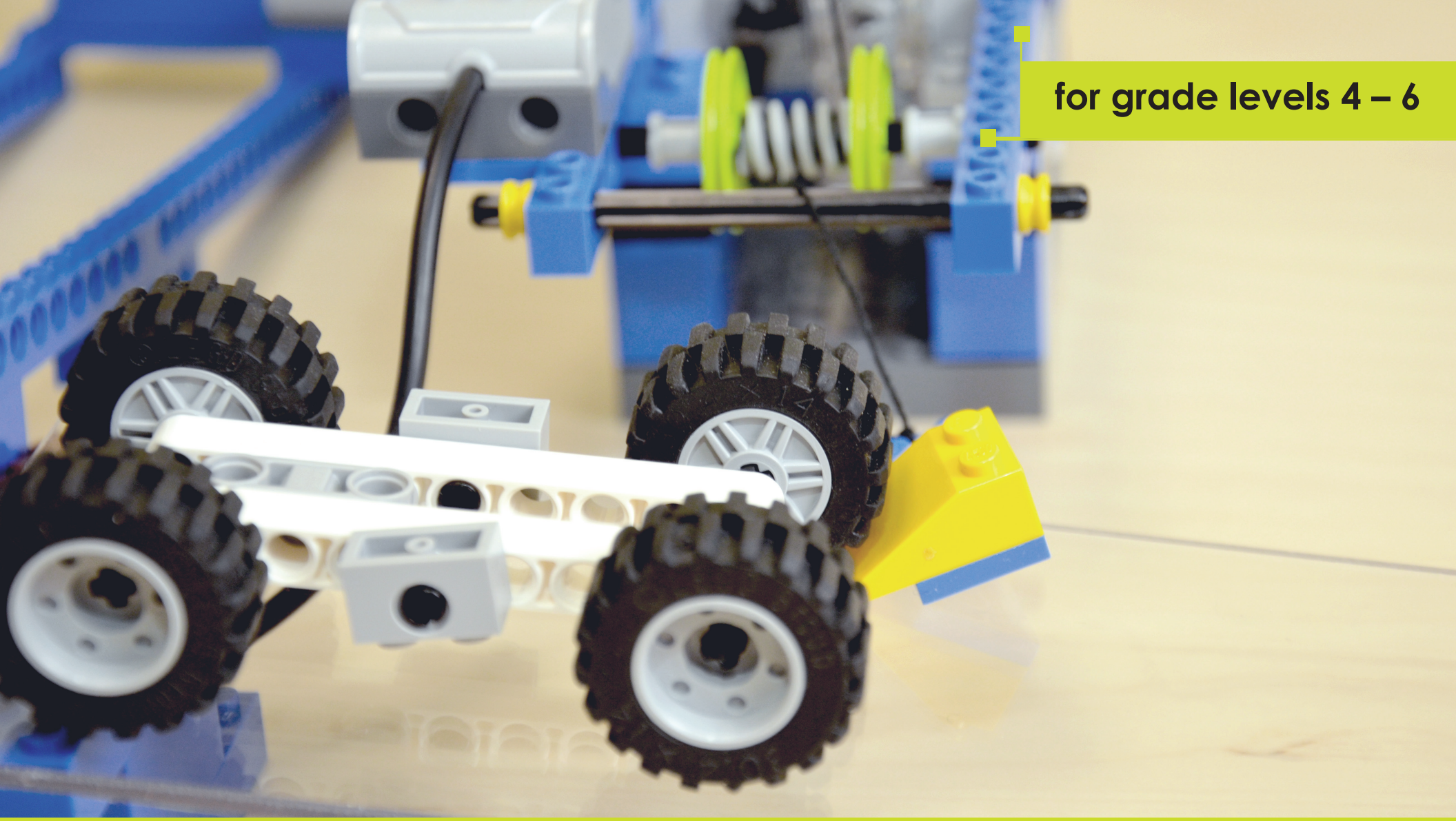


for grade levels 4 – 6

ACTIVITY 5:
PROGRAMMING GUIDE

www.enableeducation.com

Enable Education

The Rube Goldberg Challenge

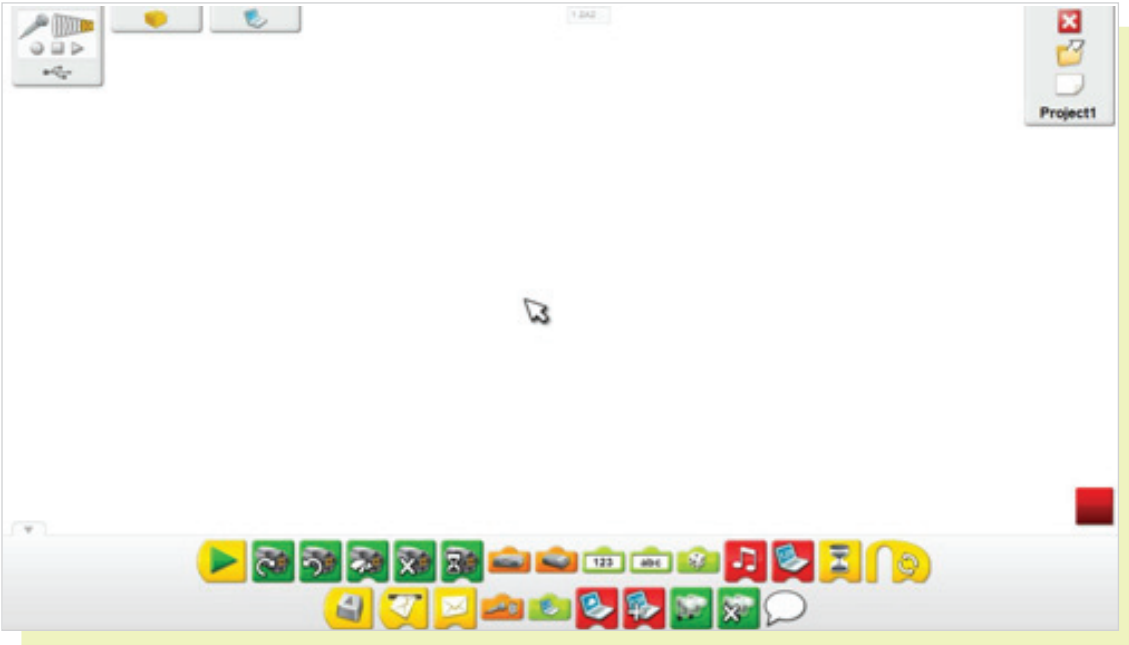
A Rube Goldberg machine is an overly engineered machine that completes a very simple task in a complex fashion and usually includes a chain reaction being set off. Enable Training and Consulting Inc. has designed a Rube Goldberg machine that meets the above criteria. We set out to perform a simple task such as pushing a ball off a table using WeDo LEGO products, but used several intermediate steps in a chain reaction to make an "overly complicated" machine.

The Rube Goldberg machine's system has situations where energy must transform from one step to another, without adding **any** energy to the system. This can only be done by converting potential energy of an object into kinetic energy and vice versa. If kinetic energy was used throughout the system the Rube Goldberg machine would begin its process at a larger height and work its way down to ground level. Since this can require larger structures to be built, we implemented the use of motors and sensors as well into our Rube Goldberg machine. In other words, instead of only converting energy forms, we also use pre-programmed instructions on a computer to control motors after obtaining input from sensors. Even though this technique may cause our system to become "stuck" in different stages, it follows the Rube Goldberg principle of creating a complicated machine to complete a simple task.

LEGO WeDo robots and computer software were used to perform the pre-programmed instructions. Two types of sensors were used to turn on the motors being used; sound sensors and motion sensors. The program was written where motors would be activated in a particular direction once the sensor is triggered. The sound sensor was used in the first stage of Rube Goldberg to run the motor of the first vehicle. A single clap of the hands begins the entire chain reaction. The motion sensor is used to activate the motor of a pulley mechanism which pulls a wedge. Another motion sensor was used in order to trigger the motor on the final car being used in the system which pushes the last ball off the table.

