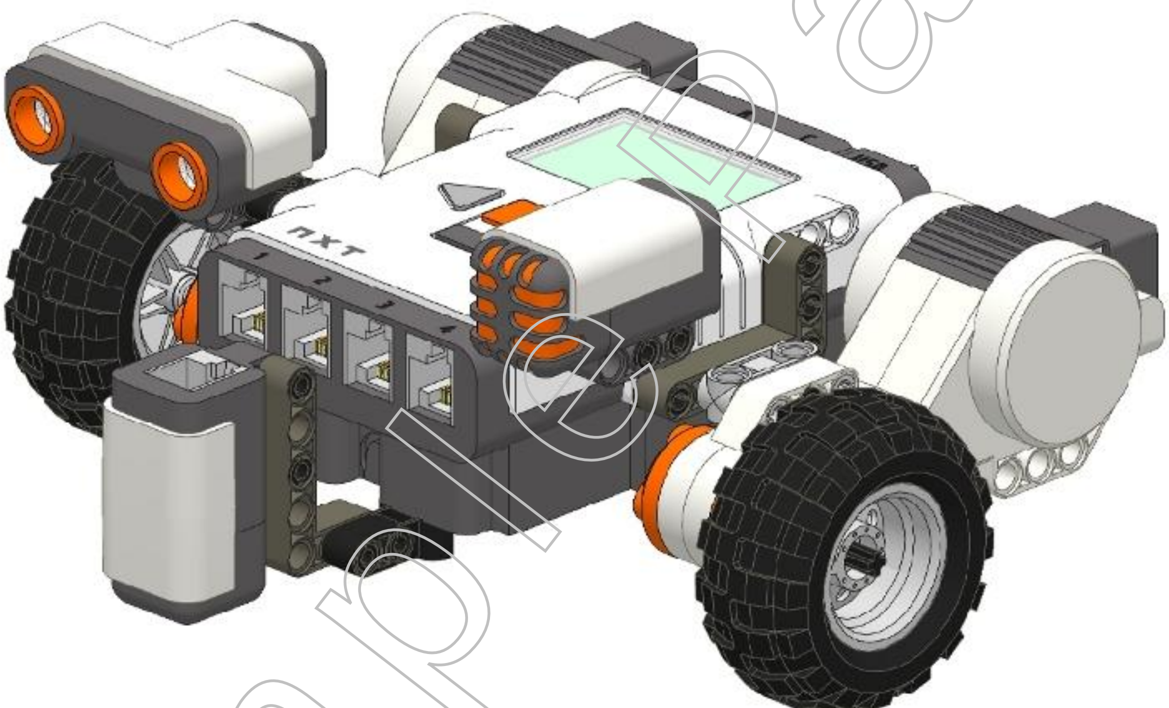
Classroom Activities for the Busy Teacher: NXT



2nd Edition

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What are the main components of a robot?

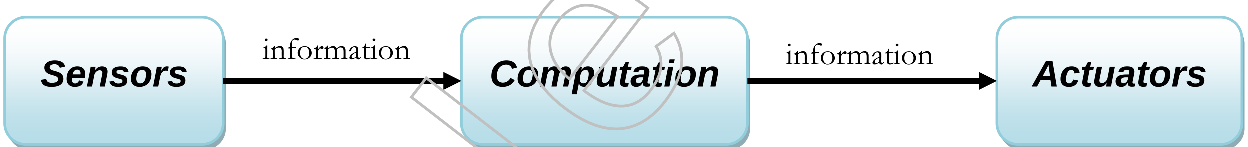
Robots can be broken down into three distinct components; sensors, computation and actuators.

Sensors are used to 'feel' the surrounding environment. The robot uses these sensors to take in information about where it is and what it is doing. Different sensors can be used to sense different conditions including light and dark, temperature, bump sensors, ultrasonic, infrared… the list goes on and on. Think about what sensors a human has, and how a robot replicates them. Sensors are classed as inputs, that is, they take information and input it into the robot's brain.

