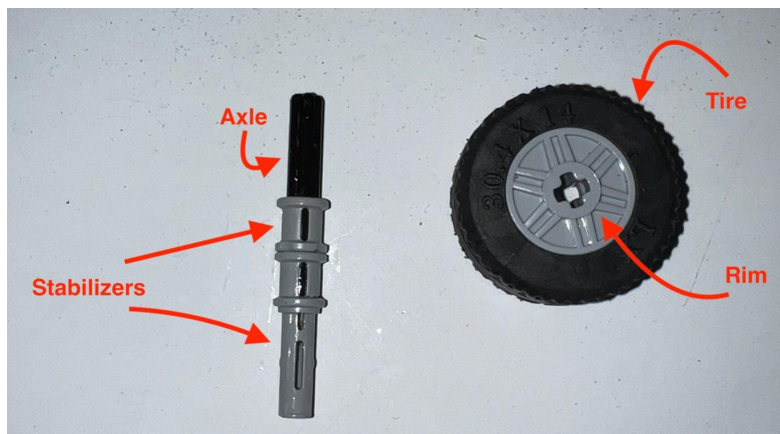
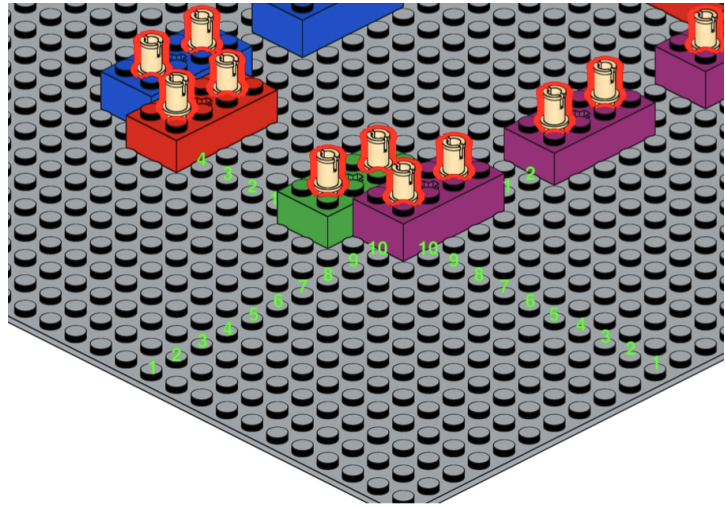


Navigating the *DIY*namics LEGO SPIKE Kit and Accompanying Software

Building a Well-Working Kit

Please follow the [PDF Instructions](#) for building the *DIY*namics LEGO SPIKE kit. The tank (sidewall + OXO turntable) is designed to sit on top of the baseplates, tightly between the wheel (on the gray baseplate in the instructions) and the parking block LEGO bricks (on the green baseplate in the instructions).

For clarity, please refer to the annotated image (seen right) of where we placed the underlying blocks on the motor side baseplate. The motor blocks and the parking blocks on the baseplates *do not have to be in the exact positions* as illustrated in the instructions. These positions are what have worked for us, but please move them as you see fit for maximum stability of your tank.



Please do not use the wheel listed in the build instructions (we have not been able to find a LEGO CAD version of the correct wheel, pictured left). The correct wheel is listed in the materials list. The axle and two stabilizers are both found in the SPIKE kit. The tire and rim are the only pieces *not* included in the SPIKE kit. Users can obtain these products by ordering from the LEGO marketplace BrickLink

(linked in the materials list). We also suggest adding WD40 to the lower stabilizer for smoothness.

We recommend placing a weight on the motor-side baseplate. The Lego baseplates are somewhat flexible, and having additional weight on the plate provides additional stability to the entire system.

