

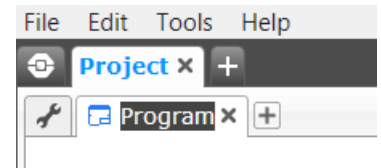
Driving and Drawing with the Lego Mindstorms EV3 Car



The first few exercises in this worksheet will walk you through how to control the Lego Mindstorms EV3 Car. After that you will use the car to hold a marker and draw shapes with it on a piece of paper.

Starting up the Lego Mindstorms EV3 software

Double click on the icon on the desktop that reads **LEGO MINDSTORMS EV3 Home Edition**. When the software opens, click on **File > New Project**. Double click the text “Program” in the top left of the screen and replace it with a name for your first program.



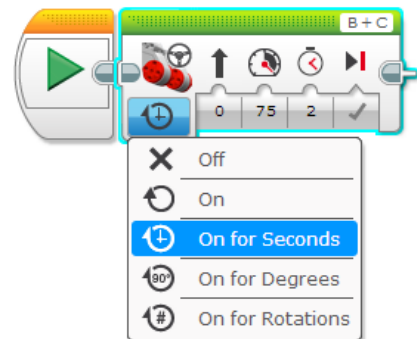
To save your project click **File > Save Project As**, give your project a name, and save it.

Exercise 1: Back and forth

1. Drag a **Move Steering** block from the programming palette and drop it to the right of the starting point in the work area. The default motors for a **Move Steering** block are B and C. You can see this in the top right of the block.



2. On this **Move Steering** block, click on the icon to the bottom left and choose “On for Seconds”.
3. Adjust the **duration** by clicking the number “1” below the clock icon. Once highlighted, type the number “2”. This will make the motors turn on for 2 seconds.



The default **power** setting for a **Move Steering** block is “75”. A positive number makes the motors move forward and a negative number makes them move backwards. You can see this underneath the gauge icon.

4. Place another **Move Steering** block to the right of the last **Move Steering** block.
5. Adjust the **duration** on this **Move Steering** block to 2 seconds as well.



6. Adjust the **power** by clicking the number “75” under the gauge icon. Once highlighted, type the number “-75”. This will make the car drive in reverse.



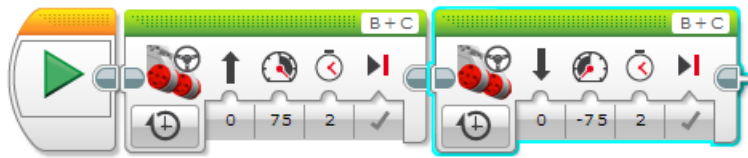
7. Make sure that the EV3 brick is turned on and connect the USB to both your computer and the EV3.
8. Locate the controller in the lower right of the work area and click the center (play) button. (**Download and run**)



You can also click the large green play button at the beginning of your sequence beam.

Action: Your car should drive forward for 2 seconds, then backwards for 2 seconds.

Final sequence beam

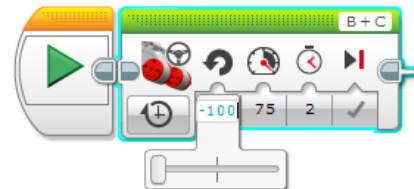


Before continuing to the next exercise, you should always click **File > Save Project**. Then, click **File > Add Program** to start a new program within that project.

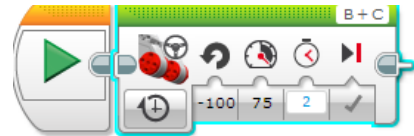
Exercise 2: Sway

1. Drag a **Move Steering** block from the programming palette and drop it to the right of the starting point in the work area.

2. Adjust the **steering** by clicking the number "0" underneath the arrow icon. Move the slider completely to the left so it reads "-100". This will make the car spin to the left.

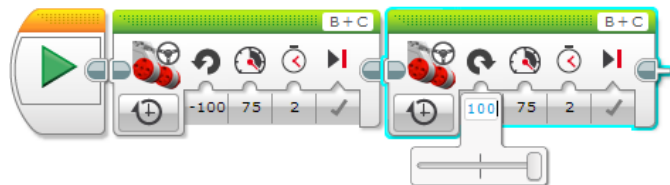


3. On this **Move Steering**, click on the icon to the bottom left and choose "On for Seconds". Set its **duration** 2 seconds.