Walk Through of Program

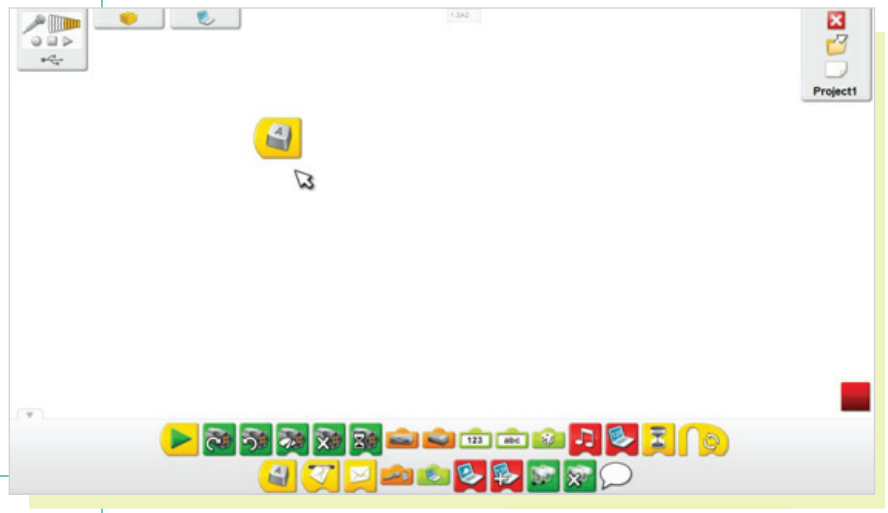
LEGO has a very easy to use system for programming WeDo robotics. The program is not written using lines of code and words, images are used instead. These images, or blocks, are placed on the screen to make a "block diagram" which will run the program. It is a very easy way to transfer more complicated concepts of programming, such as different types of loops, and "if statements" to younger children. In order to complete a command or a statement, the particular block would be dragged onto the screen from the dashboard below. Conditions that are related to each other are created by placing blocks attached to each other in a particular order. To differentiate between the multiple sensors and motors, specific numbers are assigned to each. If the program needs to be stopped at any time, the red square on the bottom right corner can be clicked.



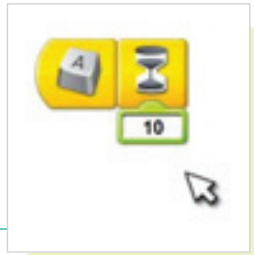
Programming the Sound Sensor

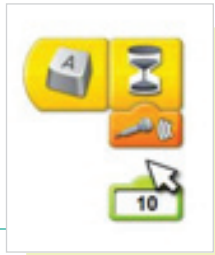
In order to program the first car, follow the steps below:

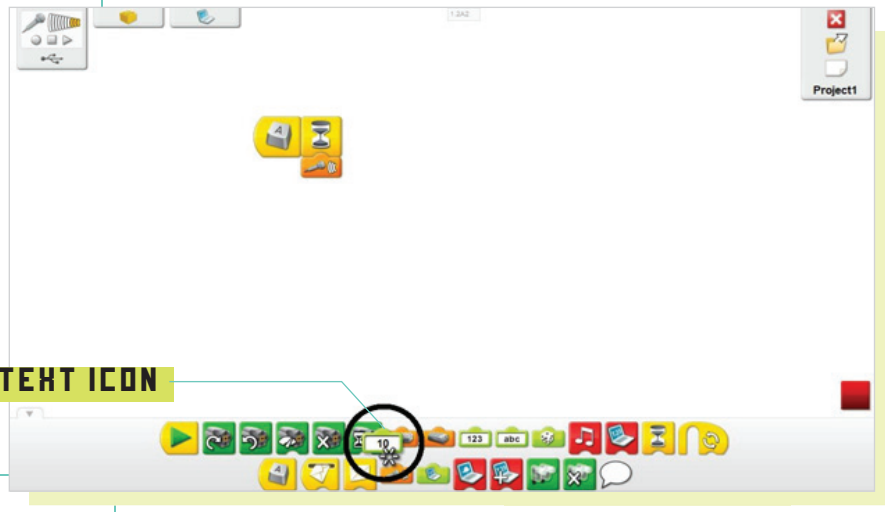
1. Place a "Start on Key" block at the beginning of your program. This block begins the function of the block when you press a specific key. To change the key being used, place your cursor on top of the block and simply type the preferred key.