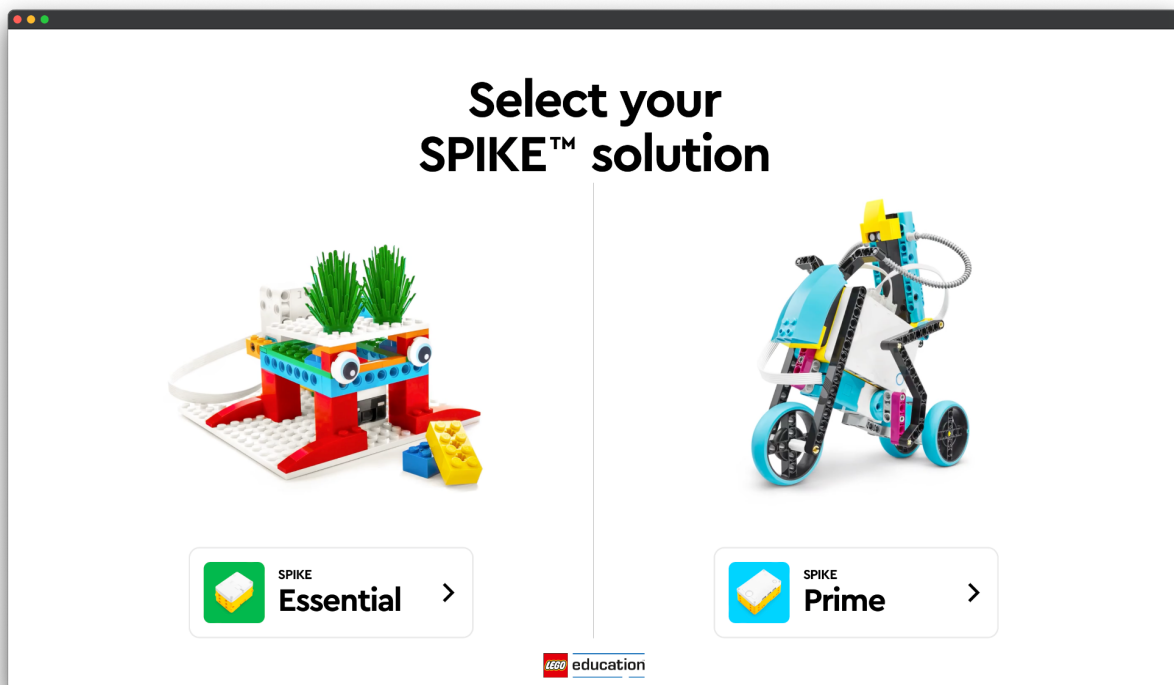
Finally, to use the more advanced LEGO SPIKE file we have available, make sure to affix a piece of blue electrical tape (or another brightly colored tape) to the sidewall of the tank. The

color sensor attached to the top of the motor prompts *SPIKE* to record a timestamp every time the colored tape passes through the sensor's lens.