4. Place another **Move Steering** block to the right of the last **Move Steering** block.

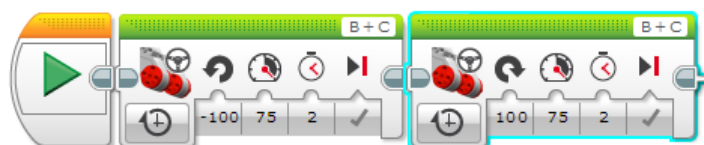
5. Adjust the **steering** slider all the way to the right so it reads "100". This will make the car spin to the right.



6. Adjust the **duration** of this **Move Steering** block to 2 seconds as well.
7. Make sure that the EV3 brick is turned on and connect the USB to both your computer and the EV3.
8. Locate the controller in the lower right of the work area and click the center (play) button. **(Download and run)**

Action: Your car should turn to the left for 2 seconds then turn right for 2 seconds.

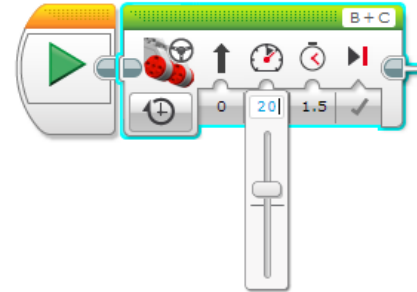
Final sequence beam



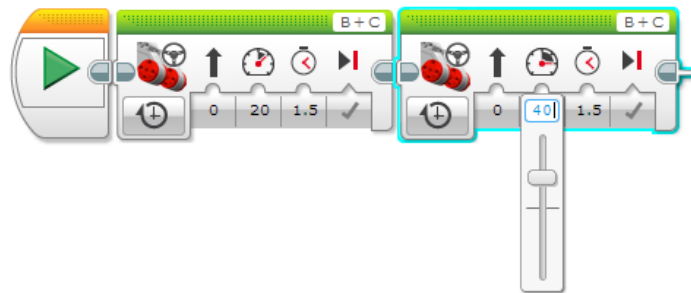
Before continuing to the next exercise, you should always click **File > Save Project**. Then, click **File > Add Program** to start a new program within that project.

Exercise 3: Faster and Faster and Faster

1. Drag a **Move Steering** block from the programming palette and drop it to the right of the starting point in the work area.
2. Adjust this move block so that the **power** slider is set to 20. Also adjust the **duration** to 1.5 seconds.



3. Place another **Move Steering** block to the right of the last **Move Steering** block and adjust the **power** to 40 and the **duration** to 1.5 seconds.



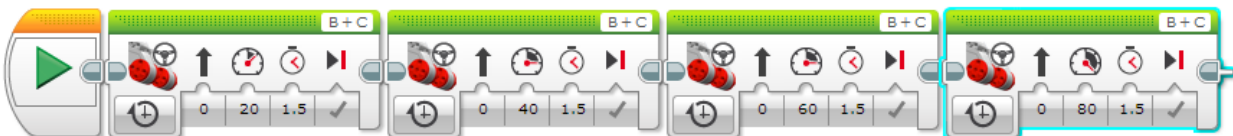
4. Place another **Move Steering** block to the right of the last one, and adjust the **power** to 60 and the duration to 1.5 seconds.

5. Place a final **Move Steering** block to the end of the sequence beam and adjust the **power** to 80 and the **duration** to 1.5 seconds.

6. Make sure the EV3 brick is turned on and connect the USB to both your computer and the EV3.
7. Locate the controller in the lower right of the work area and click the center button. (**Download and run**)

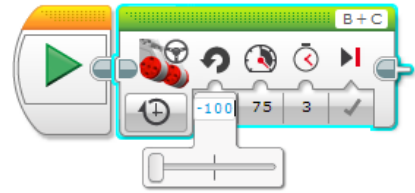
Action: Your car should drive slowly, then faster, then faster, then faster, 1.5 seconds each time.

Final sequence beam

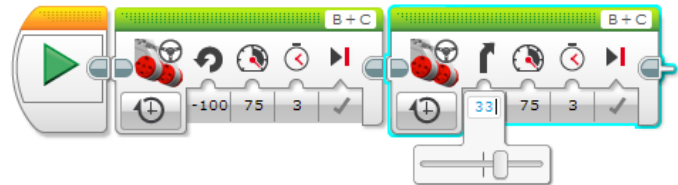


Exercise 4: Spin and arc

1. Drag a **Move Steering** block from the programming palette and drop it to the right of the starting point on the work area.
2. Adjust the **steering** of this **Move Steering** block completely to the right or left. Set its **duration** to 3 seconds. This will make the car spin, or turn in place.



