

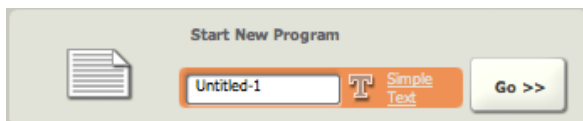


Driving and Drawing with the Lego Mindstorms NXT Car

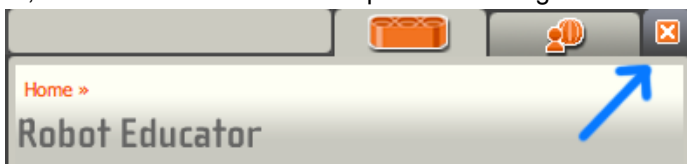
The first few exercises in this worksheet will walk you through how to control the Lego Mindstorms NXT Car. After that you will use the car to hold a marker and draw shapes with it on a piece of paper.

Starting up the Lego Mindstorms NXT software

Double-click the icon on the desktop that reads **NXT 2.1 Programming**. When the software opens, under the heading “Start New Program”, replace the text *Untitled-1* with a name for your first program, and then hit the **Go >>** button.



To save your program click **File > Save As**. Give your program a name and save it. When you have finished an exercise, click **File > New** before beginning the next exercise. To allow more space for your sequence beam, close the “Robot Educator” panel on the right-side of the screen by clicking the corresponding **X** icon.

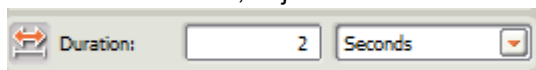


Exercise 1: Back and Forth

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



2. On this **Move** block, adjust the **duration** to 2 seconds on the configuration panel.



3. Place another **Move** block to the right of the last **Move** block.



4. Adjust its **direction** in the configuration panel so the bubble filled in is the one pointing downwards. This will make the car drive in reverse.



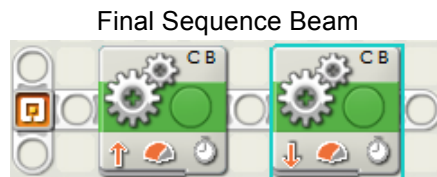
5. Adjust the **duration** of this **Move** block to 2 seconds as well.



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



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



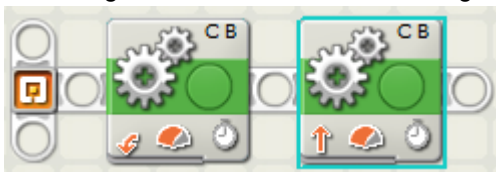
Before continuing to the next exercise you should click **File > New**. You can save your program if you like.

Exercise 2: Sway

1. Drag a **Move** block and drop it to the right of the starting point in the work area.
2. Using the configuration panel on the bottom of the screen, adjust the **steering** slider so it is completely to the left. This will use the C (left) motor while leaving the B (right) motor unused. It should look like this:



3. Using the configuration panel adjust the **duration** of the **Move** block to 2 seconds.
4. Now drag another **Move** block to the right of the last **Move** block.



5. Adjust the **steering** slider completely to the right to fully use the B (right) motor.

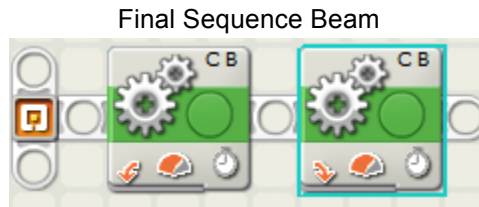


6. Adjust the **duration** to 2 seconds like the last **Move** block.

- Make sure the NXT brick is turned on and connect the USB to both your computer and the NXT.
- 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.



Exercise 3: Faster and Faster and Faster

- Drag and drop a **Move** block from the programming palette.
- In the configuration panel, adjust this **Move** block so the **power** slider is set to 20. Also adjust the **duration** to 1.5 seconds.

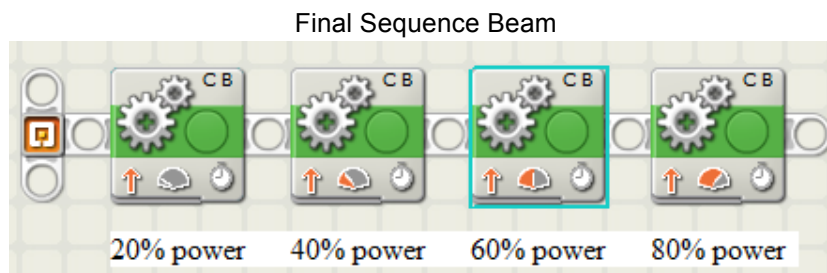


- Drag and drop another block to the right of the last **Move** block set in the work area and adjust its **power** slider 40. Also adjust the **duration** to 1.5 seconds.