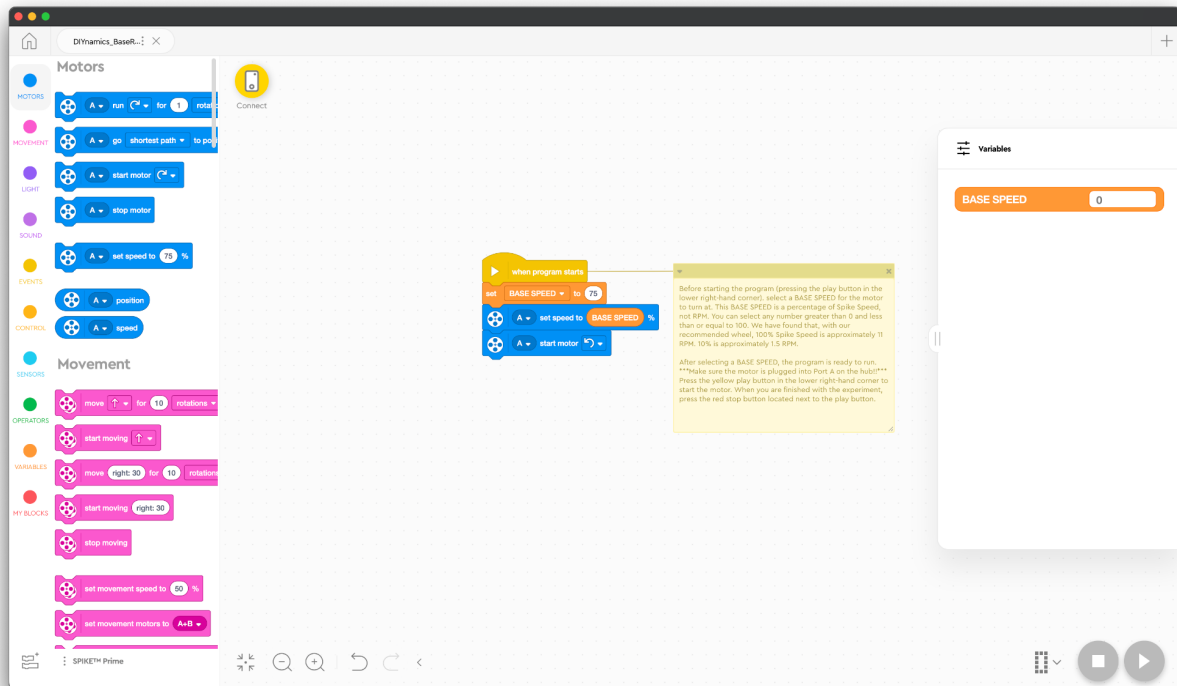
Introduction to the LEGO SPIKE Software

The *DIY*namics LEGO SPIKE kit runs via an interactive development environment called *SPIKE*. Currently, there are two versions of LEGO SPIKE: *SPIKE Legacy* and *SPIKE*. They can be downloaded via the LEGO website ([SPIKE Legacy](#), [SPIKE](#)) or through the AppStore for Apple users. Alternatively, *SPIKE* can be accessed on a web browser (they recommend Google Chrome). Both applications use a programming language called “Scratch”, and *SPIKE Legacy*, as of Spring 2023, is the only application with MicroPython capabilities. *SPIKE Legacy* and *SPIKE* require different software versions installed on the SPIKE Hub. Switching between the two applications requires downgrading the Hub via an external link when going from *SPIKE* to *SPIKE Legacy*. To downgrade the hub, use this [link](#). Upgrading the hub should take place in the respective application. *SPIKE Legacy* outputs and runs on “.lisp” files, while *SPIKE* outputs and runs on “.lisp3” files. *SPIKE* can run “.lisp” files. However, a warning does indicate some functions may not work in *SPIKE* that do work in *SPIKE Legacy*. For this reason, we recommend running files in their intended applications. We have both types available for our basic programs and a more advanced program, which calculates RPM using the color sensor, available in both as well.

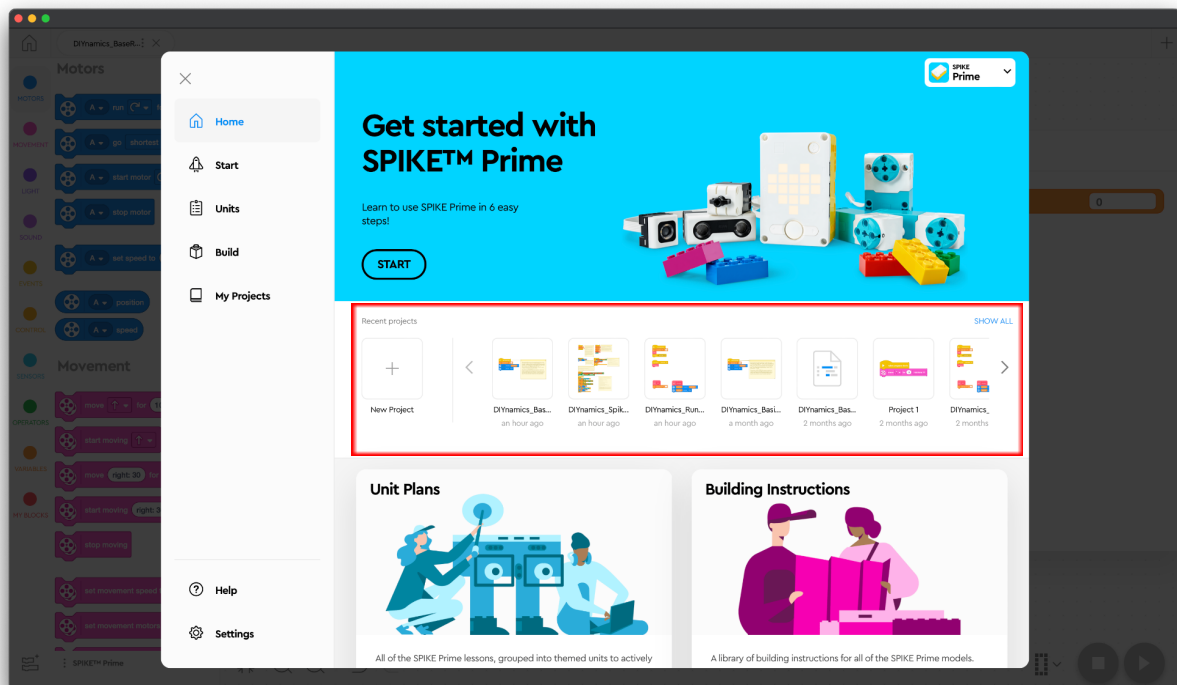
The interface of both applications is the same. Upon opening one of our provided files, the following screen will appear:



Select “Prime”. You should be directed to your selected file in *SPIKE*, as seen below in our **Base Run** file:



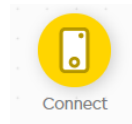
However, in some cases, you will be directed to the Home Screen:



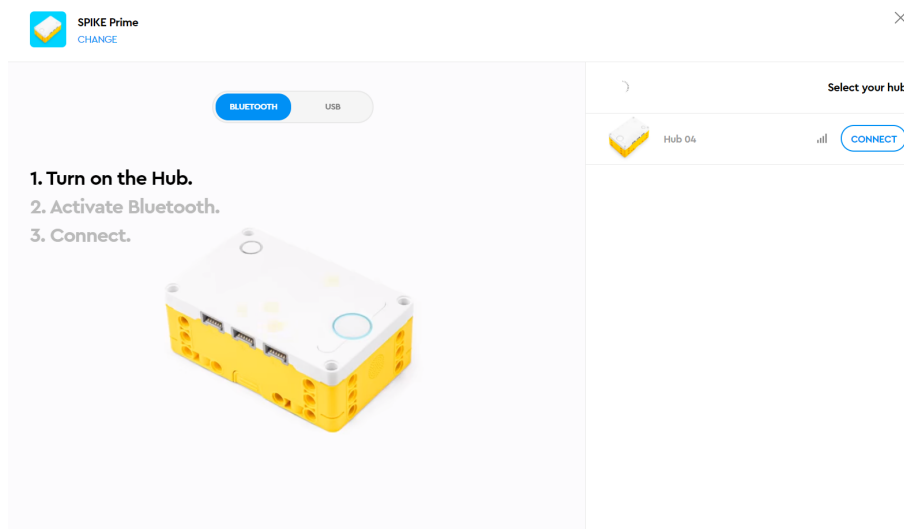
If this happens, your desired file will be listed under “Recent Projects” (boxed in red in the above image). Double-click on the file to open it.

Connecting Your LEGO SPIKE Hub

Connect your hub to your laptop via Bluetooth using the yellow “Connect Hub” button in the upper left corner of the project workspace.

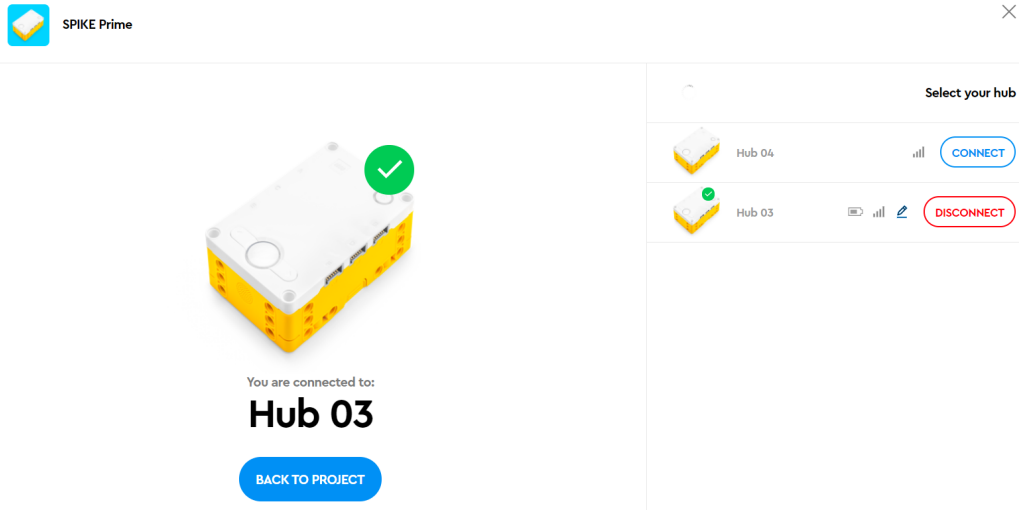


When clicked, this connection menu pops up:



Turn on your Hub by pressing and holding the ON/OFF button for five seconds. Your Hub will make some beeping noises, and the pixels will light up, indicating that it is now on.

Click the Bluetooth activation button on your Hub, then select the Hub name on the screen that matches the number on your Hub, and hit the connect button. Once it has paired, it will show the below screen (in this case, we paired with Hub 03). The first time you connect to a Hub, the program may ask if you want to rename the Hub.