3. Place another **Move Steering** block to the right of the last one and adjust its **steering** slider to be somewhere between the middle and either completely to the left or completely to the right (for instance, “33”). Also set the **duration** to 3 seconds. This will make the car arc, or turn while driving forward.

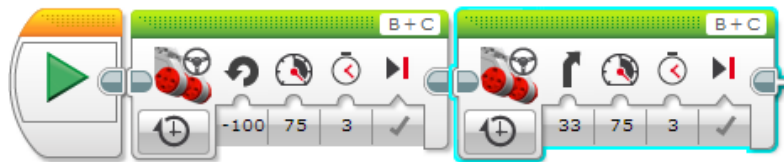


4. Make sure you turn on your EV3 and connect the USB to both your computer and the EV3.
5. At this point, make sure your program has a name. Double click the text “Program#” in the top tab of the screen and replace it with a name for this program, then save your project.
6. After saving, click the **download** button near the bottom right of the screen, then disconnect the USB cable. Now your program is downloaded to the EV3 brick and can be run without getting tangled in the USB wire.
7. On the EV3 brick, navigate to your project name and select it, then select this program from the list to run it.



Action: Your car should spin in place for 3 seconds, and then it should turn in an arc for 3 seconds.

Final sequence beam

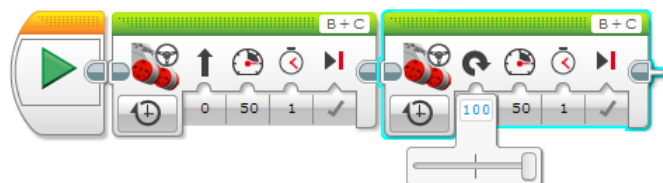


Exercise 5: Draw

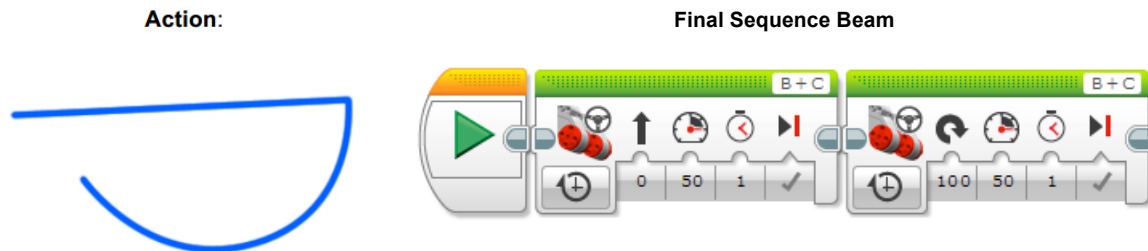
When running these exercises, place your car into the drawing arena on the paper, and insert a marker into the pen holder on the front of the robot. Make sure you only draw on the paper, not on the floor.

5.1 Half circle design

1. Start with a **Move Steering** block, set its **power** to 50 for a **duration** of 1 second.
2. Add another **Move Steering** panel block next to that one and adjust its **steering** to make it turn completely in one direction, making the car spin, and set the **power** to 50 and the **duration** to 1 second.

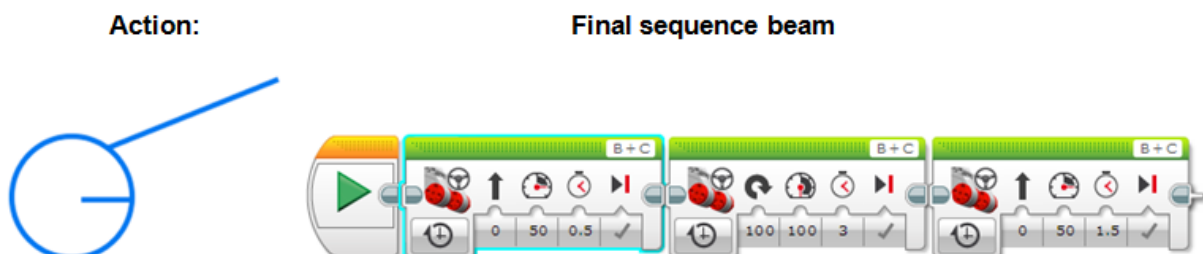


3. Make sure the EV3 brick is turned on and connect the USB to both your computer and the EV3.
4. Save your program; make sure it is named something that will help you identify it. Click the **download** button.
5. On the EV3 brick, navigate to your project name and select it, then select this program from the list to run it.



