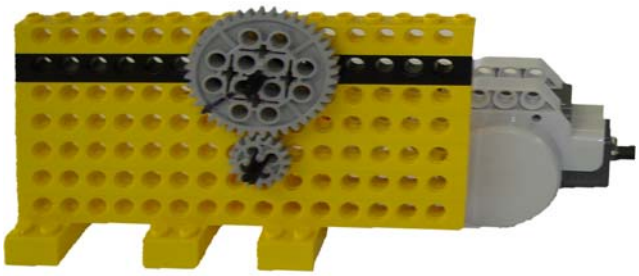
Transmissions

Task 1: Gear transmission system

In the next experiment you will learn what the influence is of the gear diameter on the velocity and direction of the transmission.

<u>Set-up:</u>

Make a construction as shown in the following picture. Mount a small gear on the axle of the engine and a large gear on the driven axle.



Let the NXT engine run.

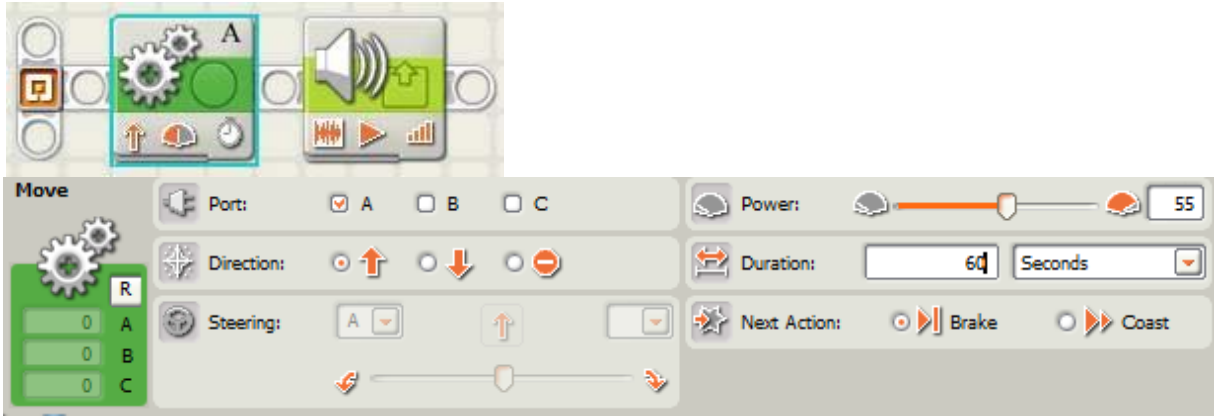
What do you notice ?

The large gear has 40 teeth.
The small gear has 16 teeth.

The large gear has a slower rotation than the small gear.

The direction of rotation of the large gear is the opposite of the direction of rotation of the small gear.

Let the NXT run the program called “minute” and analyze how many revolutions the large gear makes per minute. To make counting easier you can mount a long LEGO part on the large gear. This way you will be able to notice the number of revolutions more easily.



Program “minute”

What do you notice?

In one minute the large gear makes around 30 revolutions. This means that the number of revolutions of the large gear is 30 min^{-1}.

Some maths:

Now you still do not know what the number of revolutions of the small gear is. Calculate the number of revolutions (n_1) and the transmission ratio (i).

Given:
Number of teeth on the small gear = 16 teeth z_1
Number of teeth on the large gear = 40 teeth z_2
Number of revolutions of the large gear = 30 min^{-1} n_2

Wanted:
number of revolutions small gear ($n_{1)}$
transmission ration (i)

Solution:

$$n_1 . z_1 = n_2 . z_2$$

$$n_1 = \frac{n_2 \cdot z_2}{z_1} = \frac{30 \cdot 40}{16} \left[\frac{\min^{-1} .1}{1} \right] = 75 \min^{-1}$$

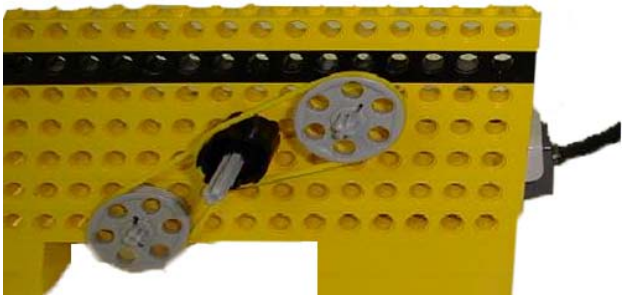
$$i = \frac{n_1}{n_2} = \frac{75}{30} \left[\frac{\min^{-1}}{\min^{-1}} \right] = 2{,}5$$

Task 2: Belt transmission system

In the following experiment you learn what the influence of the belt pulley diameter is on the speed and direction of the belt transmission.