Close the popup and return to the project by clicking the blue “Back to Project” button.

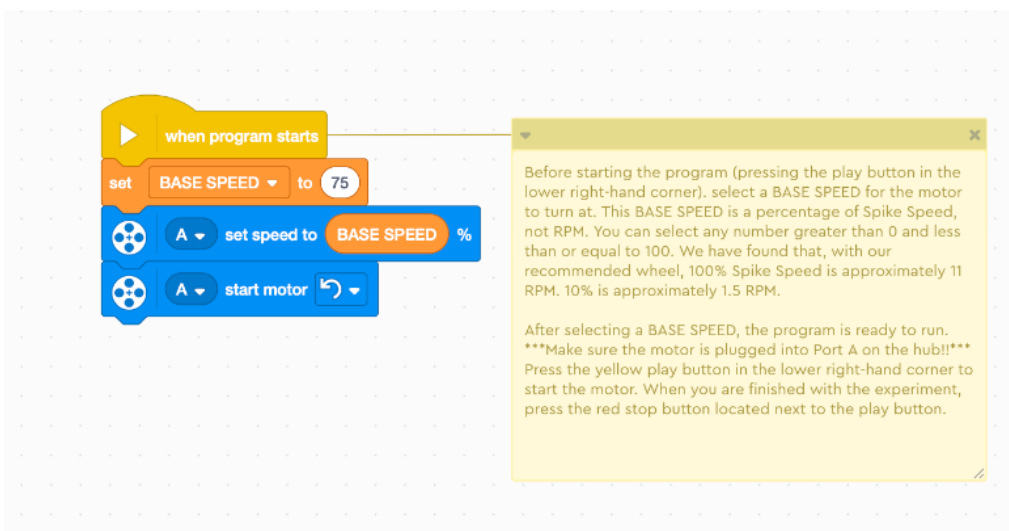
The “Connect Hub” button in the upper left corner should now look like the following image, indicating that your Hub is properly connected.



DIYnamics LEGO SPIKE Files

We have three different file types available for running the motor of the *DIYnamics* LEGO SPIKE Kit: **Base Run** (available in both *SPIKE Legacy* and *SPIKE*), **Base Run MicroPython** (only available for use in *SPIKE Legacy*), and **Run RPM** (available in both *SPIKE Legacy* and *SPIKE*).

Base Run (Scratch, *SPIKE Legacy* and *SPIKE*)



The **Base Run** file turns the motor *without* simultaneously calculating the RPM of the tank. Therefore, to run this program, the color sensor is not required for the build of the LEGO SPIKE Kit.

After connecting the Hub to your computer, input a `BASE_SPEED`. You can do so by highlighting the number in the white oval-shaped space (where “75” is in the above image) and typing in any integer greater than 0 and less than or equal to 100. This number represents a LEGO SPIKE percentage of speed, not RPM. We have found that, with our recommended wheel, 100% LEGO SPIKE speed is approximately 11 RPM. 10% is approximately 1.5 RPM. Note that this may change with your configuration, and we highly suggest each user conduct a series of tests using the LEGO SPIKE color sensor for accuracy.

Make sure you have connected the motor cable to port “A” on the Hub, and you are ready to start the program. To start the program, press the yellow “play” button located in the lower right corner of the SPIKE screen. This will start the wheel of the motor and turn the tank counterclockwise. The program will run until the red “stop” button is pressed in the SPIKE App.

Base Run (MicroPython, *SPIKE Legacy*)

Below is the MicroPython code for running the **Base Run** SPIKE Program. The program follows the same functionality as the Scratch version; however, this MicroPython version can only be run in *SPIKE Legacy*.

The import lines are automatically populated by *SPIKE Legacy*. This program does not use all of them, but we keep them for consistency.

Make sure your motor is plugged into port ‘A’ on the Hub, and set the variable `BASE_SPEED` to any integer between -100 and 100. Negative values will turn the tank counterclockwise, and positive values will turn the tank clockwise.

To start the program, click the yellow “play” button in the lower right corner of the screen. The motor will turn until the red “stop” button is pressed.

