ASTRONAUT

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Design phase: Humanoid bipedal motion

Looking for inspiration

- Humans are driven to **explore the unknown**, and the **space** is a territory that has a lot of **mysteries** that have called humans' attention since **ancient times**.
- **Human space exploration** helps to unravel the mysteries about our place in the Universe.
- On **July 20, 1969**, the US Apollo 11 mission made the first **moon landing**.
- The term "**astronaut**" derives from Greek and means "space sailor."
- An **astronaut** is someone who has been launched as a crew member aboard a **spaceship** into **outer space** to investigate it.

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Nazca lines

- The Nazca was a culture located in a **southern desert of Peru**, and it is famous due to its inexplicable and impressive **lines drawn in the ground**.
- The lines are known as **geoglyphs** – drawings on the ground made by removing rocks and earth to create an **image**.
- The lines are drawn in **geometric patterns** and distinct animal and humanoid shapes.

- The size of the straight lines runs up to **30 miles**, while the animals and humanoids range from **50 to 1200 feet in length**. Given their sizes, the lines are best seen **from the air**.
- Scientists believe that the majority of lines were made by the **Nazca people**, around **A.D. 1 to 700**.
- One of the most popular lines is a humanoid figure nicknamed **"The Astronaut."**

- On a piece of paper, you can sketch some **ideas** of how your astronaut prototype will look like!

I will design an astronaut prototype inspired by the ones drawn by the Nazca people!

Humanoid bipedal motion

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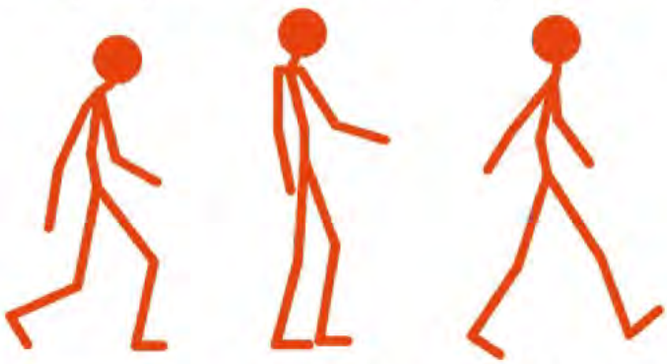
- The humanoid robot overall design is a very complex task since they are designed and manufactured to **resemble the human body**.
- When a humanoid performs biped walking, the **stability** must be guaranteed at any moment.
- The **center of gravity** is very important in the development of walking humanoids.



- In the **1970s, Honda** started wide research on humanoid bipedal robots, and nowadays there are numerous **research projects** performed by companies and universities to **develop better humanoid robots**.

Build phase: Parallel Chebyshev's lambda

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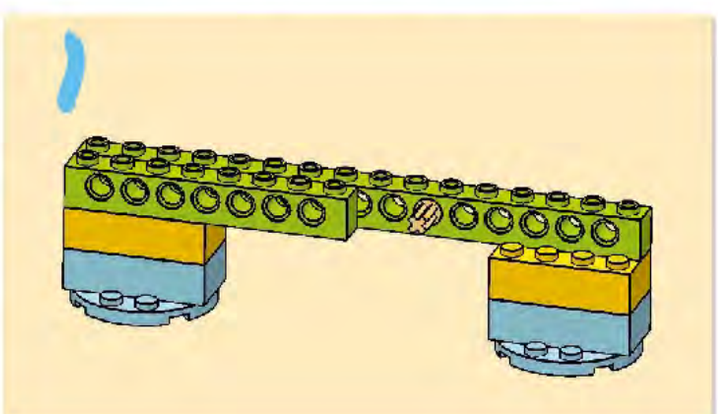
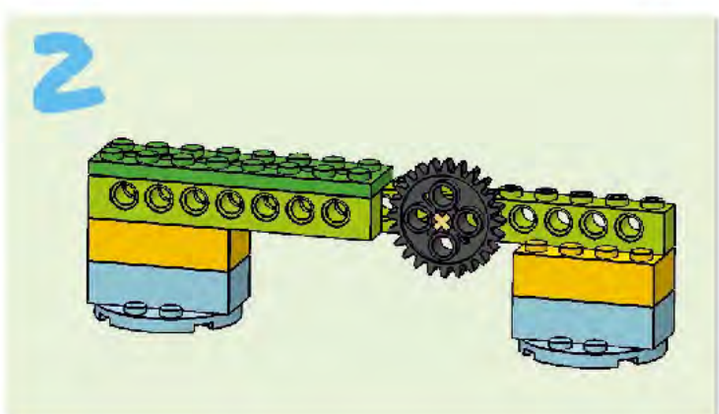
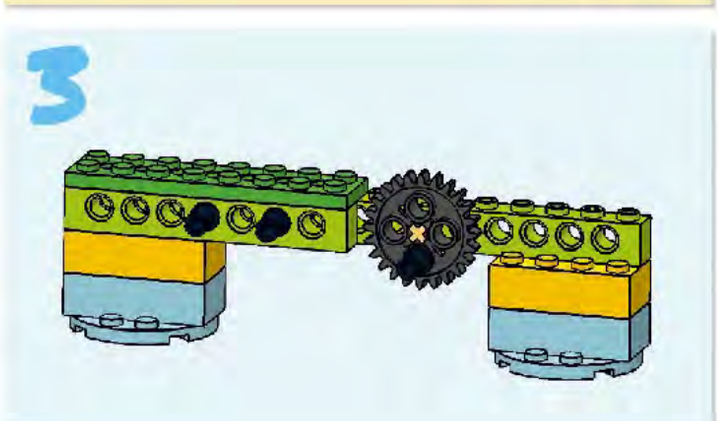
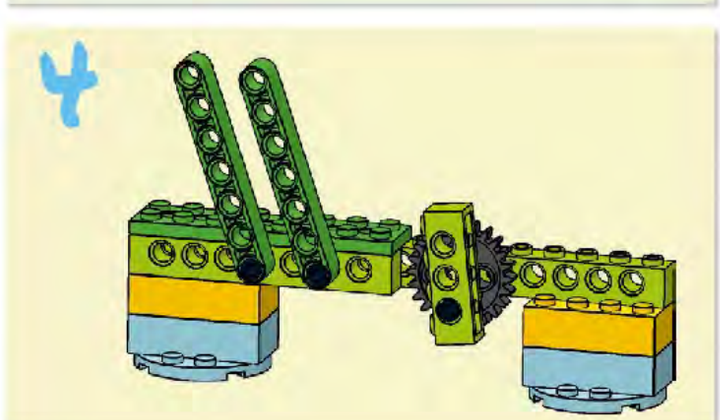
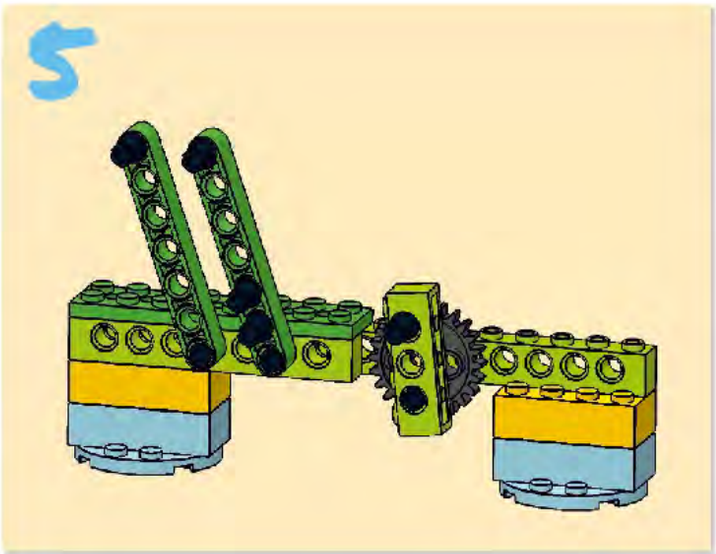
- Follow the building instructions to build your own **parallel Chebyshev's lambda linkage**.

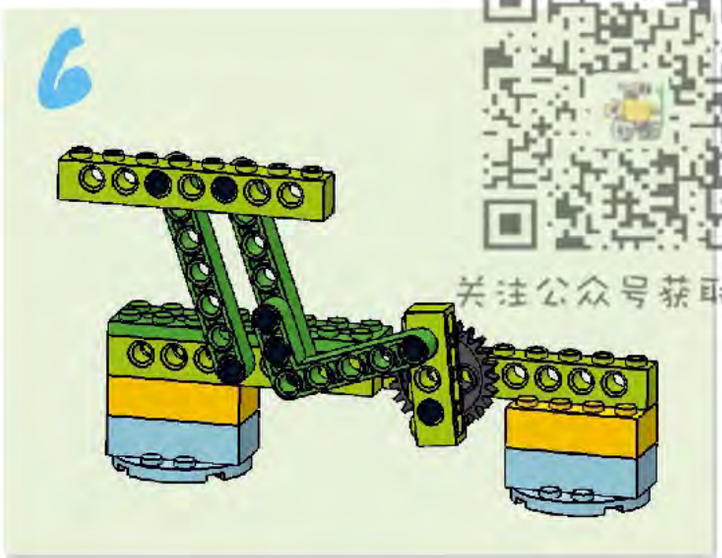












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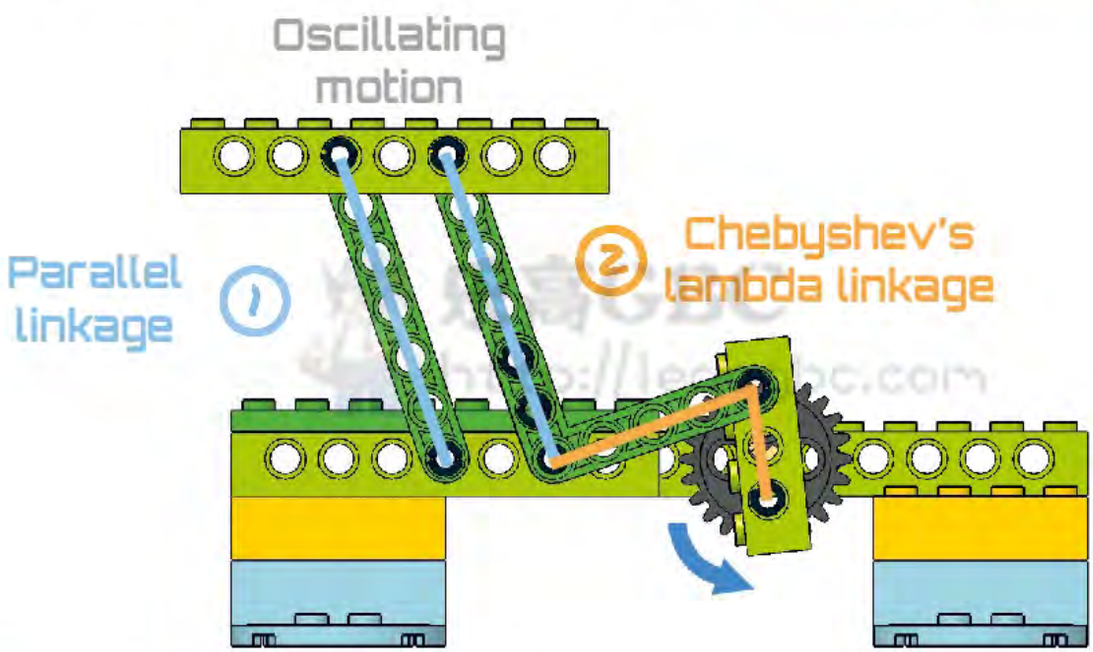
· Turn the gear to see the motion generated by your **parallel Chebyshev's lambda linkage**.