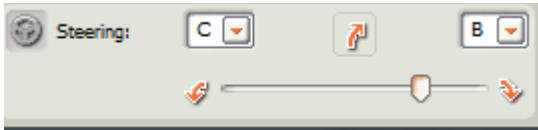
- Place another **Move** block to the right of the last one, and adjust its **power** setting to 60, and its **duration** to 1.5 seconds.
- Place a final **Move** block to the end of your sequence beam and adjust its **power** setting to 80. Also set the **duration** to 1.5 seconds.
- Make sure the NXT brick is turned on and connect the USB to both your computer and the NXT.
- 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 for 1.5 seconds, then faster for 1.5 seconds, then faster, then faster.



Exercise 4: Spin and Arc

1. Start by placing a **Move** block to the right of the starting point on the work area.
2. In the configuration panel, adjust the **steering** to the right or left completely in this **Move** block. Set its **duration** to 3 seconds. This will make the car spin, or turn in place.
3. Place another **Move** block to the right of the last and adjust its **steering** slider to be between the middle and either motor B or C, It should look something like this:



4. Also set the **duration** for this **Move** block for 3 seconds. This will make the car arc, or turn while driving forward.
5. Make sure you turn on your NXT and connect the USB to both your computer and the NXT.
6. At this point, you should save your program, and give it a filename. After saving, click the **download** button (the button to the bottom left), then disconnect the USB cable. Now your program is downloaded to the NXT brick and can be run without getting tangled in the wire.
7. After downloading the program press the grey button on the NXT to head back to the program menu. You can then find your program by its filename using the left and right arrows on the NXT. Once you have found your program, press the orange button twice to start 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

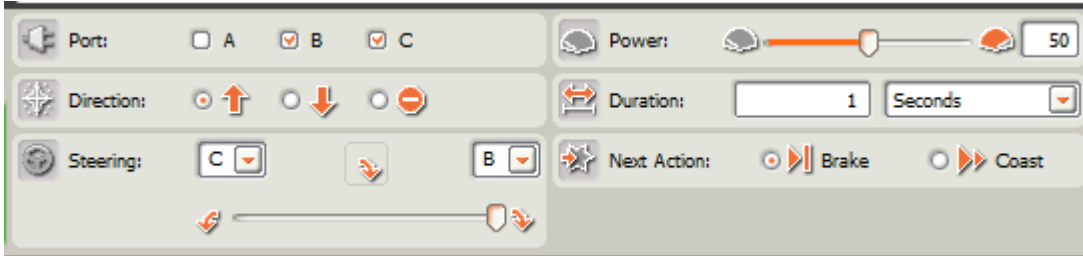


Exercise 5: Draw

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

5.1 Half Circle Instructions:

1. Start with a **Move** block, set its **power** to 50, and make it move forward for a **duration** of 1 second.
2. Add another **Move** block next to that one and have it turn completely in one direction using the configuration panel. This also should be at a **power** of 50 and a **duration** of 1 second.



3. Make sure the NXT brick is turned on and connect the USB to both your computer and the NXT.
4. Save your program; make sure it is named something that will help you identify it. Click the **download** button.
5. After downloading the program press the grey button on the NXT to go back within the menu. Navigate and find your program by its filename using the left and right arrows on the NXT. Once you have found your program, press the orange button to select it, then again to start it.



Action:



Final Sequence Beam



5.2 Circle and lines design

1. Drag and drop a **Move** block set its **power** to 50 and **duration** to .5 seconds moving forward.
2. Place another **Move** block and set it to turn completely in one direction for 3 seconds at a **power** of 100.
3. Place a final **Move** block to a **power** of 50 for a **duration** of 1.5 seconds moving forward.
4. Save your program, download it to the NXT brick, unplug the USB cable, and run it on the NXT.