The computation component consists of an onboard computer that the robot uses to process the information coming from its sensors. This can be as small as a few computer chips right through to a full personal computer. The level of complexity of the required tasks will dictate the amount of computational ability needed by the robot.

The last distinct component of a robot is its actuators. Actuators are a fancy way of saying 'bits that move'. These may be motors in the wheels, or engines that make the arms go back and forth. It could also be hydraulic pistons or pneumatic cylinders. Actuators are a form of outputs, along with lights and speakers. The robot brain tells these outputs to do different tasks.

Generally speaking, the sensors provide the information to the computers, which in turn tell the motors what to do.



Path of information flow in a robot

Where did the term 'Robot' come from?

While the idea of artificial beings have been around for many years, the term 'robot' was first coined by Czech writer Karel Čapek in his play R.U.R. (Rossum's Universal Robots) in 1920. The word is derived from the Czech 'robota', which translates as 'forced work', 'slave' or 'servitude'. Čapek credits his brother Josef as the true inventor of the word.

Robots have enjoyed the majority of their exposure through movies and science fiction writings, such Star Wars and the Asimov series of 'Robot' books.

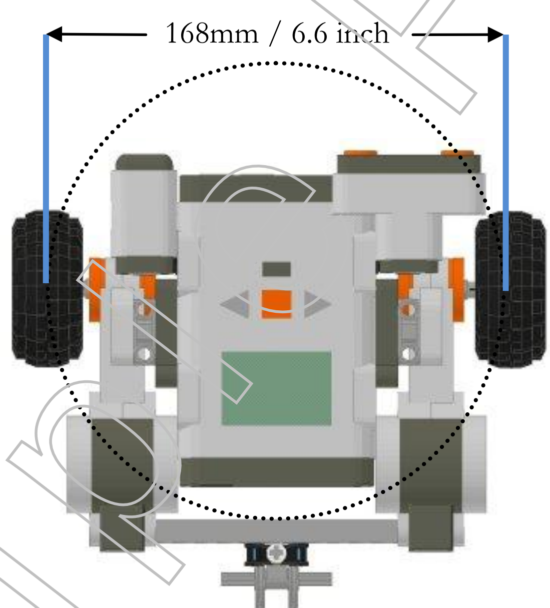
Robots in their presently accepted state were first developed in the 1950's, with George Devol's Unimate robot, capable of lifting hot pieces of metal from a die casting machine and stacking them. The first Unimate was sold to a General Motors assembly plant in New Jersey.

For the challenge where students are asked to make their robots turn 180 degrees, they will typically type in 180 degrees and download it. When they come to run the program though, they will find that their robot will not actually turn 180 degrees but in fact, if they are using the DomaBot design, it will only turn 45 degrees.

This behaviour occurs because the move block is designed to control the *wheel* of the robot, not the whole robot. If we observe the wheel, we will find that it does in fact turn exactly 180 degrees, just as it was told to do. The angle turned by the robot however is dependent on a few different conditions such as the size of the wheels and the distance between the wheels. To test, place a strip of tape on the floor. Start the robot with both wheels on the tape. A perfect 180 degree turn will result in the wheels ending up back on the tape.

Calculating the required duration to make the robot turn 180 degrees can be done either mathematically or experimentally depending on the ability of the students.

Mathematically: The robot needs to trace out half a circle that is defined by the distance between the 2 wheels. On the DomaBot, this is 168mm (6.6 inch).