· The **parallel Chebyshev's lambda linkage** changes the **rotational motion** of the gear into an **oscillating motion** of the green beam.

· The particularity of the **oscillating motion** generated is that the beam always keeps its **horizontal position** at any moment.

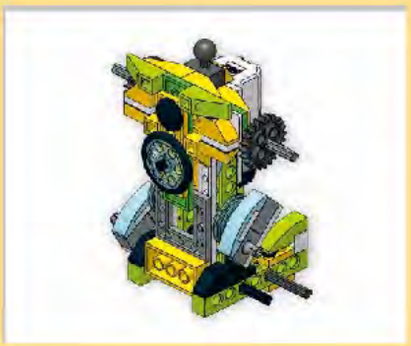
· The parallel Chebyshev's lambda linkage is a **multiple linkage** since it is composed of two: a **parallel linkage** and a **Chebyshev's lambda linkage**.

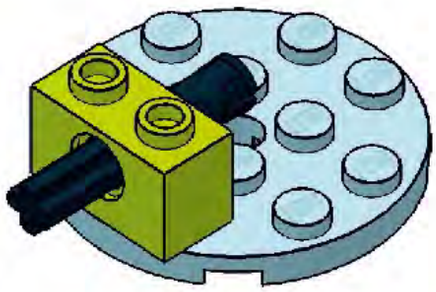
· Now you are ready to build your WeDo astronaut prototype!

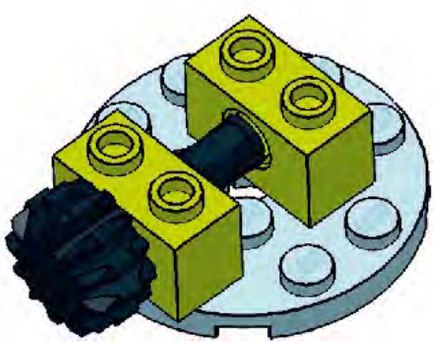
· Before you start building, prepare a **suitable workspace**.

· Keep in mind that the WeDo set has small pieces, so prepare a table with enough space to easily identify all the pieces and prevent them from getting lost.

Building instructions







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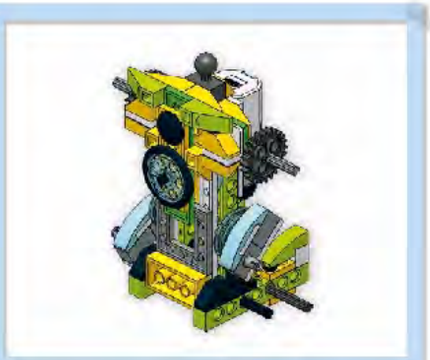

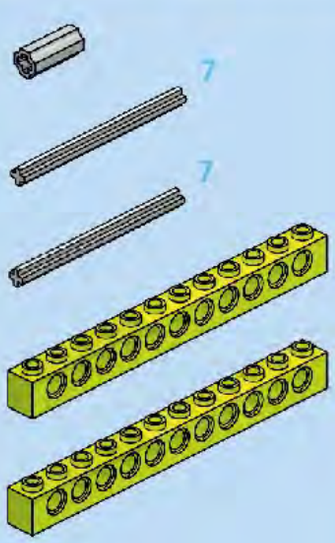

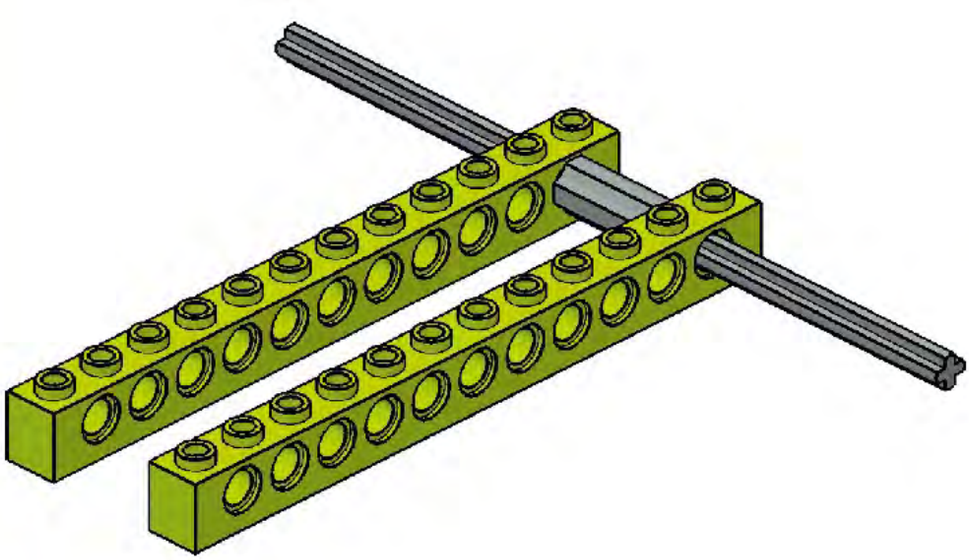

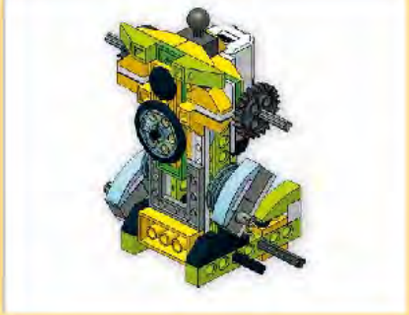

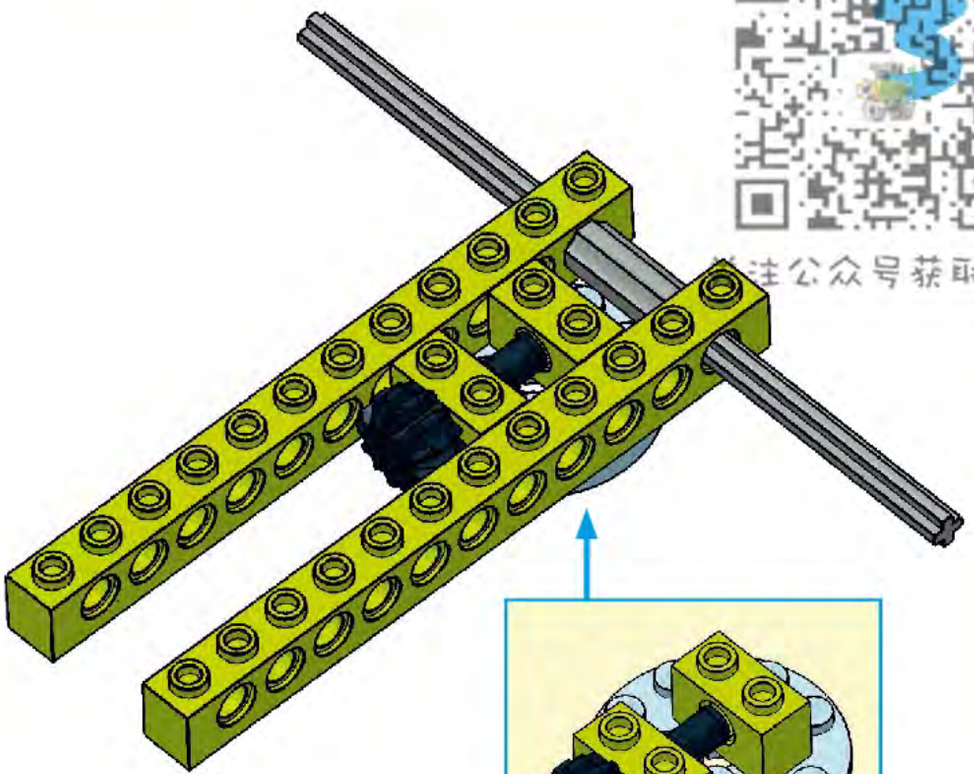

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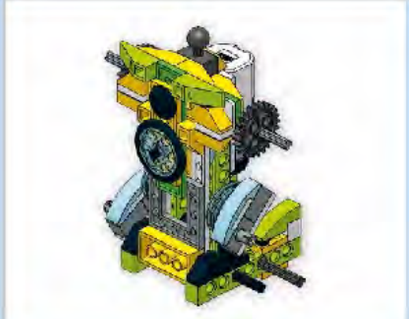