MicroPython code (you can copy and paste this into a *SPIKE Legacy* MicroPython project or open our provided file):

```
from SPIKE import PrimeHub, LightMatrix, Button, StatusLight, ForceSensor,
MotionSensor, Speaker, ColorSensor, App, DistanceSensor, Motor, MotorPair
from SPIKE.control import wait_for_seconds, wait_until, Timer
from math import *

hub = PrimeHub()
# setting variables
```



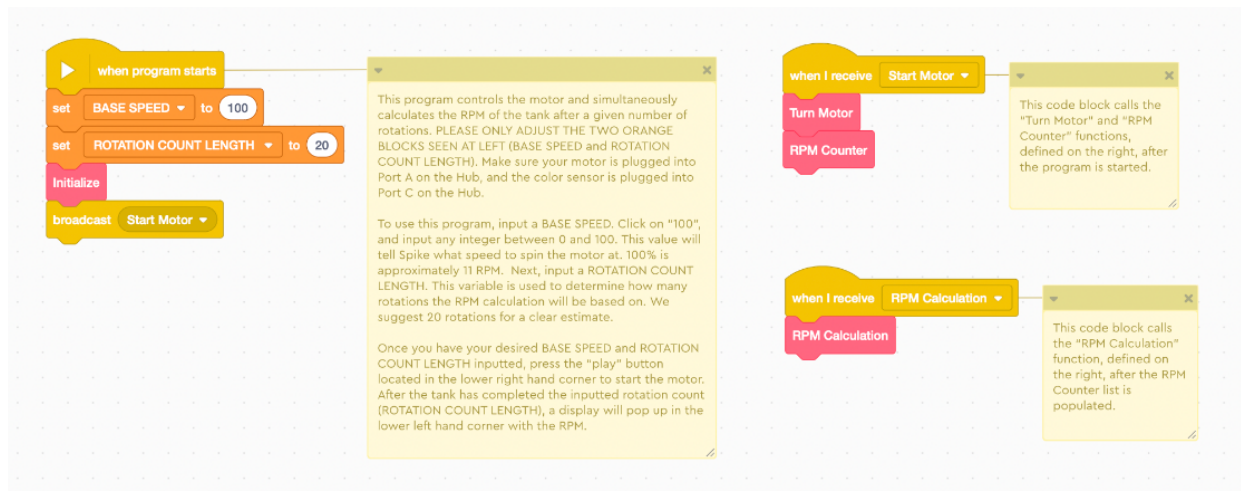
```
# make sure the motor is plugged into Port A on the hub!
wheel_motor = Motor('A')

# negative values turn the tank can counterclockwise
# positive values turn the tank clockwise
# Input any number between 0 and +/-100
BASE_SPEED = -100

# setting the default speed of the wheel motor to our variable 'default
speed'
wheel_motor.set_default_speed(BASE_SPEED)

wheel_motor.start() # starting the motor
```

Run RPM (Scratch)



Run RPM is the most advanced LEGO SPIKE program we have, and it is written in Scratch. The program can be executed in MicroPython as well, however the data collection in MicroPython is more limited compared to that of Scratch's capabilities.

This program performs the same function as the **Base Run** file, while simultaneously recording rotation periods, and ultimately outputting an RPM for the tank via a pop-up display in *SPIKE*. The color sensor attached to the top of the motor prompts *SPIKE* to record a timestamp every time the piece of blue tape affixed to the sidewall of the tank passes through the sensor's lens. After *SPIKE* has recorded the desired number of tape pass-throughs (AKA tank rotations), the program will display the RPM of the system in the lower left corner of the screen.

This program requires two inputs. The first is the `BASE SPEED` input. After connecting the Hub to your computer, highlight the number in the white oval-shaped space (where “100” is in the above image) and type in any integer greater than 0 and less than or equal to 100. This number represents a SPIKE percentage of speed, not RPM. We have found that, with our recommended wheel, 100% SPIKE speed is approximately 11 RPM. 10% is approximately 1.5 RPM. Again, note that this may change with your configuration, and we highly suggest each user conduct a series of tests using the SPIKE color sensor for accuracy.

The next input is the `ROTATION COUNT LENGTH`. This variable is used to determine how many rotations the RPM calculation will be based on. We suggest 20 rotations for a clear estimate, but you can increase or decrease this count by highlighting the number in the white oval-shaped space (where “20” is in the above image) and typing in any integer. The higher the number, the longer it will take for the RPM of the system to display.

Make sure you have connected the motor cable to port “A” and the color sensor cable connected to port “C” on the Hub, and you are ready to start the program. To start the program, press the yellow “play” button located in the lower right corner of the SPIKE screen. This will start the wheel of the motor and turn the tank counterclockwise. The program will run until the red “stop” button is pressed in the SPIKE App.