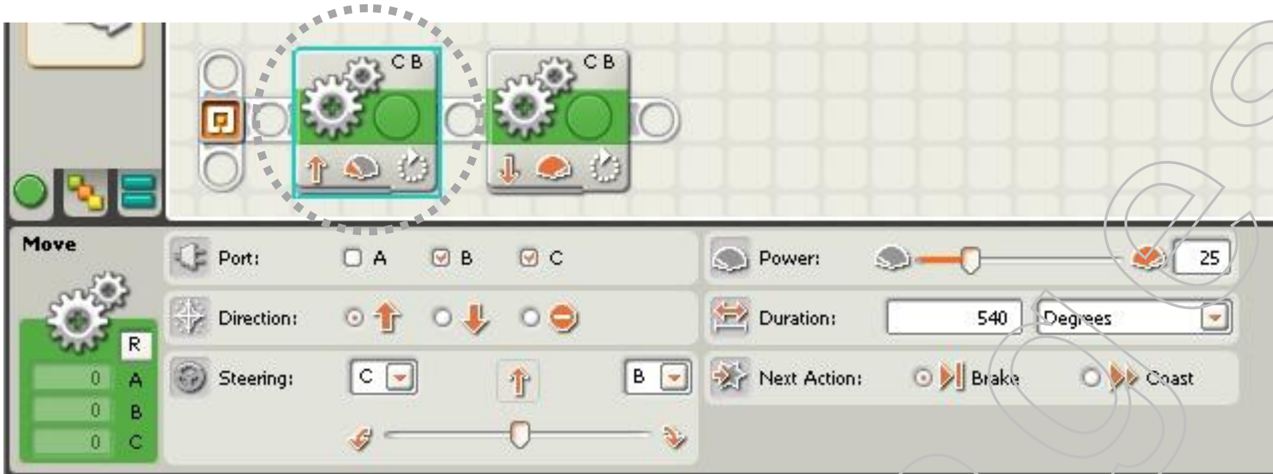


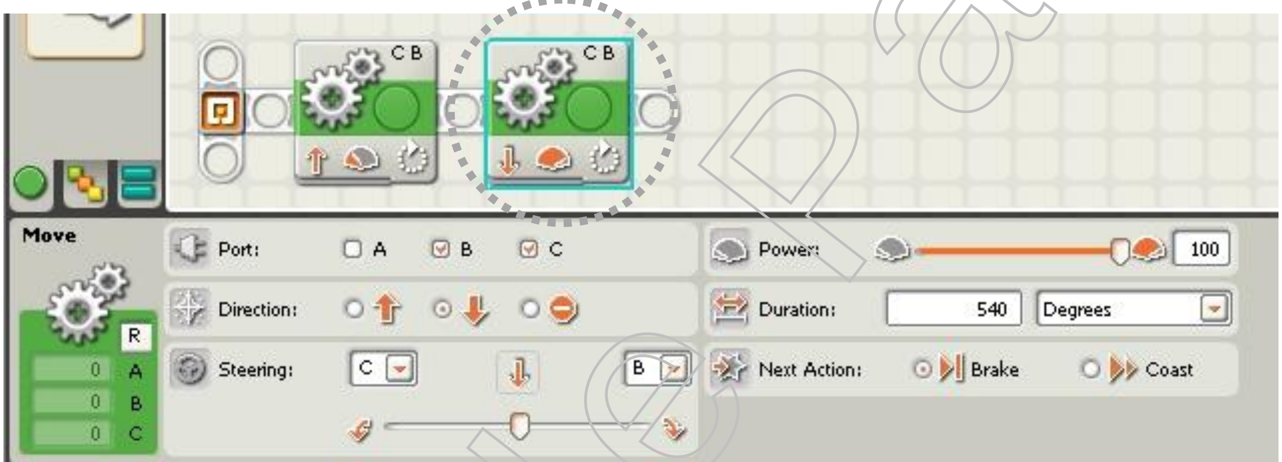
This distance can be calculated as half the circumference of a 168mm (6.6 inch) diameter circle.

$$\text{distance} = \frac{\pi \times 168\text{mm}}{2} = \frac{\pi \times 6.6\ \text{inch}}{2}$$