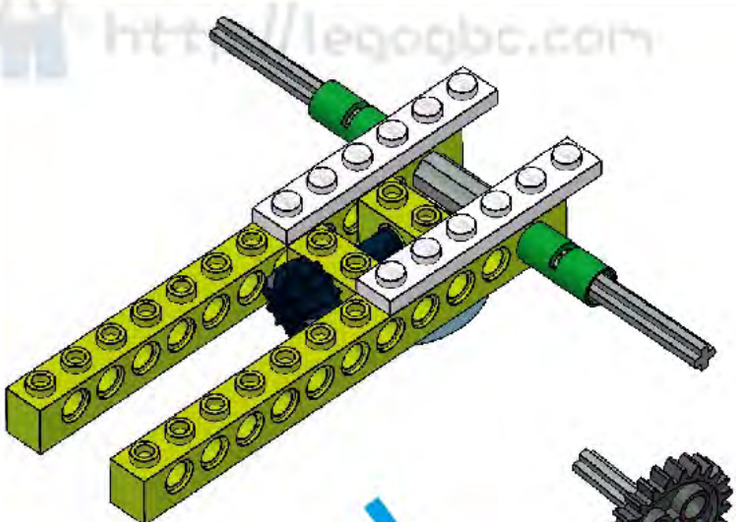

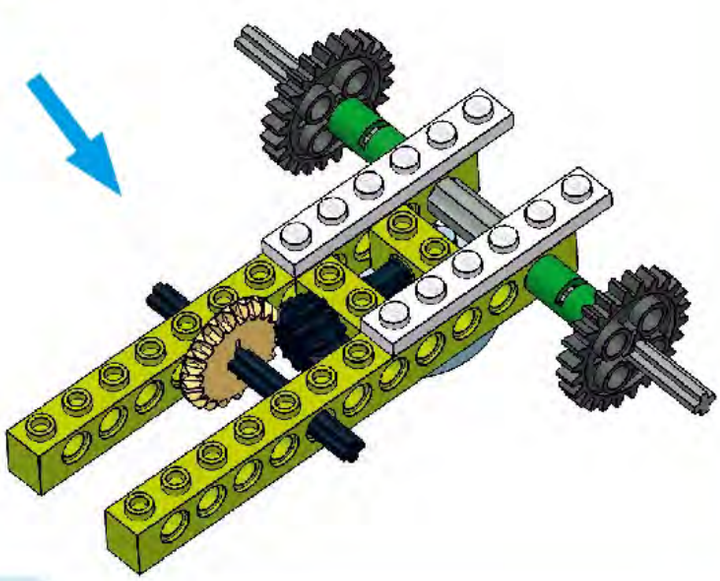

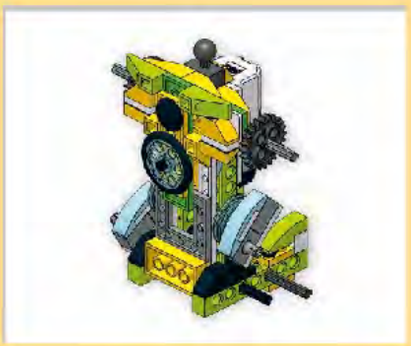

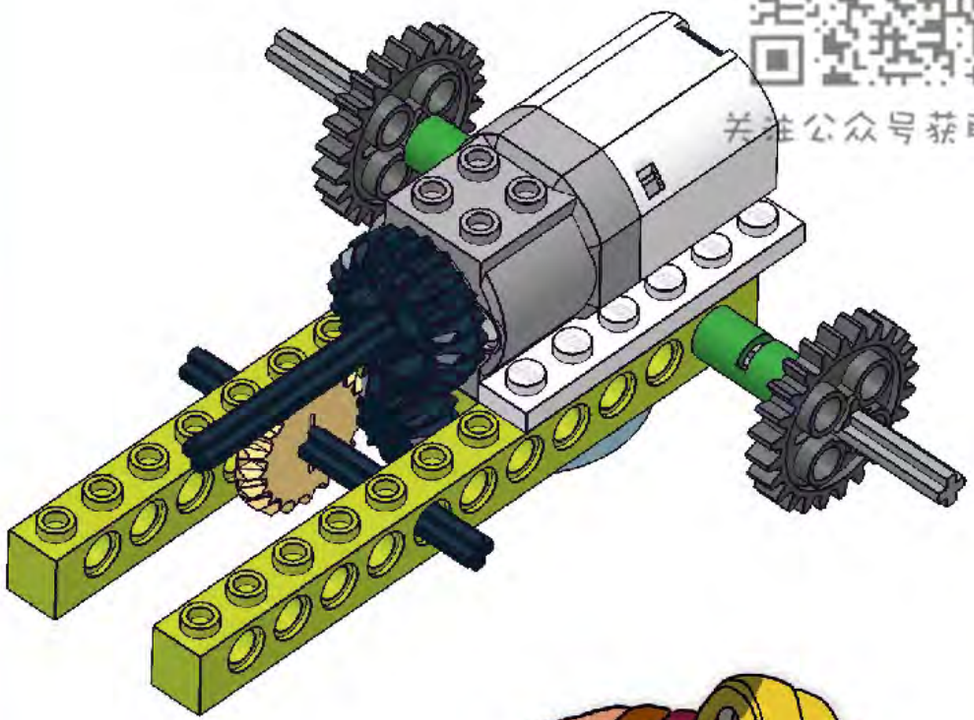

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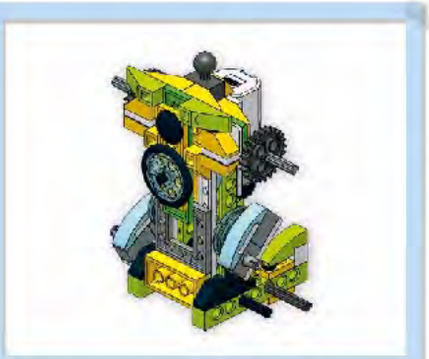