5.2 Circle and lines design

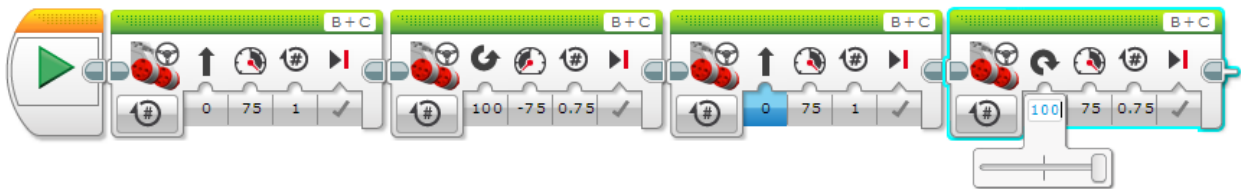
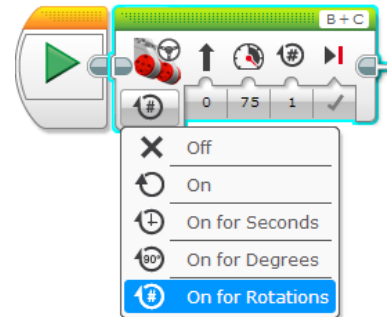
1. Drag and drop a **Move Steering** block, set its **power** to 50 and make it move forward for a **duration** of 0.5 seconds
2. Place another **Move Steering** block, set its **power** to 100, and adjust its **steering** to make it turn completely in one direction for duration of 3 seconds.
3. Place a final **Move Steering** block, set its **power** to 50 and make it move forward for a **duration** of 1.5 seconds.
4. Save your program, download it to the EV3 brick, unplug the USB cable, and run it.



Exercise 6: “Z” shape using rotations

Up until this point we’ve only been using time to control the movements of each motor. We will now use **rotations** (the number of revolutions the motor will turn) and **degrees** (360 degrees = 1 rotation).

1. Start with a **Move Steering** block. The default state of a **Move Steering** block is “On for Rotations” at a **power** of 75 for a **duration** of 1 rotation. Those are the settings we need for this step, so we do not have to adjust it.
2. Place another **Move Steering** block and make it turn all the way to the right at a **power** of -75 for duration of 0.75 rotations. This will make the car drive backwards while turning right.
3. Add another **Move Steering** block and make it go forward at a power of 75 for duration of 1 rotation.
4. Add another **Move Steering** block and make it turn all the way to the right at a **power** of 75 for duration to 0.75 rotations. This will make the car drive forwards while turning right.

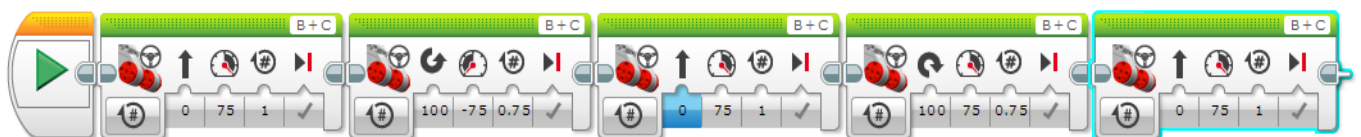


5. Place a final **Move Steering** block moving forward at a **power** of 75 for **duration** of 1 rotation

Action:



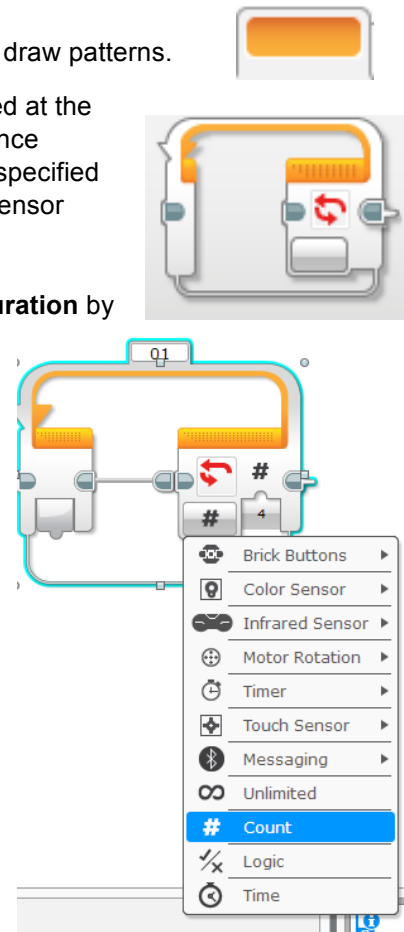
Final Sequence Beam



Exercise 7: Loops

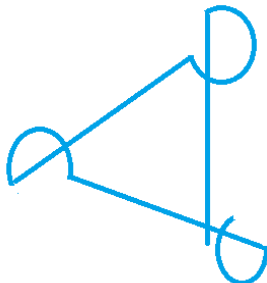
Now we will repeat a sequence of **Move Steering** blocks to make the car draw patterns.

1. Click on **Flow Control** (orange/2nd tab) on the color palette located at the bottom of the screen. Drag and place a **Loop** block on the sequence beam. Any blocks placed inside of a **Loop** block will repeat for a specified number of times, forever, for a specific length of time, based on sensor input, or based on a true/false condition.
2. After placing the **Loop** block on the sequence beam, adjust its **duration** by clicking the infinity icon. From the pop-up list, change it from "Unlimited" to "Count", then change the **count** by clicking on the number "1". Once highlighted, type the number "4". This will set the loop to repeat 4 times.
3. Now go back to **Action** (green/1st tab) and add a **Move Steering** block within the **Loop** block, and set its **power** to 50 and **duration** to 1 second. The **Loop** block should expand when another block is placed inside of it.



4. Add another **Move Steering** block within the **Loop**, to the right of the first **Move Steering** block, and make it turn complete in one direction at a **power** of 50 for a **duration** of 1 second.
5. Save your program, download it to the EV3 brick, unplug the USB cable, and run it.

Action



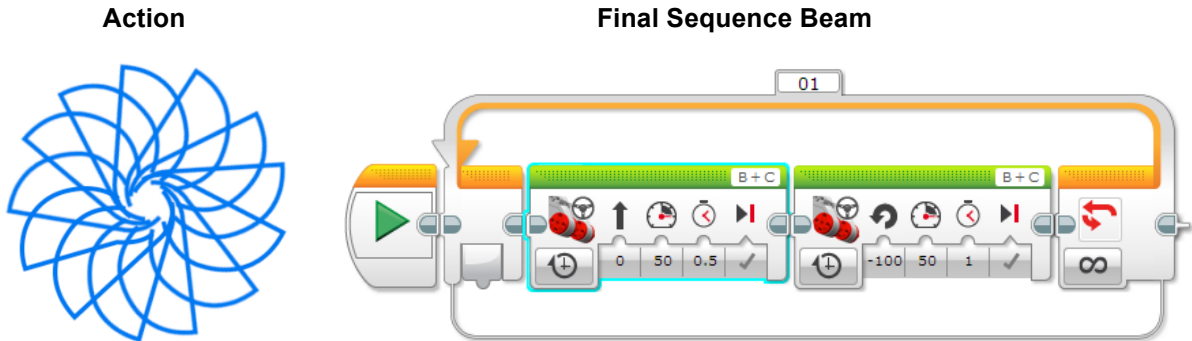
Final Sequence Beam



The “endless” design

1. Start with a **Loop** and set its duration to **Unlimited**.
2. Place a **Move** block within the **Loop**, and set its **power** to 50 and **duration** to 0.5 second.
3. Add a second **Move** block to turn completely in one **direction** for 1 second at a **power** of 50.

Note: Since the loop is infinite, the process will continue indefinitely. To stop the loop while it is running, pick up the car and press the back button on the brick, located on the top-left of the brick directly below the screen, to stop the program from running.



Create your own design!

Now you can change the blocks inside of the **Loop**, or add as many new **Move** blocks as you want. Experiment with different combinations of twists and turns to make your own design!

For more information on Artbotics see artbotics.org

Please send any questions or comments to Adam Norton at anorton@cs.uml.edu