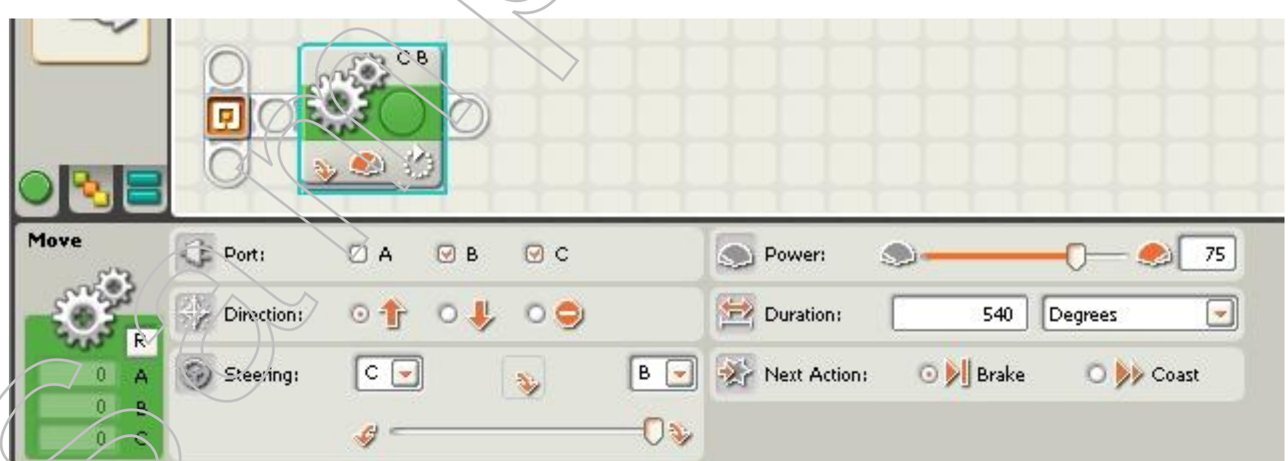
$$\text{distance} = \quad 264\text{mm} \quad = 10.4\ \text{inch}$$

Drive Forward 540° slow, then 540° back as fast as possible





Turn the robot around 180° (The WHEEL needs 540 degrees for the ROBOT to turn 180 degrees)



Theory

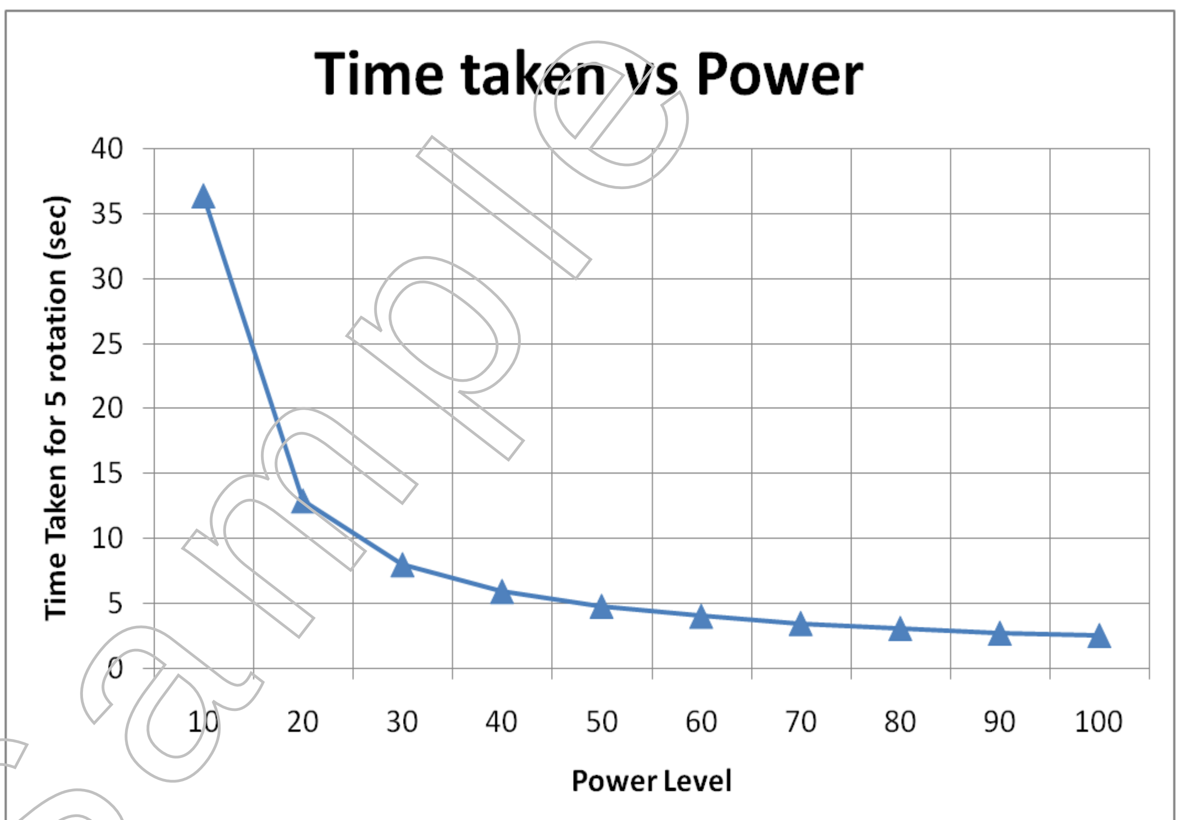
Students will need to understand the nature of speed and velocity. The speed of the robot is given as the distance travel within a specified time. This may take on a number of forms such as kilometres per hour, meters per second, feet per second etc.