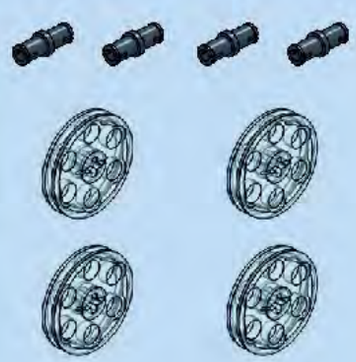

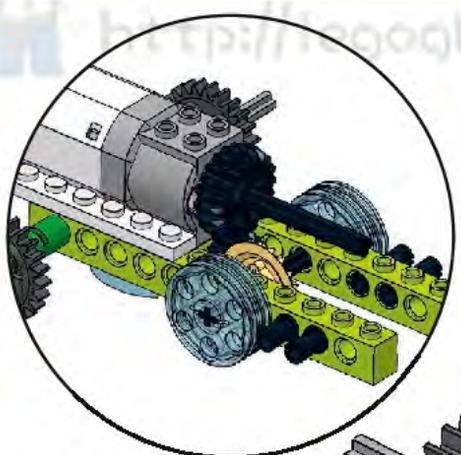

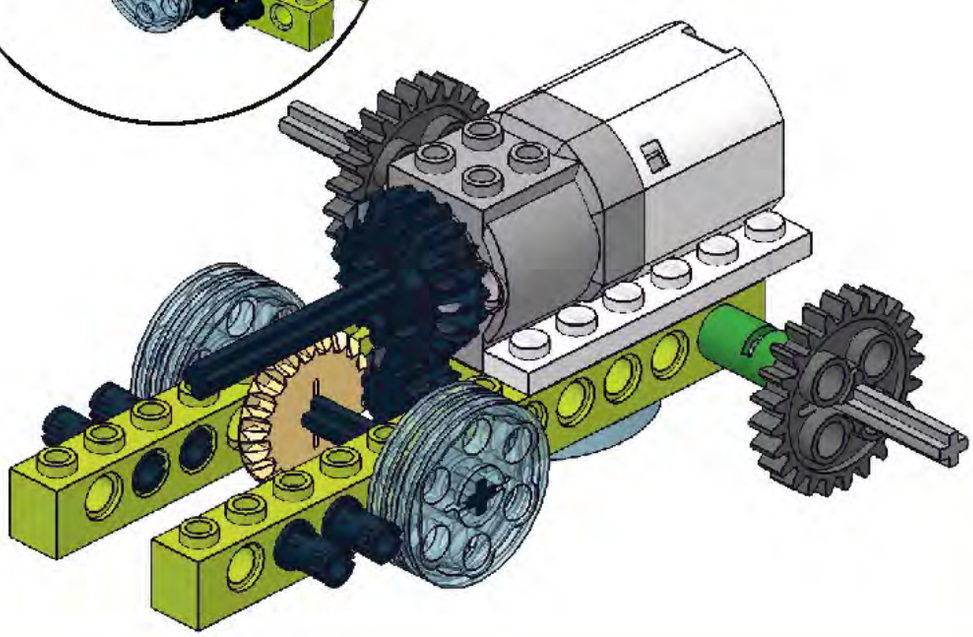

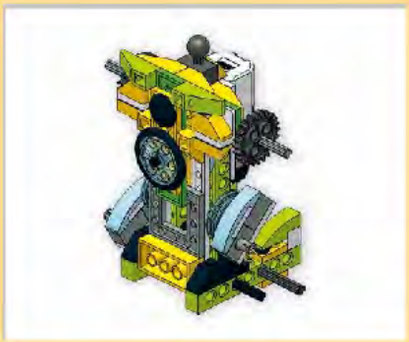

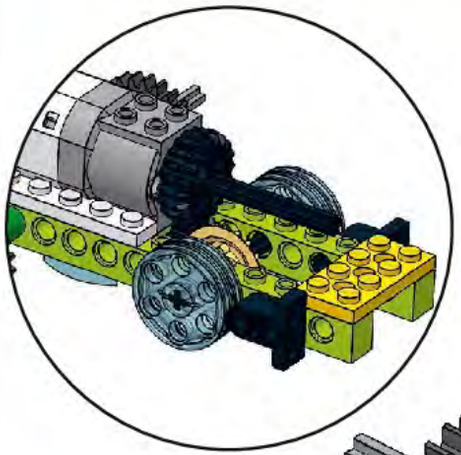

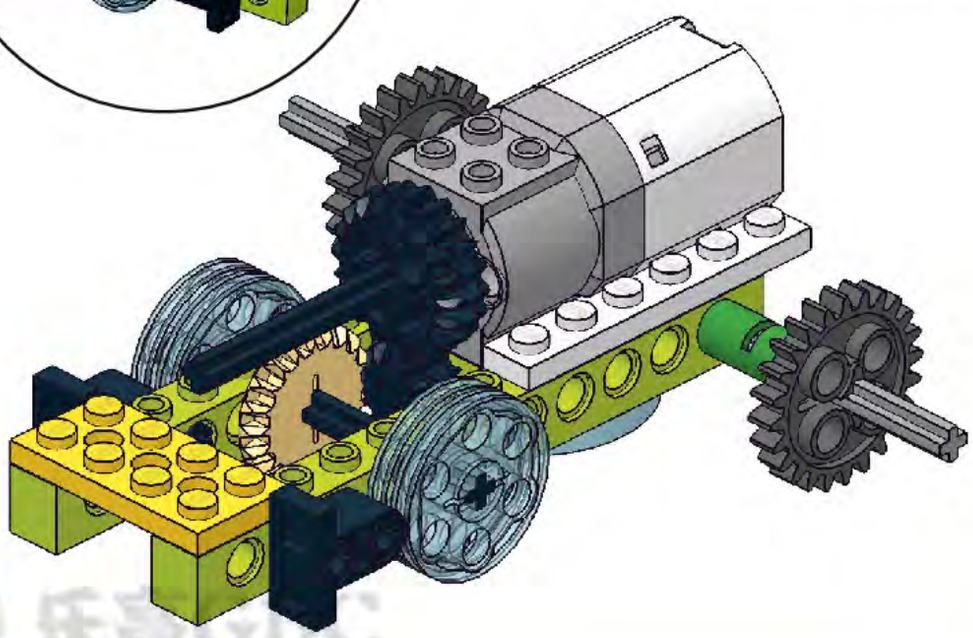

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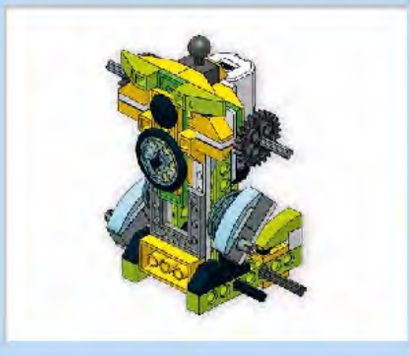
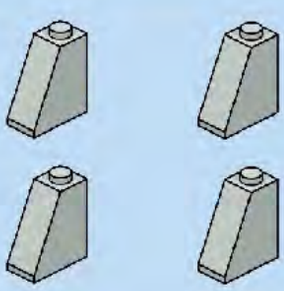
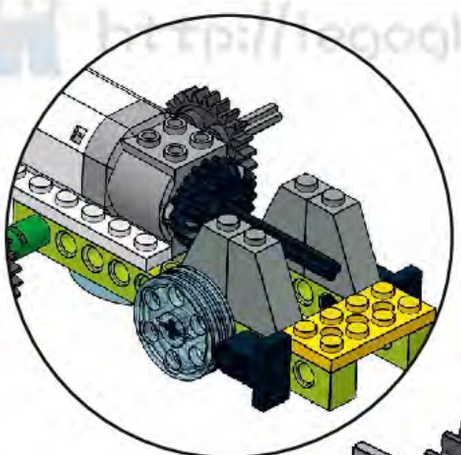
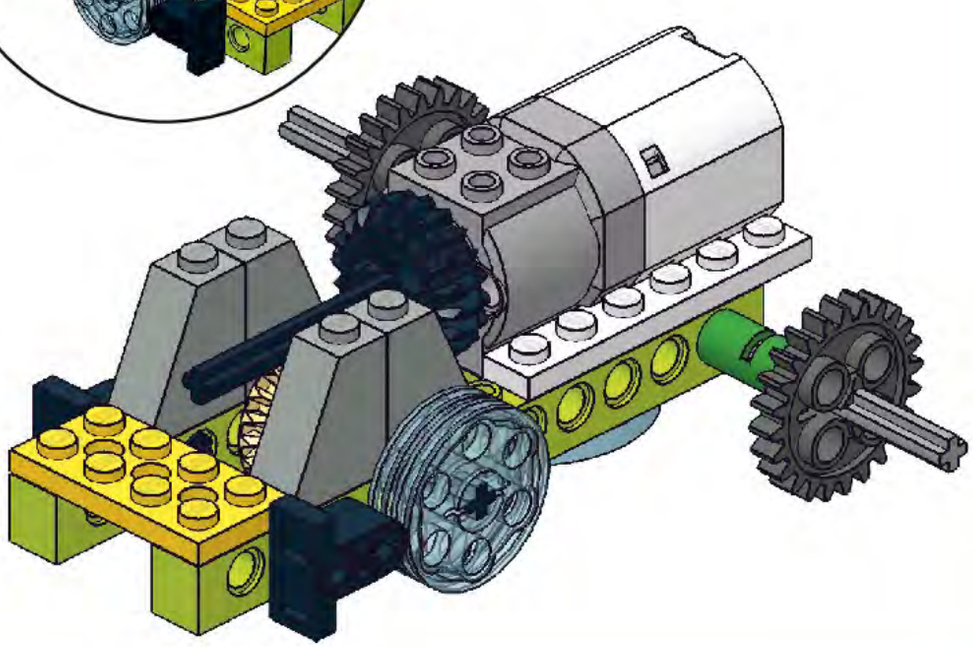
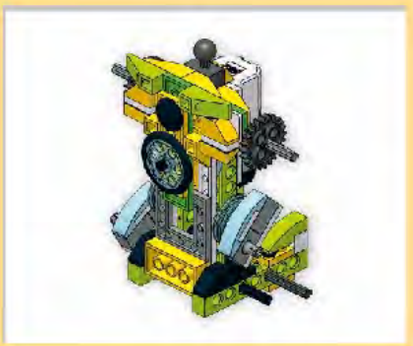


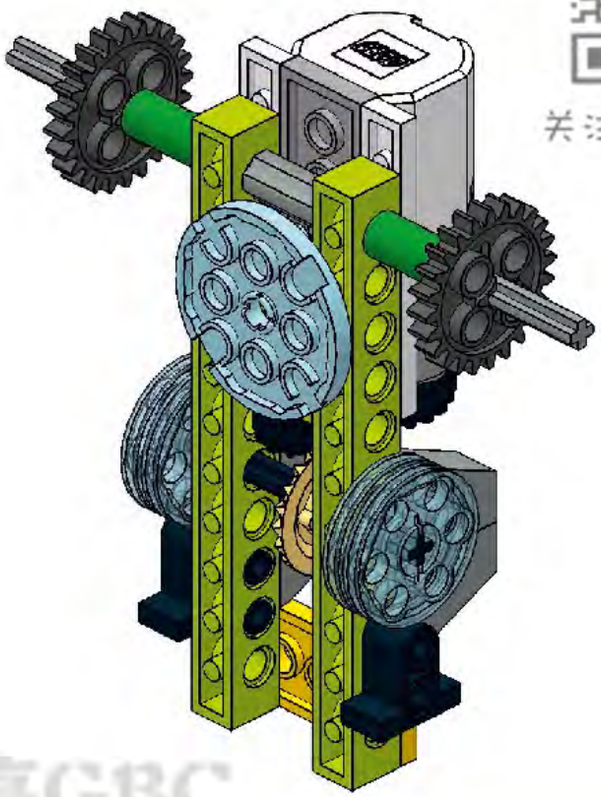








Flip over your prototype to have the same view.



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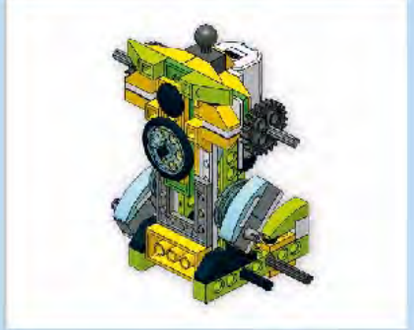

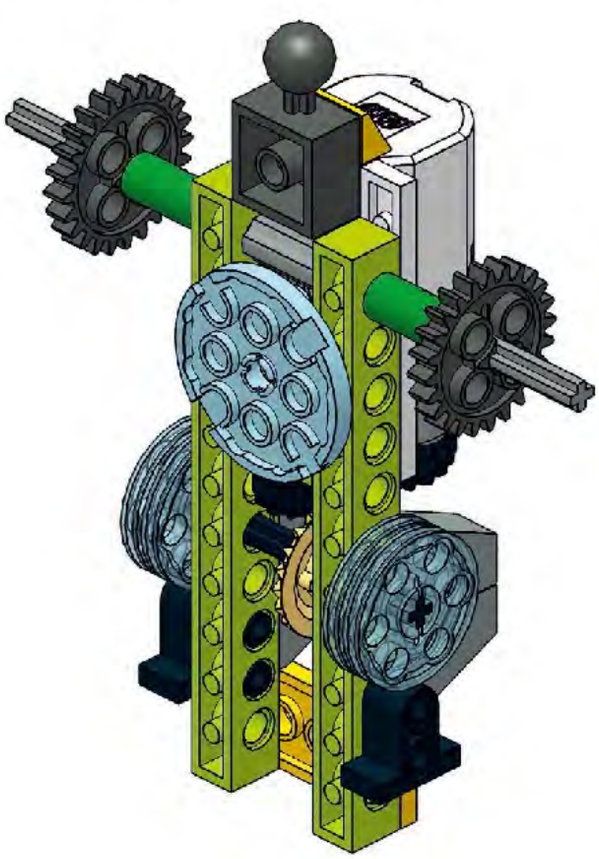

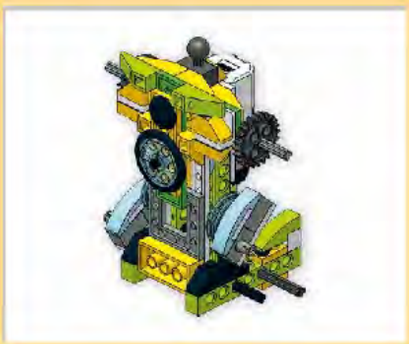

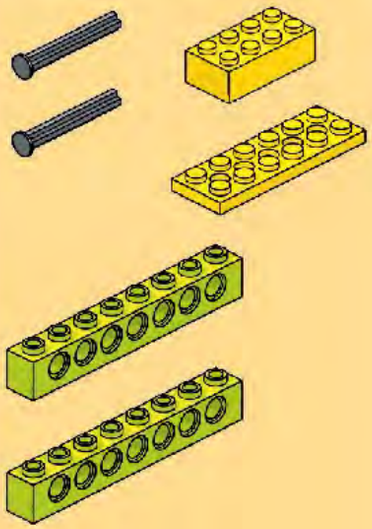

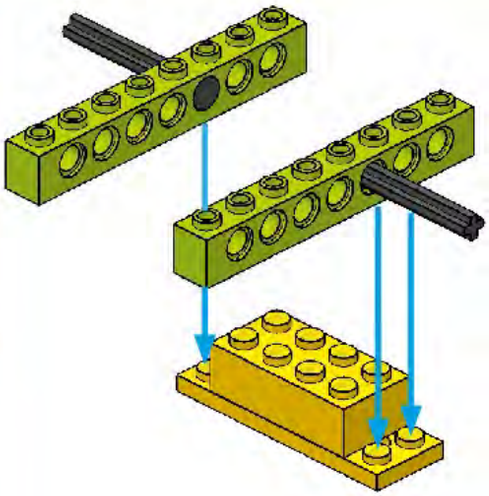

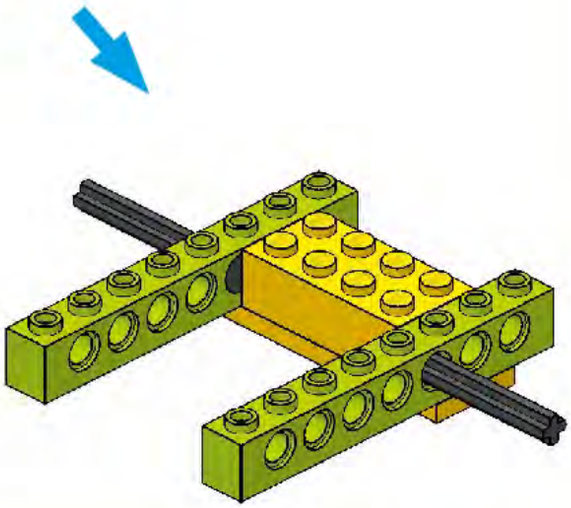

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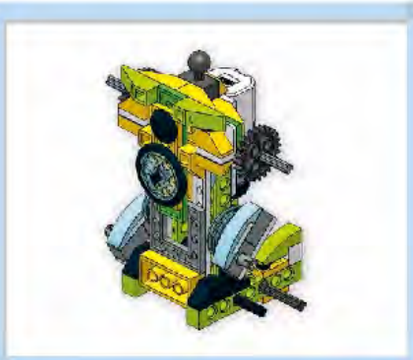

