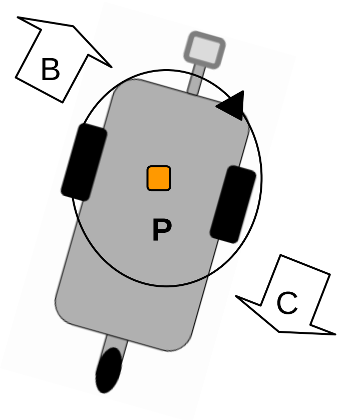
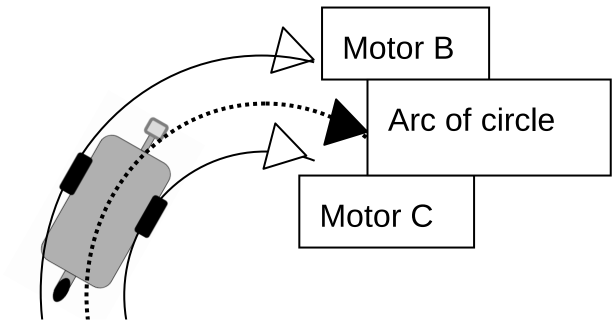
Arc Turns & Steering

In this activity we will investigate the difference between a spin turn and an arc turn and how to control an arc turn



PIVOT turn – Very tight circle made by one wheel traveling forward and the other backwards. The robot pivots from a position mid way between the two wheels. The angle of the spin turn can be controlled exactly by calculating the length of the arc of the forward wheel and programming this wheel in degrees . Because we only have to program one motor forward this is the simplest type of turn to accurately control



Arc turn – A gentle turn with a range of arc/circle sizes and therefore many different circle radii are possible. Both the inside and outside wheels of the robot execute an arc and both wheels of the robot move forward. The programmer controls the amount of power (and therefore speed) of each motor initially by using the steering configuration of NXTg programming. The closer the motors power settings are to each-other, the bigger the circle and gentler the arc.

We have already seen how to control a spin turn within the NXTg program and by using a mathematical formula to calculate the degrees required for a specific turn.

Eventually we will use the same of formula to calculate the length of the arc of the circle made by the arc that exists in the middle between the two wheels in the arc turn, but initially we'll examine exactly what happens when we simply use steering in the NXTg programming

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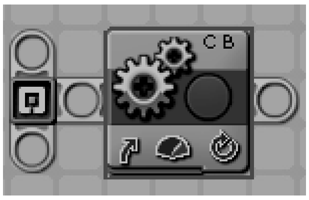
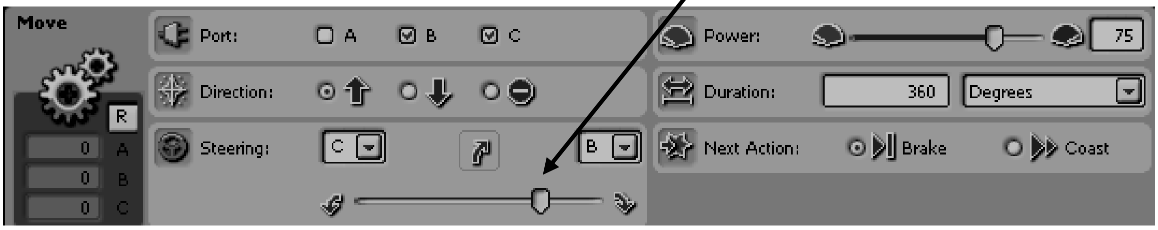
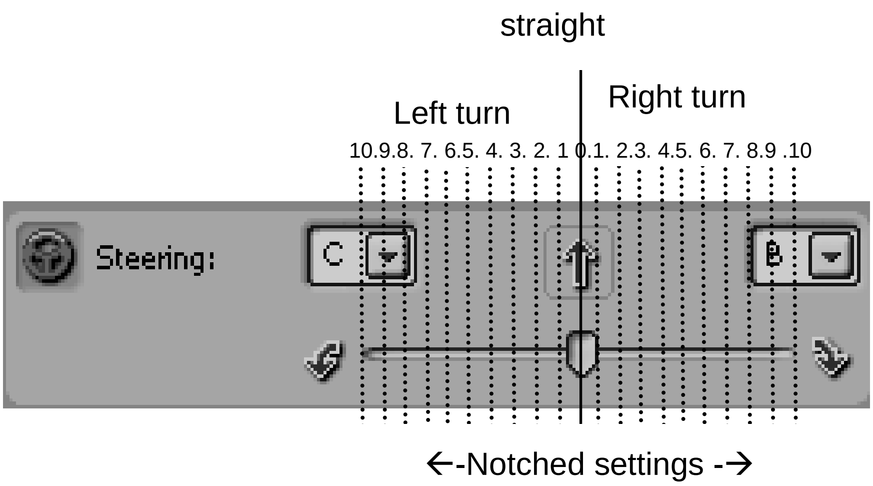
For the uninitiated, steering control of the NXT robot is akin to magic, most people simply use a simple “visual check and see” system initially without actually knowing what exactly each setting of the steering will deliver.