Action:



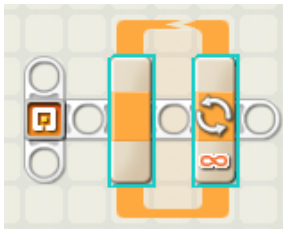
Final Sequence Beam



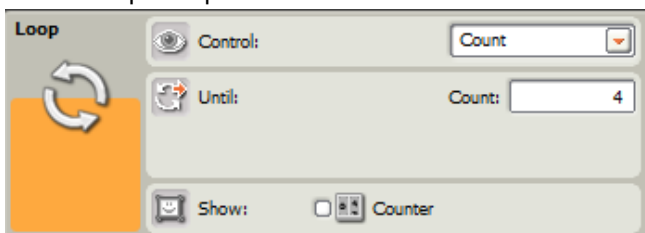
Exercise 6: Loops

Now we will repeat the sequences of **Move** blocks to make the car draw patterns.

1. 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. When it is placed on the sequence beam you can click either of the rectangles of the block to select it. In the configuration panel, adjust its **control** from “forever” to “count”, and change the **count** to 4. This will set the loop to repeat 4 times.

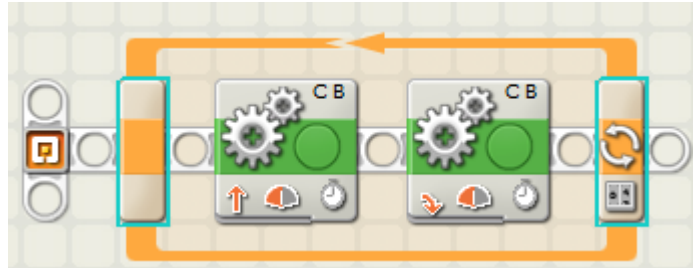


- Now add a **Move** block within the **Loop** block, and set its **power** to 50 and **duration** to 1 second. The **Loop** block should expand when dragging a **Move** block inside of it.
- Add another **Move** block within the **Loop**, to the right of the first **Move** block, and make it turn to one direction completely at a **power** of 50 for 1 second.
- Save your program, download it to the NXT brick, unplug the USB cable, and run it on the NXT.

Action:



Final Sequence Beam



The “endless” design

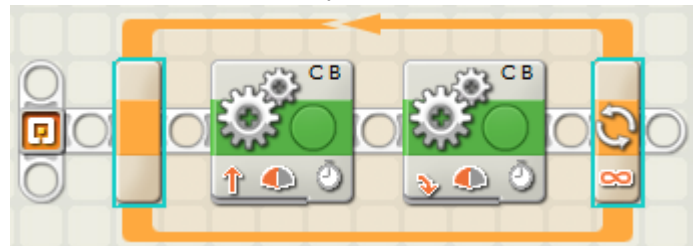
- Start with a **Loop** and set its duration to **Forever**.
- Place a **Move** block within the **Loop**, and set its **power** to 50 and **duration** to 1 second.
- Add a second **Move** block to turn completely in one **direction** for 1 second at a **power** of 50.

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 dark grey rectangular button; this will stop the program from running.

Action:



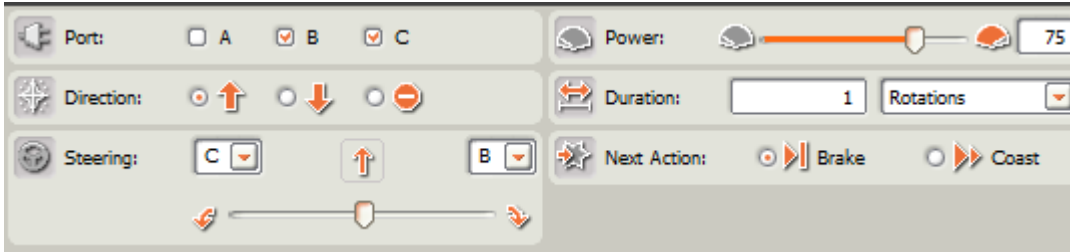
Final Sequence Beam



“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).

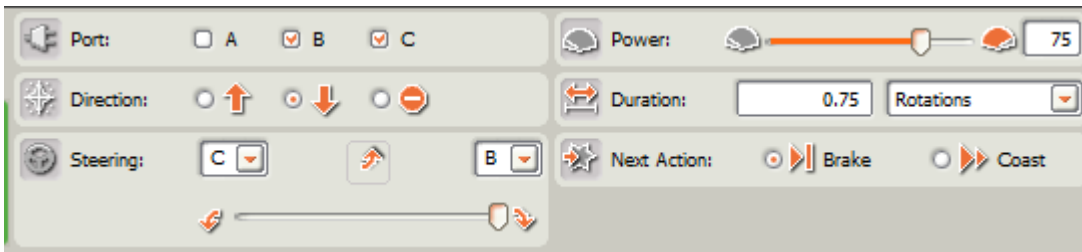
1. Place a **Move** block into the work area and adjust the **duration** of this **Move** block to 1 rotation.