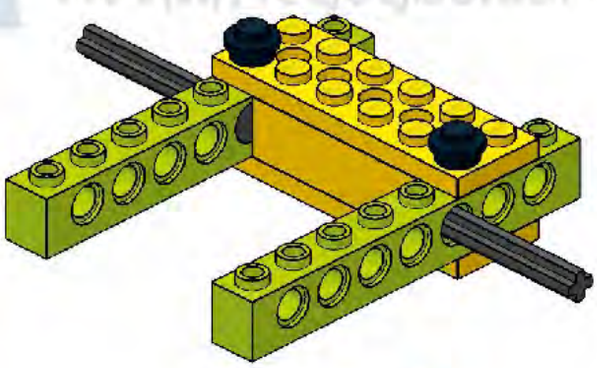

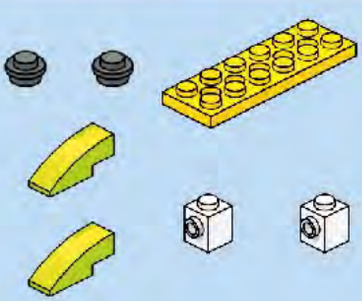

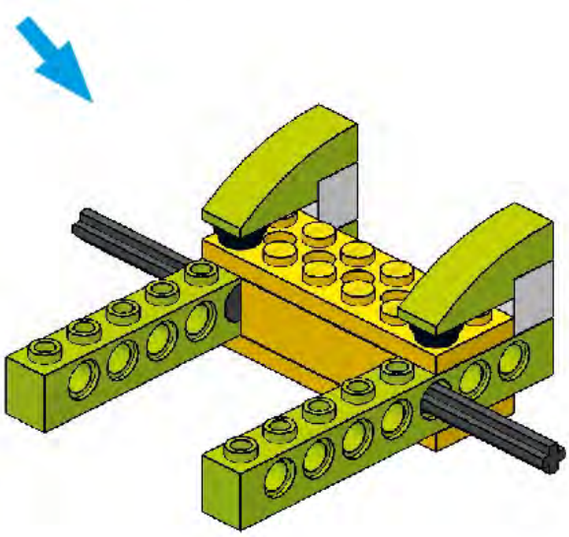

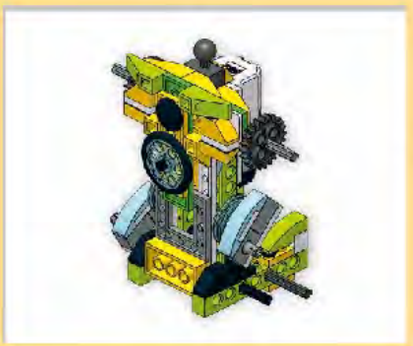

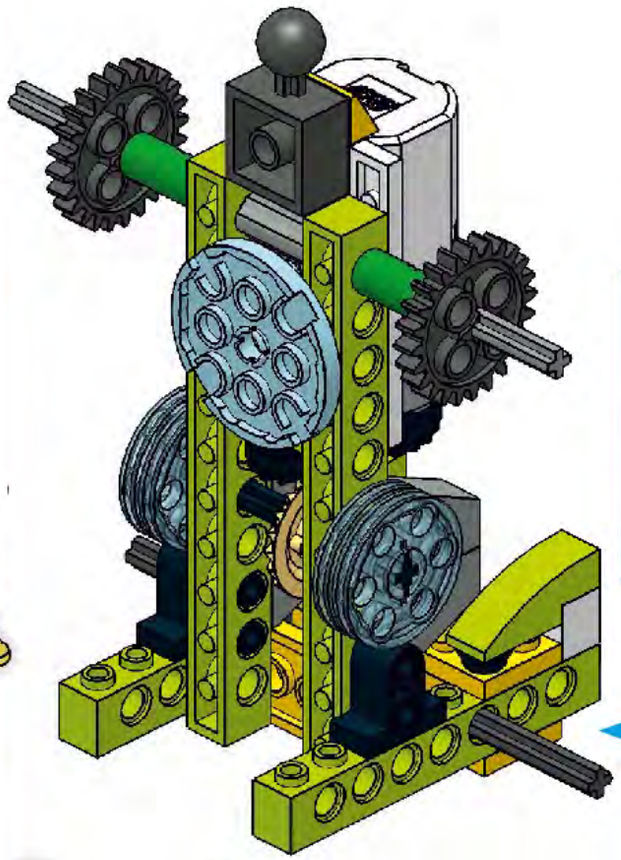

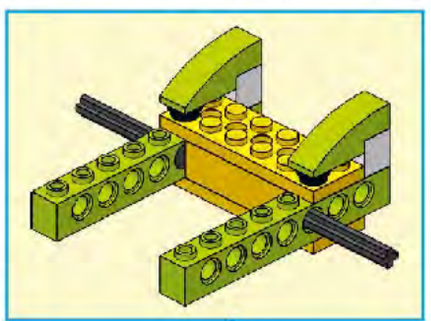

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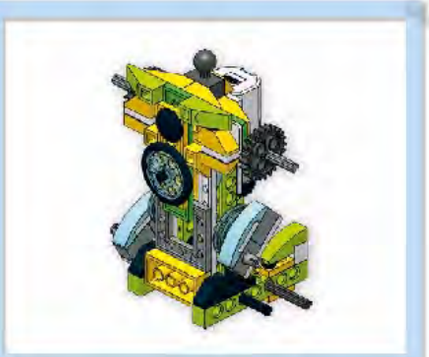

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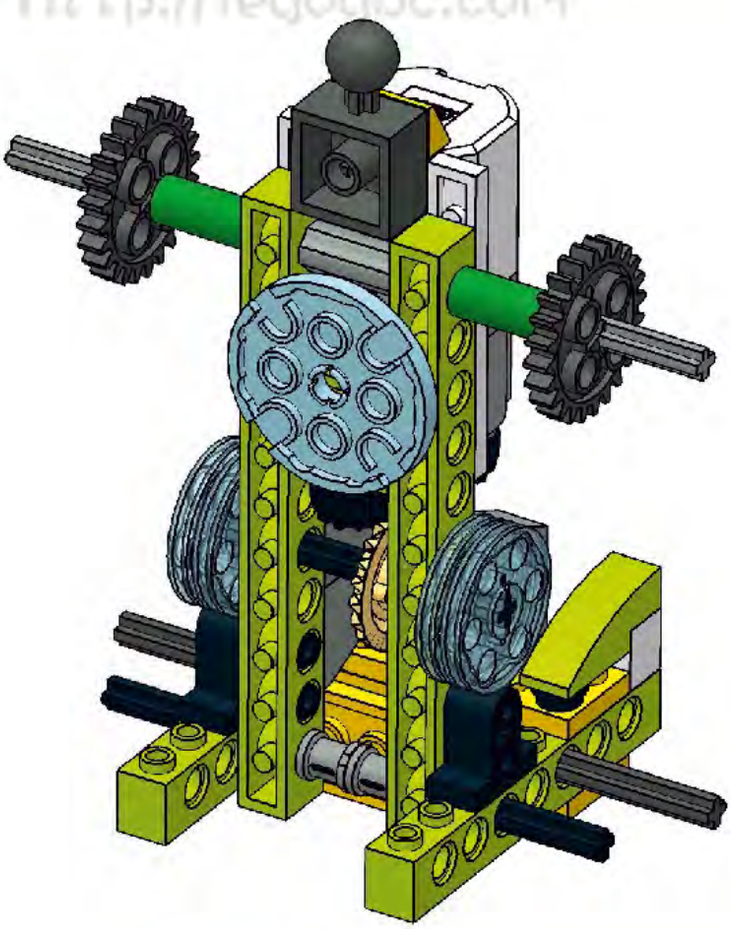

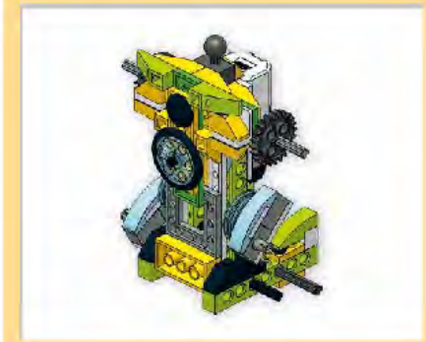

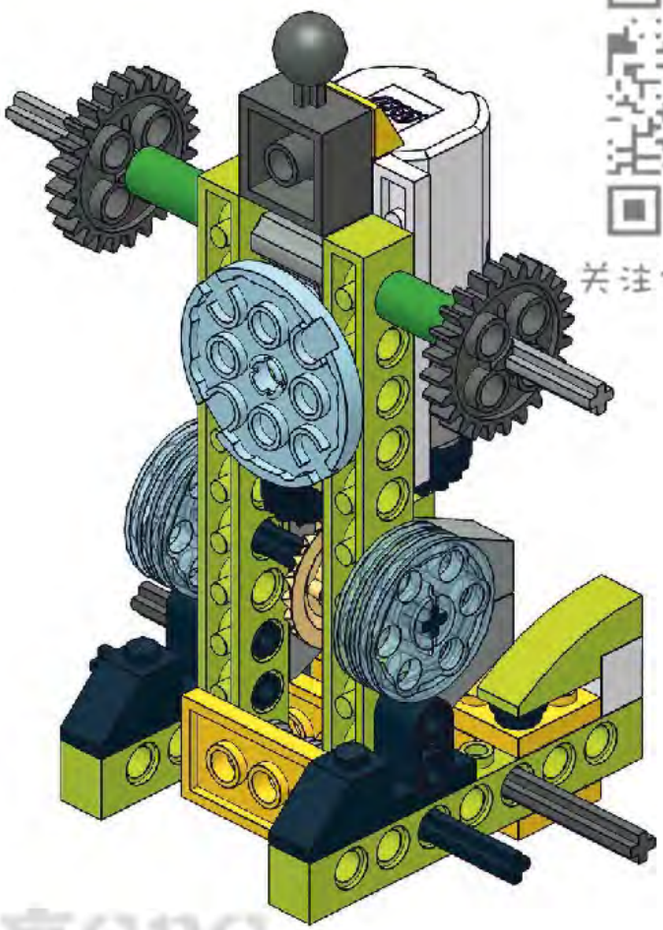

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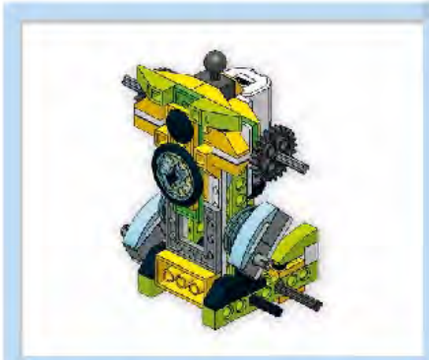