2. Place the "Wait For" block onto the block diagram and attach the "Sound Sensor" block next onto the block diagram. This car was set off with a sound sensor, so type the custom message "Sound Received". To do this, put your cursor on top of the textbox until the letter T appears, then type the message.

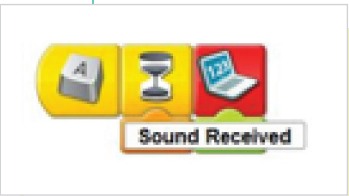




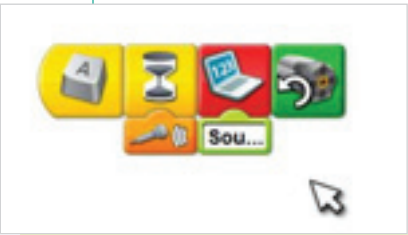


ACTIVITY 5: PROGRAMMING GUIDE

3. Place the "Add to Display" block next onto the block diagram. This car was set off with a sound sensor, so type the custom message "Sound Received". To do this, put your cursor on top of the textbox until the letter T appears, then type the message.



4. Place the "Motor that Way" block next. You must make sure that the motor is turning the correct way based on your application. Thus, "Motor this Way" may also be used if you want the motor to spin in the other direction.

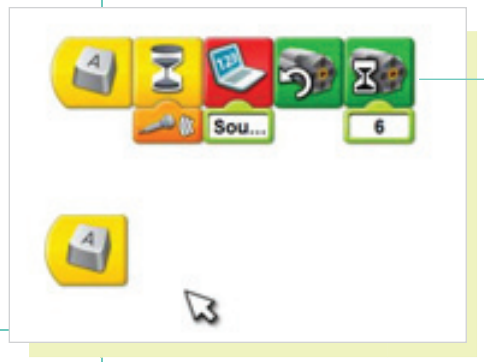


5. Finally, we will place a timer for how long the motor is going to run for, so that it is not continuously rotating throughout the whole process. Place a "Motor on For" block onto the block diagram. The timer works in 1/10 of a second intervals. Therefore, the time can be changed by placing the cursor on the textbox and typing in the number of seconds you want the timer to run multiplied by 10. Choose 0.6 seconds by typing in 6.

Programming the Motion Sensor

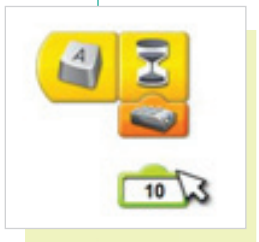
In order to program the Pulley, follow the steps below:

1. Place a "Start on Key" block below the previous blocks.

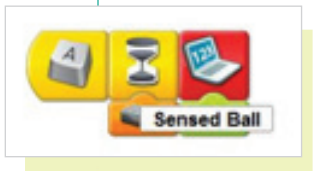


SOUND SENSOR

2. Place a "Wait For" block onto the block diagram and attach the "Motion Sensor" block underneath it. Remove the text box which was there previously by dragging the block into the dashboard below until a star appears besides it. This block means that the program will only continue past this point when motion is sensed.



3. Place the "Add to Display" block next on the block diagram. The motion of the pulley is triggered by the ball being sensed by the motion sensor, so type the custom message "Sensed Ball".



ACTIVITY 5: PROGRAMMING GUIDE

4. Place the "Motor Power" block onto the block diagram. This controls the amount of power given to a particular motor from a scale of 1 to 10, with 10 being the most amount of power. Right-click the number to increase it to a value of 7. Left-clicking will decrease the value.