Set-up:

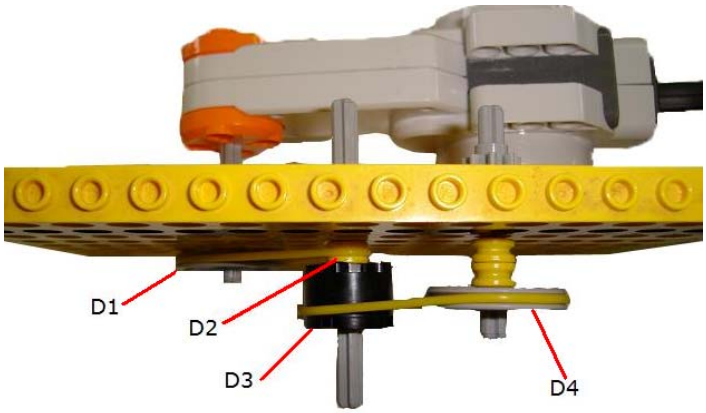
Make a set-up as you can see in the picture on the right (front view) and the one on the next page (top view). Make sure that one of the large pulleys is mounted on the axle of the engine. Make sure that all belts (rubber bands) are tightened.



Let the NXT engine run.
What do you notice ?

The last pulley rotates faster than the first pulley and more slowly than the pulleys on the middle axle.

The first pulley rotates in the same direction as the last pulley.



Some maths:

If you keep the NXT power on 55% as in task 1, then how many rotations will the last pulley make?
Figure out the rotation ratio (i) as well.
Use the same speed for the drive axle as in experiment 1.

Given:
Diameter 1 (D_1) = 24mm
Diameter 2 (D_2) = 7mm
Diameter 3 (D_3) = 16mm
Diameter 4 (D_4) = 24mm
Number of revolutions of the first pulley (n_1) = $75 min^{-1}$

Wanted:
Number of revolutions of the last pulley (n_4)
Transmission ratio (i)

Solution:

$$n_1.D_1 = n_2.D_2$$

$$n_2 = \frac{n_1 \cdot D_1}{D_2} = \frac{75 \cdot 24}{7}\left[\frac{\min^{-1}.1}{1}\right] = 257{,}14\,\min^{-1}$$

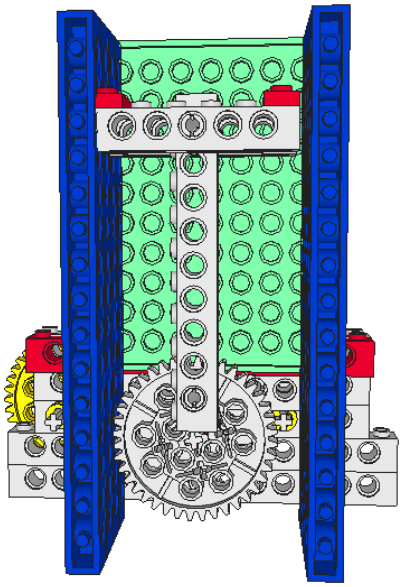
$$n_2 = n_3$$

$$n_3.D_3 = n_4.D_4$$

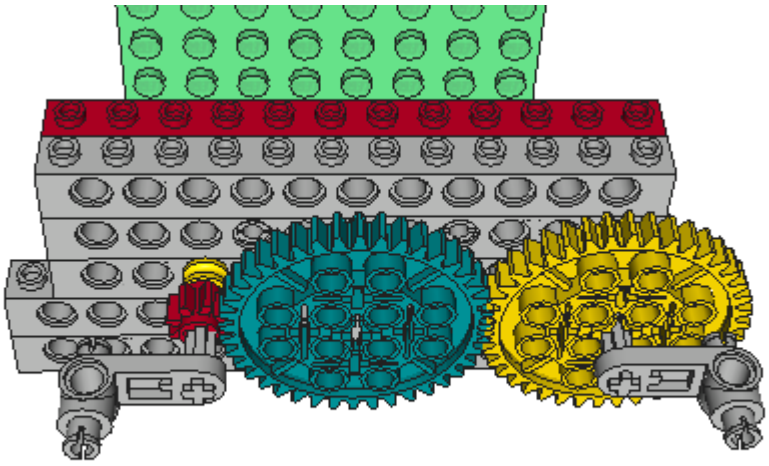
$$n_4 = \frac{n_3 \cdot D_3}{D_4} = \frac{257{,}14 \cdot 16}{24}\left[\frac{\min^{-1}.1}{1}\right] = 171{,}43\,\min^{-1}$$

$$i = \frac{n_1}{n_4} = \frac{75}{171{,}43}\left[\frac{\min^{-1}}{\min^{-1}}\right] = 0{,}44$$

Experiment 3 : Crank-connecting rod mechanism



The crank connecting to rod mechanism is a nice example of the transmission of a circular motion to a linear motion.
In de following experiment you will learn how the power of such a system is influenced by the chosen gear transmission.



In the construction above you see a crank connecting to rod mechanism. The piston can be put in motion by 2 handles mounted on one of the gears. The first handle is mounted on the smallest gear that will drive the larger middle gear. The second handle is mounted on the large right hand gear that will also drive the same-sized middle gear.

Put a weight on the piston and turn the handle of the small gear. Next do the same with handle on the large gear.

What do you notice ?

The load will go up faster if you use handle 2, but you need to use more power than with handle 1.