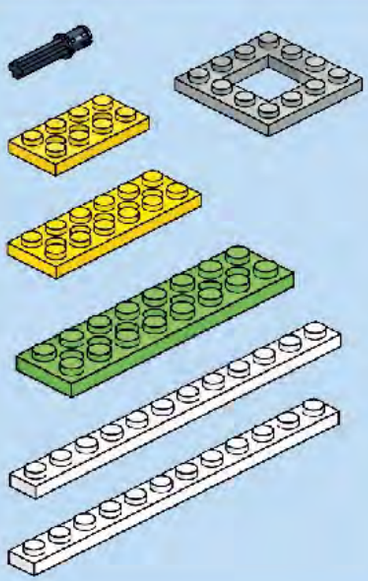

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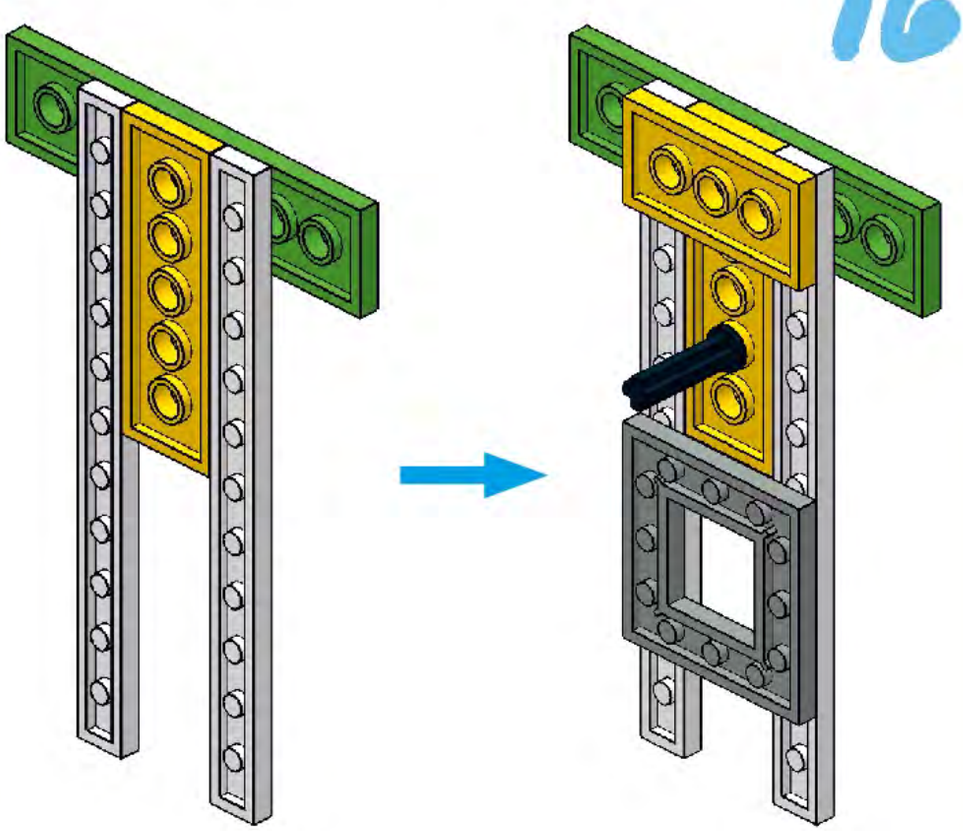

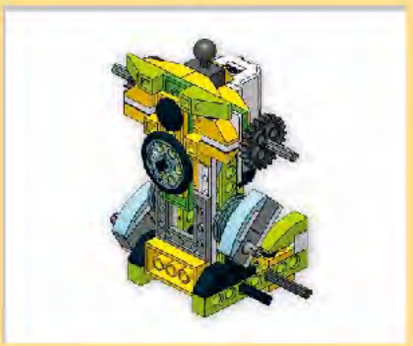

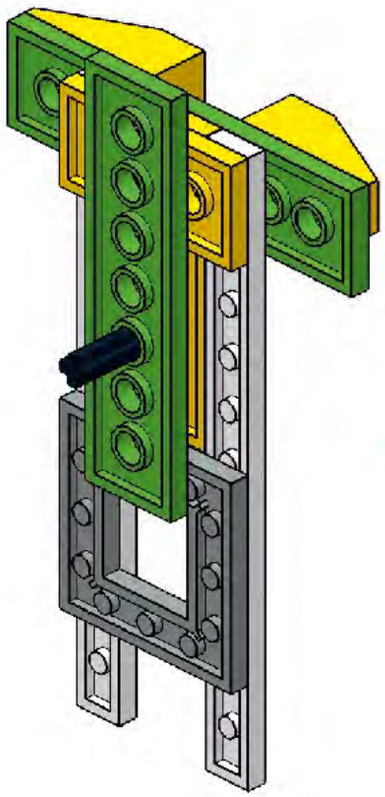

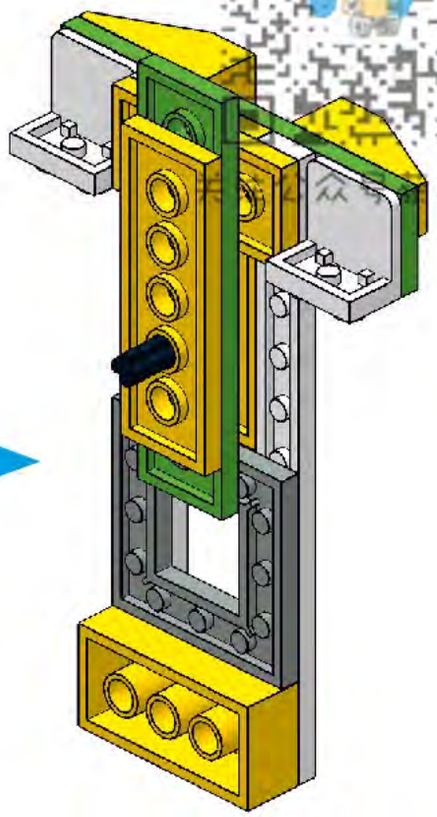

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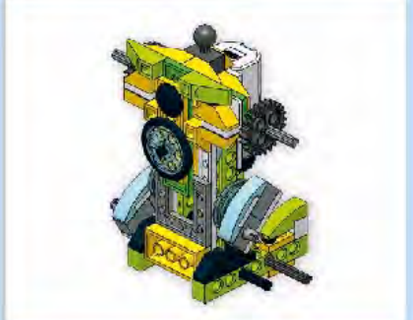