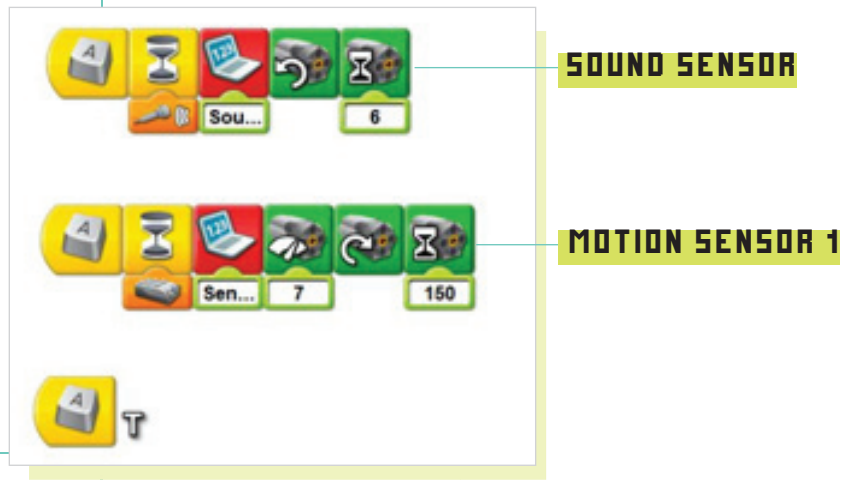
5. Place the "Motor This Way" block next.

6. Finally, place a timer for how long the motor is going run for the pulley mechanism. Place a "Motor on For" block onto the block diagram. Choose 15 seconds by typing in a value of 150.

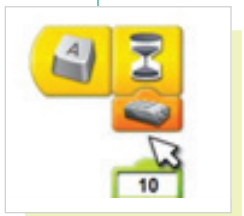
Programming a 2nd Motion Sensor

In order to program the second car, follow the steps below:

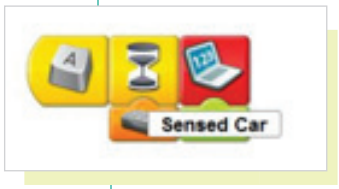
1. Place a "Start on Key" block below the previous blocks.



2. Place a "Wait For" block onto the block diagram and attach the "Motion Sensor" block underneath it. Remove the text box which was there previously by dragging the block into the dashboard below until a star appears besides it. This block means that the program will only continue past this point when motion is sensed.



3. Place the "Add to Display" block next on the block diagram. The motion of the final vehicle is triggered by the car being sensed by the motion sensor, so type the custom message "Sensed Car".



4. Place the "Motor That Way" block next.

5. Finally, we will place a timer for how long the motor is going run for the final vehicle. Place a "Motor on For" block onto the block diagram. Choose 0.8 seconds by typing in 8.

As we can see, all three programs have similar blocks, so it is important to differentiate which motor needs to run when a certain button is pressed. Now we change the associated keys used to start each program, so that all three programs do not all start with the letter "A" being pressed. We can change the first program to start with the letter Q by hovering over the "Start on Key" block and pressing Q. We can do the same for the last program to change it to Z.

Also, the motors need to be differentiated so that the three programs will run the correct motors and read the correct sensors. We do this by labelling the motors and sensors. If they're not labeled, the program will not run successfully since it will not recognize which motor to turn on once a sensor has received input.

To label the different motors and sensors press Shift and then right click on the motor block. More right clicks increase the label value, while left clicks decrease the value. Small dots will now appear on top of the motor representing the label. You will need to follow the same procedure for the sensors as well. In our example we have labels for the three motors being used, and the two motion sensors as well.

Trouble Shooting

Why isn't my program running?

There are many reasons why your program may not run properly. Included is a short list of some of the possibilities.

Note that there are issues that could arise in your hardware or software. We will go over a few issues so that you will know what types of problems to look for.

- You may not have the correct ports selected in your sensor properties.
- You may not have the correct ports selected in your motor properties
- You may not have everything connected to the LEGO WeDo hub.
- Make sure that you are pressing the correct key when you initialize your program.

Conclusions

The basics of WeDo programming are implemented in this document. These basics consist of a motion sensor waiting to be triggered and then a motor running.