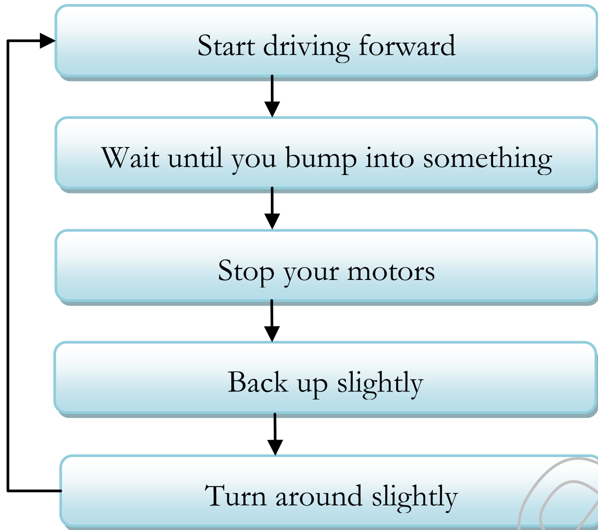
The speed of the robot will be dependent on the power level as well as the weight of the robot. A heavier robot will take longer to complete the 5 rotations than a lighter robot. If we are using the DomaBot, we should find that a duration of 5 rotations will allow the robot to move a reasonable distance to measure.

Encourage the students to take multiple runs and take the average of all their data to reduce the impact of any experimental error.

When plotting this data, the students will find that there is not a straight line relationship between the power level and the time taken to complete 5 rotation of the wheel. The student will have to sketch out a curve to best fit their data. The more data points we can gather, the more accurate we will be to fit the curve.

This data was taken for the standard DomaBot running at 8.2V battery power. Lower battery levels will change the speed of the robot so ensure that all data is gathered in one session, using the same robot each time.