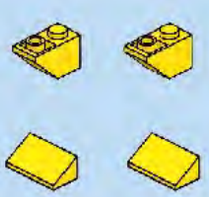

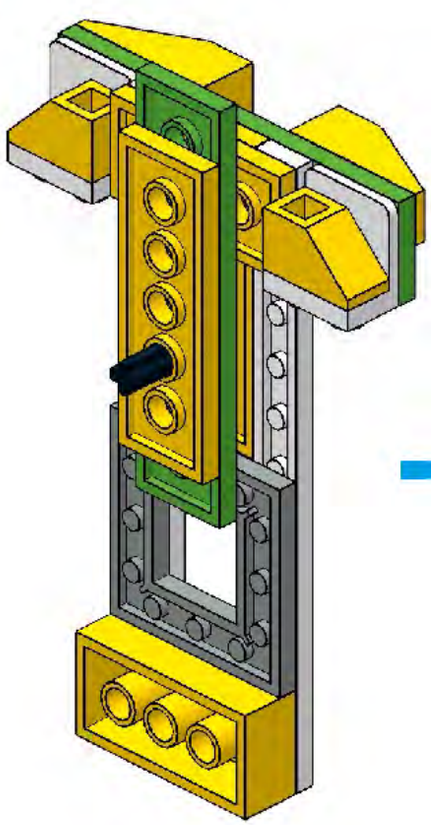

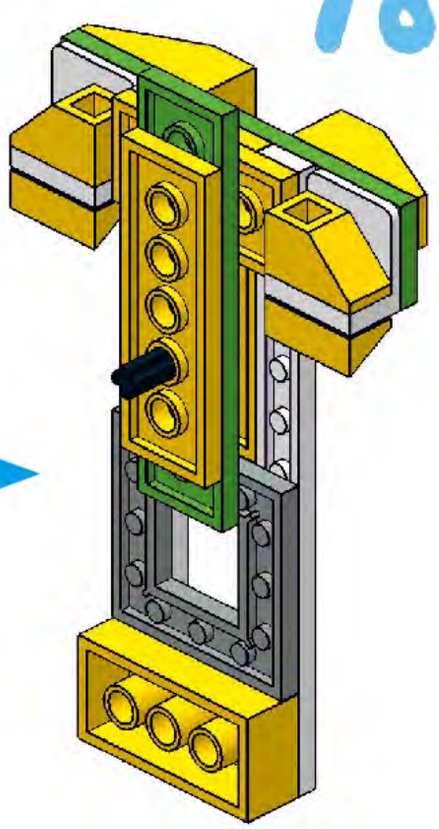

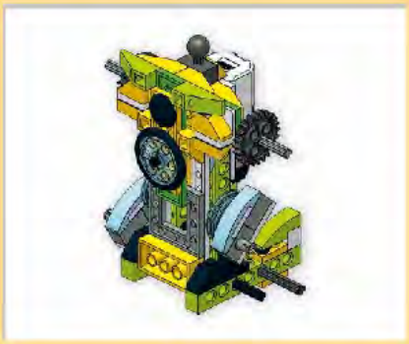

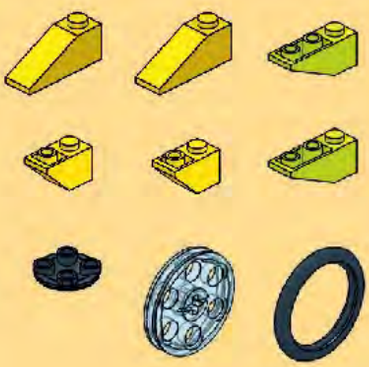

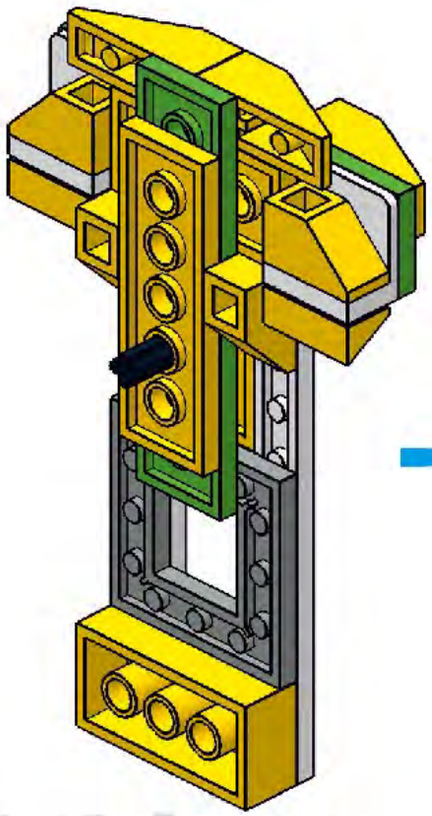

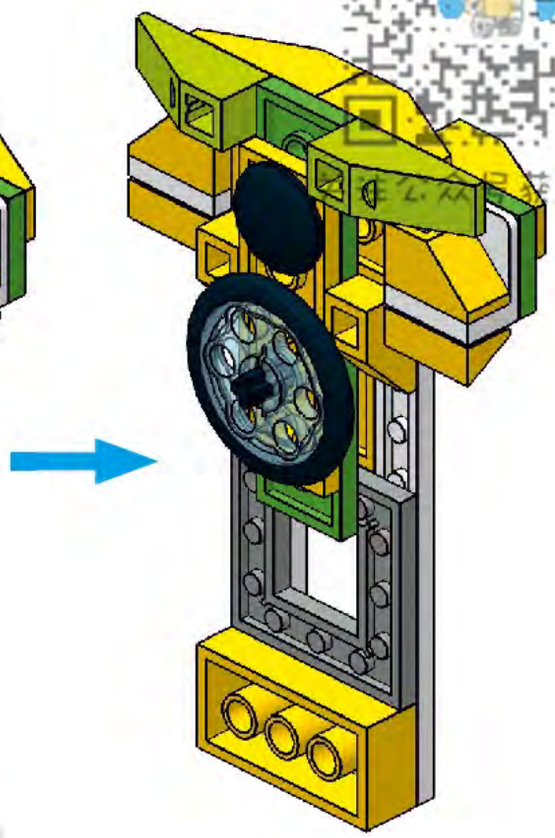

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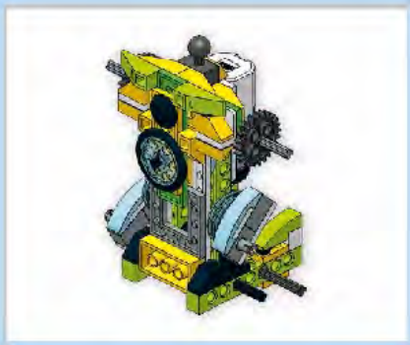

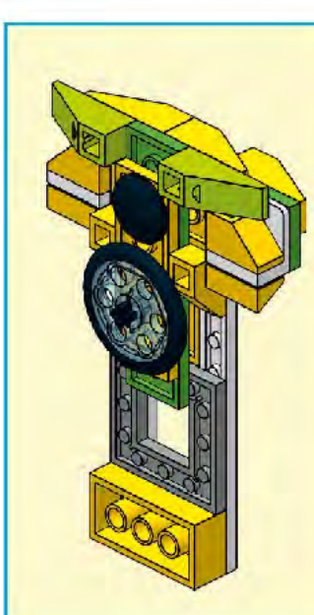

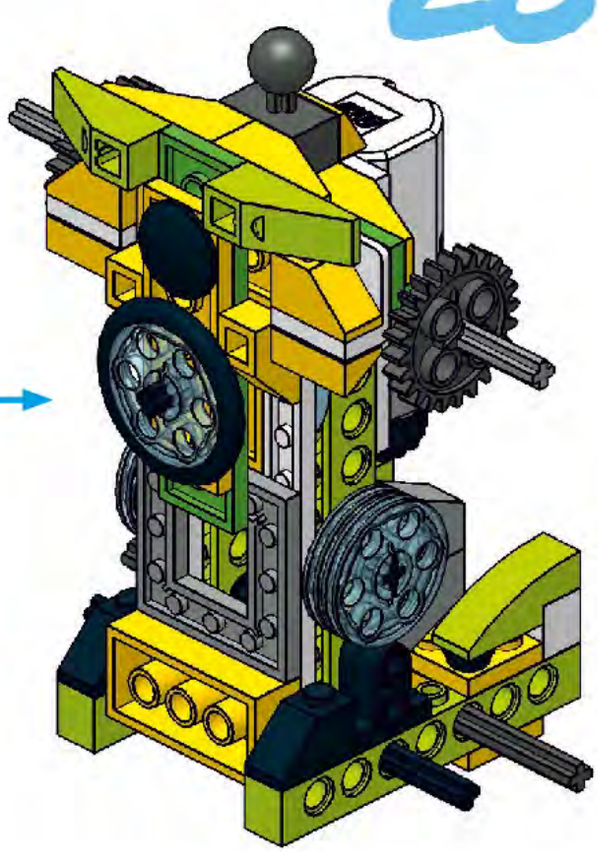

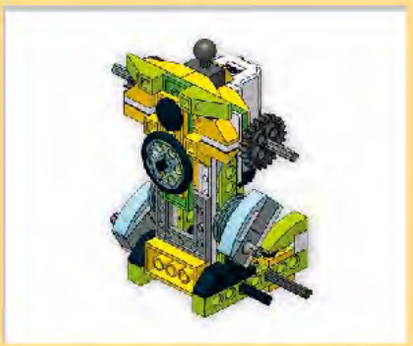

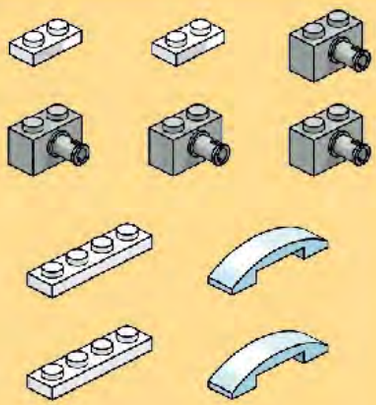

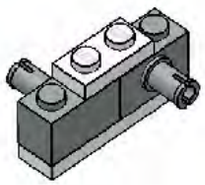

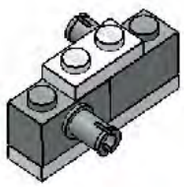

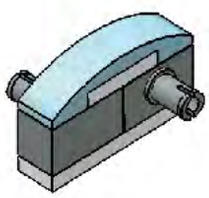

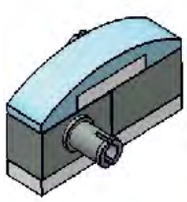

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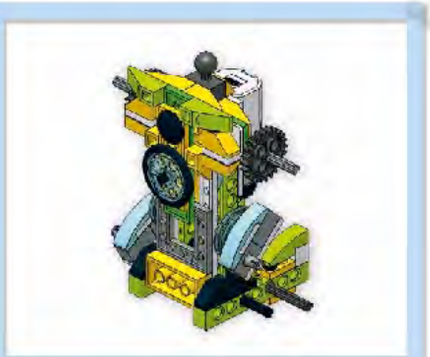