2. Place another **Move** block and set its **direction** to “stop”; this will make the car perform a hard stop after the previous **Move** block.



3. Place another **Move** block and make it turn all the way to the right using the steering panel. Also set the direction to **backwards** and its **duration** to 0.75 rotations.



4. Add another **Move** block and make it go forward for 1 rotation.
5. Add another **Move** block and make it stop.
6. Add another **Move** block and make it turn all the way to the right using the steering panel. This time set the direction to **forwards** and its **duration** to 0.75 rotations.

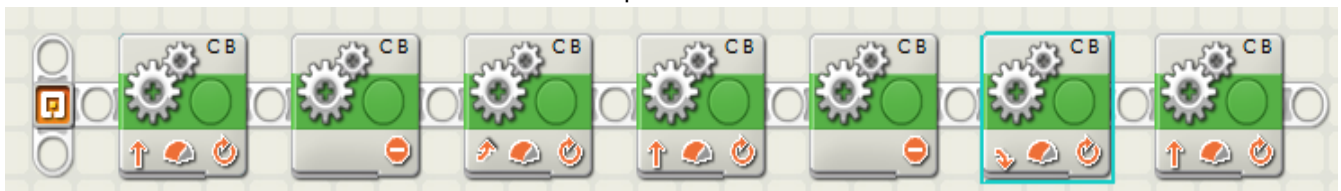


7. Make a last **Move** block moving forward for 1 rotation.

Action:



Final Sequence Beam

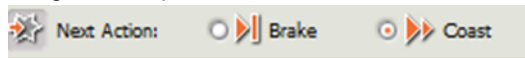


Why are the edges of the “Z” shape rounded and not sharp?

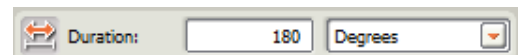
CHALLENGE: Do this same exercise using only degrees.

Wavy Pattern using degrees

In this exercise we will set every **Move** block to “coast,” which makes the car slow to a halt instead of a hard stop. In the configuration panel of each **Move** block set the **Next Action** to **Coast**. This will give the resulting design a sharper look.



1. Start the exercise by placing a **Loop** block on the sequence beam.
2. Place a **Move** block in the **Loop** and make it turn very sharply to the left for a duration of 180 degrees at a **power** of 50.
3. Add another **Move** block and make it a wide right turn. The **duration** for this move block should be 180 **degrees** at a **power** of 50.
4. Add another **Move** block and make it a wide left turn, but set the length of it to 180 **degrees** at a **power** of 50.

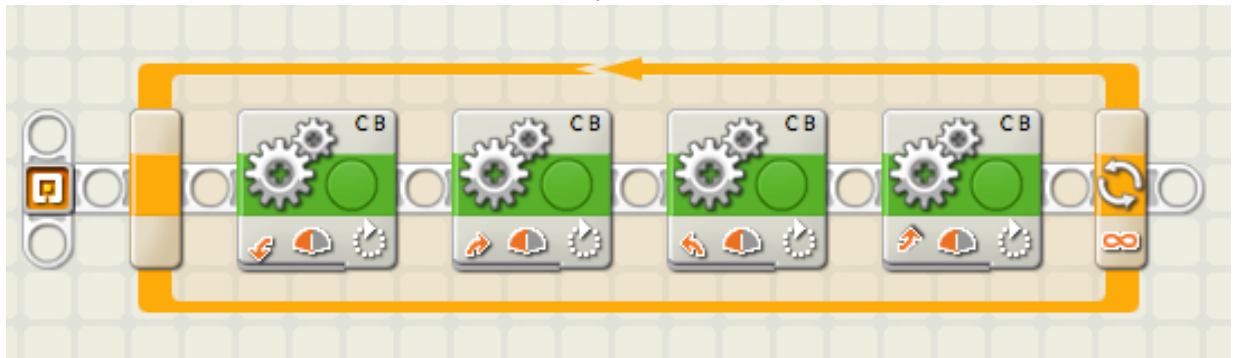


5. Add a final **Move** block with a sharp right turn, but set its direction to backwards. Set it for a **duration** of 70 **degrees** at a **power** of 50.
6. Make sure all of the **Move** blocks have their **Next Action** to **Coast**.

Action:



Final Sequence Beam



Now you can change the first 4 blocks or add as many new **Move** blocks as you want and the pattern will be repeated. 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