What size circle/arc will this setting deliver?
We’ll find out…..



The steering slider in the NXT configuration panel for the MOVE icon has 10 distinct “notched” stop-points Left and Right (excluding straight ahead) , each stop-point delivers a certain sized circle/arc (here we will just deal with the generic basic robot, other “builds” of robots with different distances between the drive wheels)



We already know that in positions 10 left and 10 right the robots wheels will actually switch to one motor forward and one motor backwards (a pivot turn) as this is the most acute circle type in the range.

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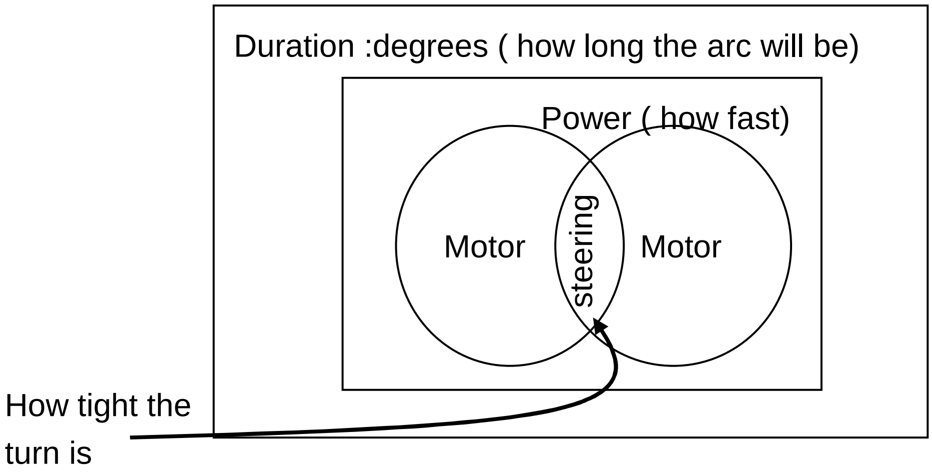
In addition if the programmer alters the power setting as well as STEERING, power will automatically delivered to the motors (and therefore wheels) in a set ratio. To explain this visually…..>



In this investigation we want to discover the <u>number of degrees</u> we need to program the axle to turn to result in a <u>complete circle</u> (made by the imaginary arc created in the middle of the wheels) for each of the 18 remaining steering settings. Record the degrees and the radius of the circle made for each of the steering settings. Measure the radius from the mid point between the two wheel tracks to the middle of the circle. Record these measurements on the next page

Then we will measure the radius of the circle that the robot makes to discover how big the circle is.

Additional Materials

Prepare a large stamp pad with a paint and water moistened sponge on an ice cream container lid and run your robot's wheels over the pad before you run the program each time. You will also need some large pieces of paper to run the robot on. You will also need a tape measure.

Do a test run to ensure the robot makes a complete circle for each of the 9 settings left and right. (18 in all) Then load the wheels with paint and off you go. Record your results on the next page

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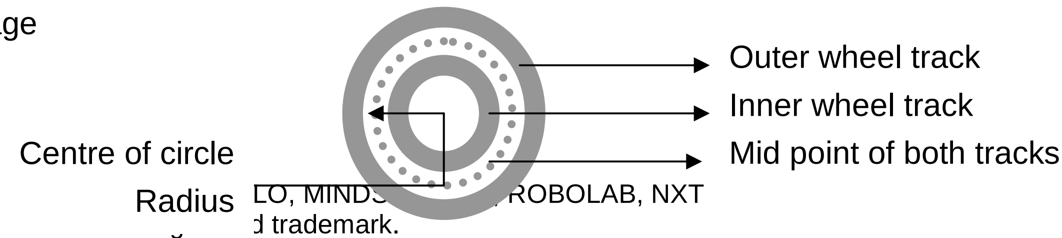