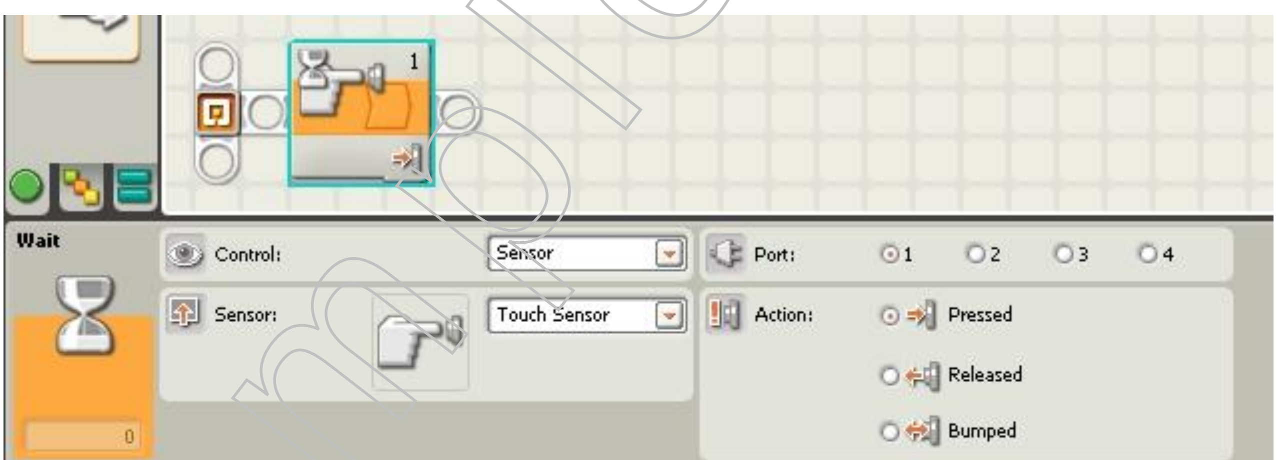




Flowchart outlining possible program flow to solve the Help! I'm stuck challenge

NXT-G Specific

To do this project, we will need to introduce a new set of commands, the **Wait** blocks. These blocks allow us to use the various sensors to control the movement of the motors. The first block we will implement is the **Wait for Touch** block.



Wait for Touch Block: Wait until the touch sensor has been pressed before moving to the next block

It is best to think of this block as a description. "Wait at this block until the button on Port 1 is pushed. Once the button has been pushed, continue on to the next block."

Chapter 15:

Robot Wave

Overview: Create your own robotic supporters for the local sporting match

Project: Students will synchronise multiple robot to perform a Robot wave.

Equipment required:

- 1 NXT robot kit per group
- 1 computer per group

Teachers Notes

Students will line their robots up, and on starting, each of the robots will move forward and then move backwards. Individually this program is quite unexciting, but when teamed up with multiple robots, the effect can be very appealing.

The emphasis for this challenge is the coordination of several robots. The program required to do the basic motion is quite straight forward, but the success of the robots is dependent on all robots running at the correct time.

A Robot wave is created in a sporting stadium when a group of people stand up and sit down again. The people immediately to their side do the same and the 'wave' progresses around the stadium.

The basic program to implement a Robot wave is as follows.

- Wait for a set period of time
- Drive forward, 75% power for 1 second
- Drive backward, 75% power for 1 second

The key component is how long each robot is required to wait before heading off. The first implementation should have Robot 1 wait for 0.5 seconds, before driving forward. Robot 2 will wait for 1 second, Robot 3 will wait for 1.5 seconds and so on down the line.

Student Worksheet – DomaBot Basics

Group Name________________________ Group Members___________________________

Overview: NASA is in the market for a new planetary rover to explore the recently discover planet NXTopia. You are required to design and construct a robot that is capable of following a set of commands to explore the planet's surface. Before the robot is deployed, it must be extensively tested to ensure it will perform as expected. You can't fly a technician to NXTopia to reboot the robot!

Before we send our robot into space, we must first test it thoroughly here on earth. Run the following experiments and observe how your robot behaves. Do not move to the next experiment until your teacher has seen your current experiment.

Drive Forward for 90° of the wheels
How far did your robot travel? ___________________

Drive Forward for 0.25 rotations of the wheels
How far did your robot travel? ___________________

What is the circumference of the robots wheel?
(hint: you will need to measure the diameter of the wheel) ___________________

How far will the robot drive if the wheels turn 3 rotations? ___________________

Program your robot to move 3 rotations and measure how far it goes.
Does it go as far as you expected?

Drive Forward 540° slow, then 540° back as fast as possible

Turn the robot around 180°
What happened? How far did your robot turn if you type in 180°? ___________________

How much Duration does the wheel need for the robot to turn 180°?
(hint: keep experimenting until it is perfect!) ___________________

Right Wheel Assembly - Base Design