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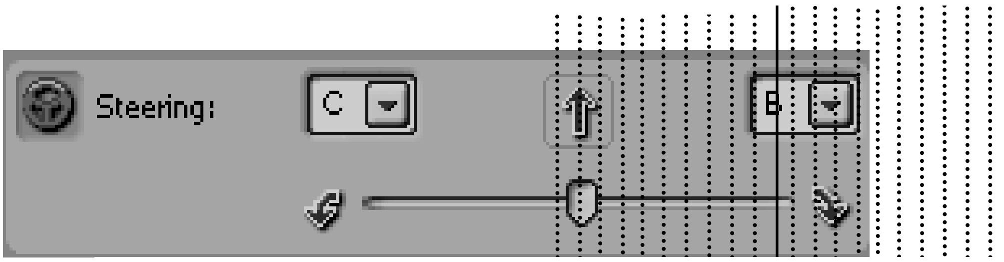
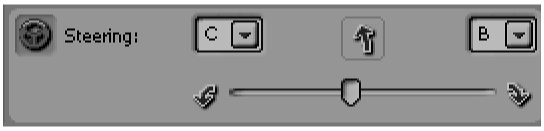
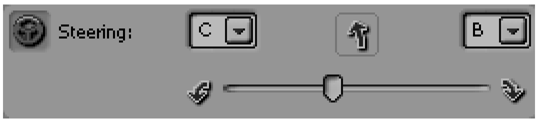
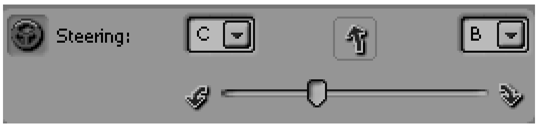
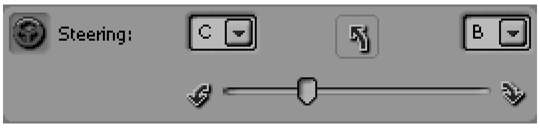
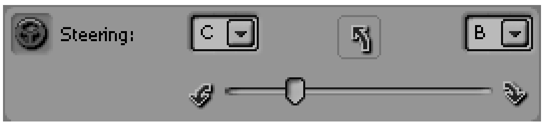
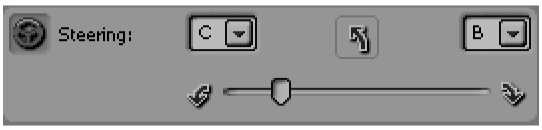
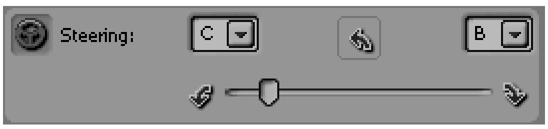
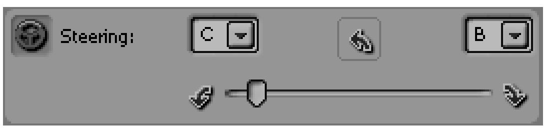
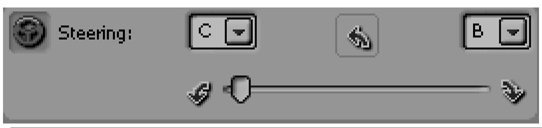
Left turn

Right turn



Degrees required for full circle & circle radius

	Motor C- Left Degrees	Motor C- Left Radius	**Full Circle settings** Motor B - Right Degrees	Motor B - Right Radius
				
				
				
				
				
				
				
				
				
	Spin turn		Spin turn	

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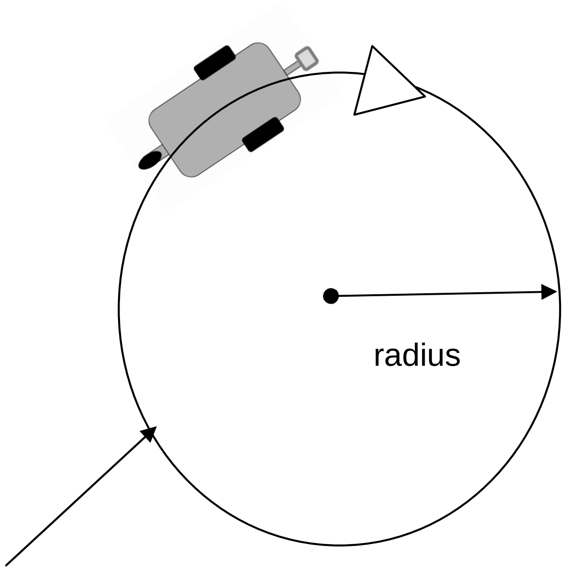
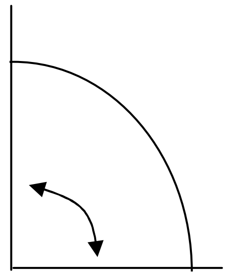
We can now “reverse engineer” some of the robot’s control settings. And determine just how many degrees we need to program the robot to move to execute an arc of a specific length, bearing in mind that the arc is a specific segment length line on the circumference of a circle. The “bigger picture “ is locating the centre point of the circle and what is the arc of the angle?





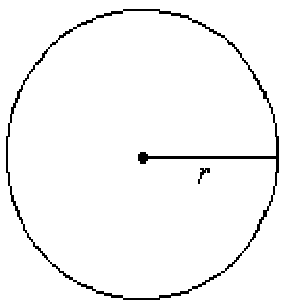
Angle
degrees?

Circumference

The perimeter of a circle is called the circumference. The circumference is the distance around the circle.

Formula Reminder

The circumference, C, of a circle is given by the formula



$$C = 2\pi r$$

where r is the radius of the circle, and

$$\pi \approx \frac{22}{7} \approx 3.142$$

If a circles radius is 14 cm how do we calculate the circumference?

$$\begin{aligned} C &= 2\pi r \\ &= 2 \times \frac{22}{7} \times 14 \\ &= 88 \end{aligned}$$

Circumference 88 cm.

nb.

If the radius, r, is a multiple of 7, we may use $\frac{22}{7}$ as an approximation for π.

http://www.clarku.edu/~djoyce/trig/angle.htmlhttp://www.mathwarehouse.com/geometry/circle/arc-of-circle.php

http://www.mathwarehouse.com/geometry/circle/interactive-central-angle-of-circle.php