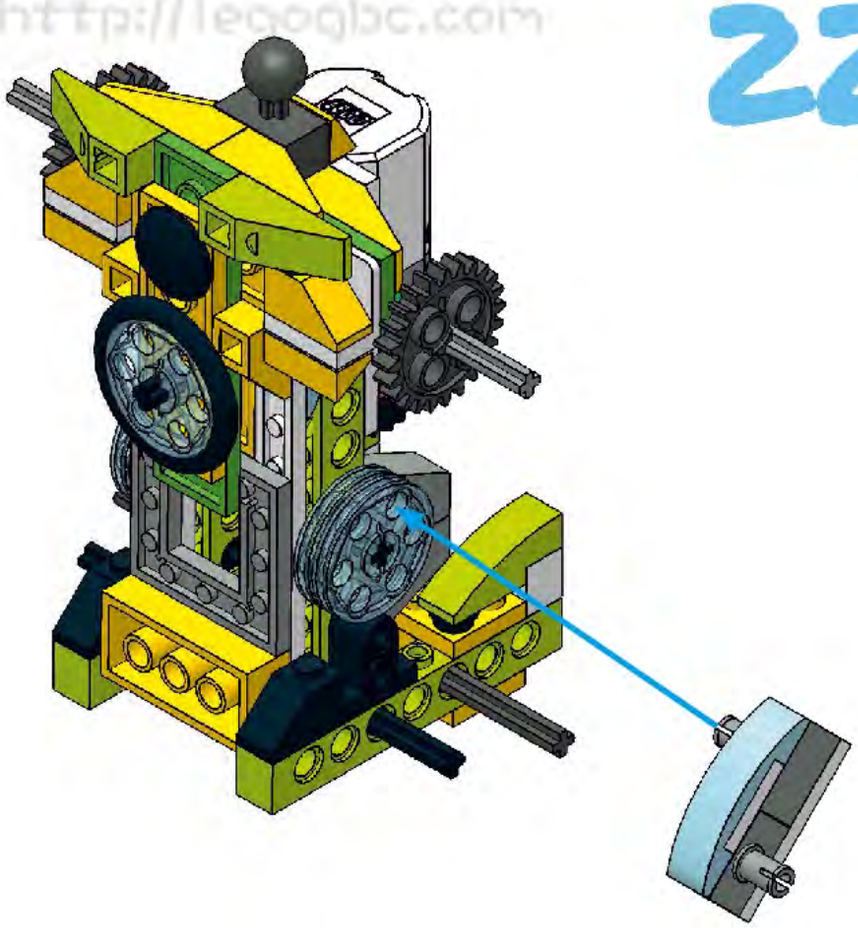

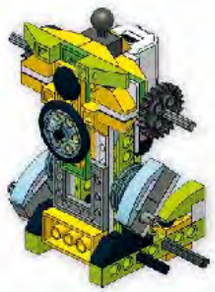

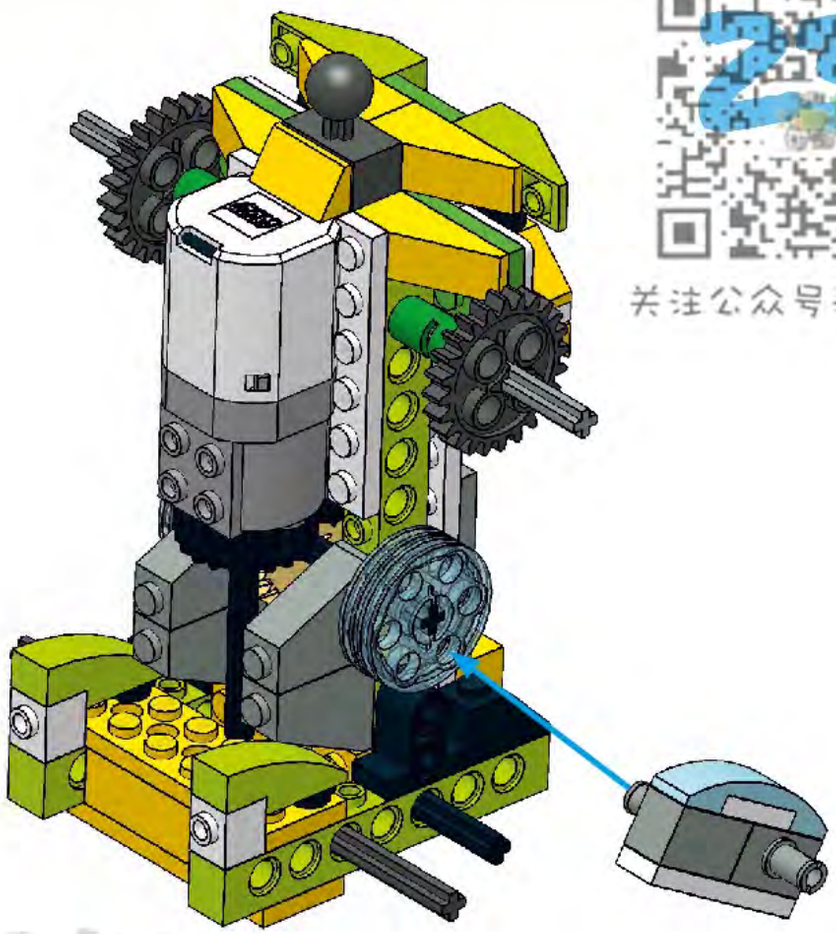

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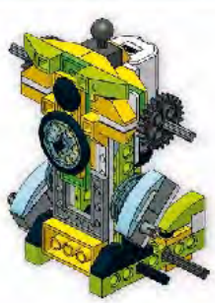

Be careful! The astronaut uses an "out-phase" motion, meaning that one of the connectors is in the opposite position of the other one.

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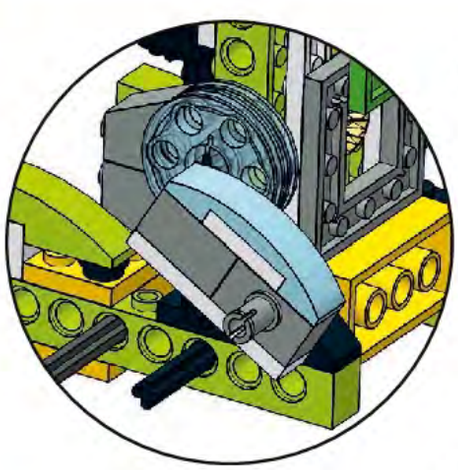

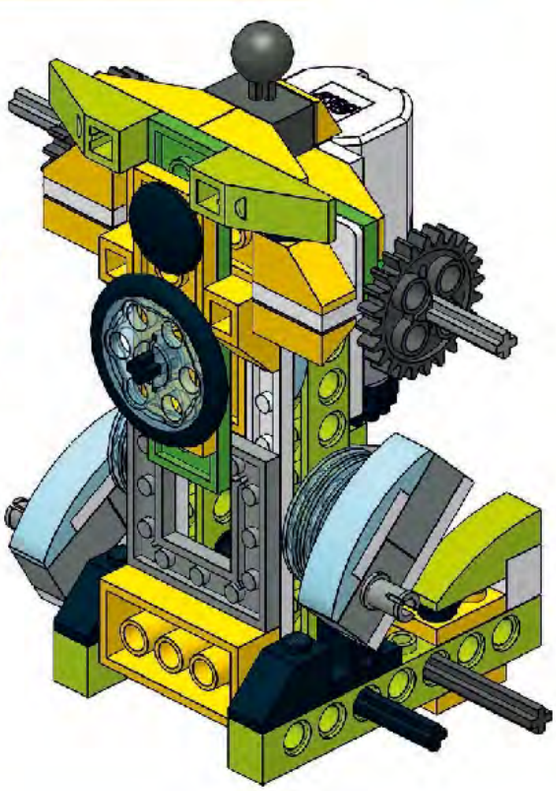

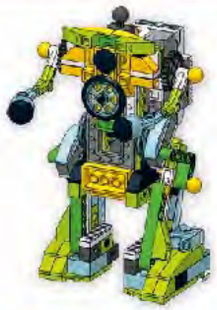

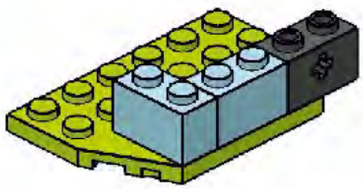

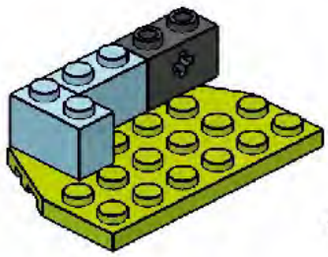

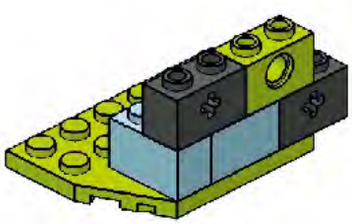

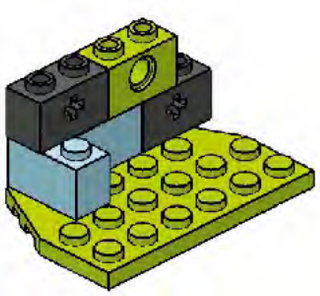

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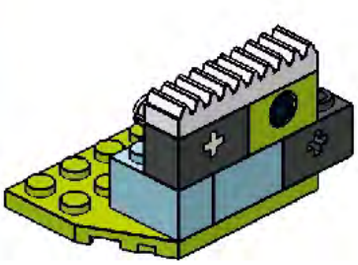

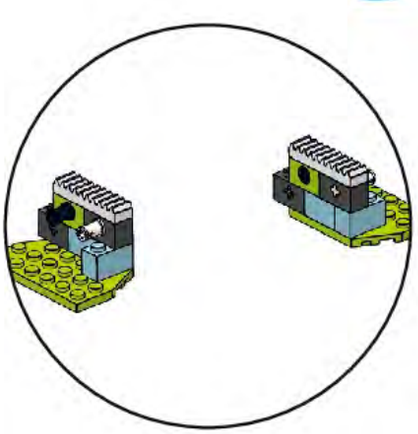

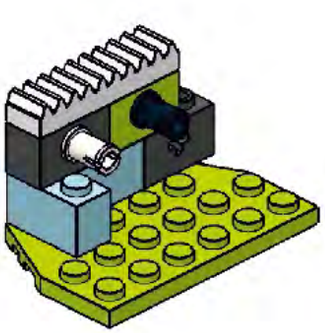

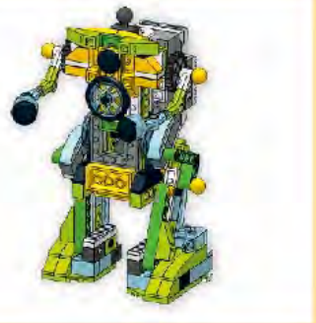

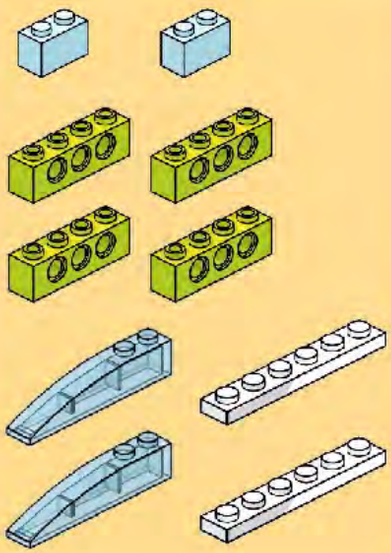

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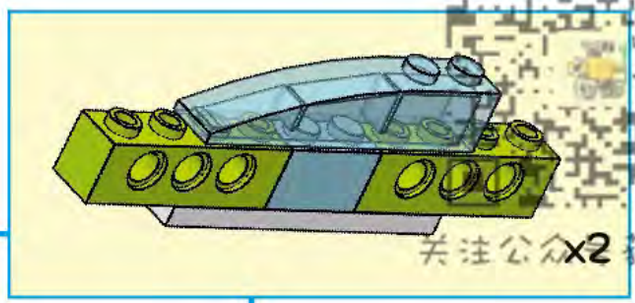

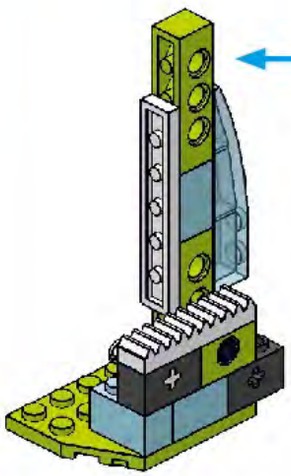

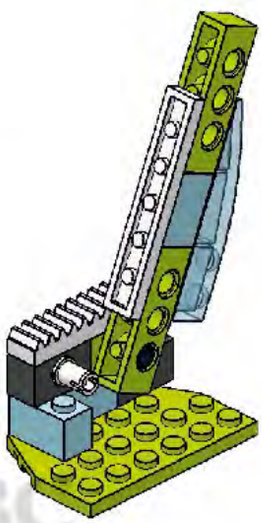

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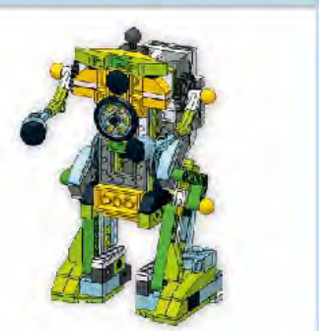

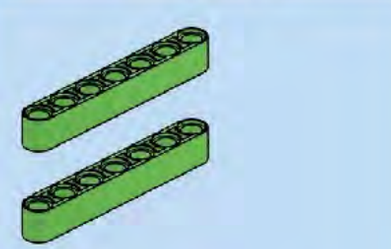

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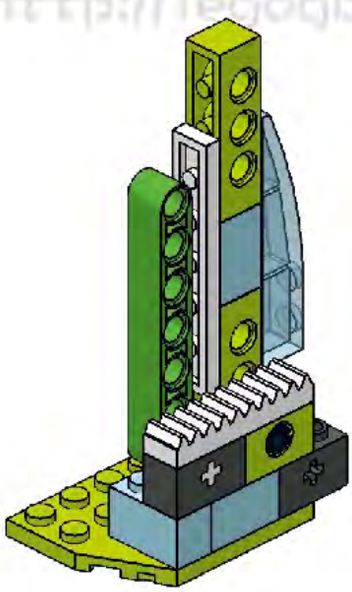

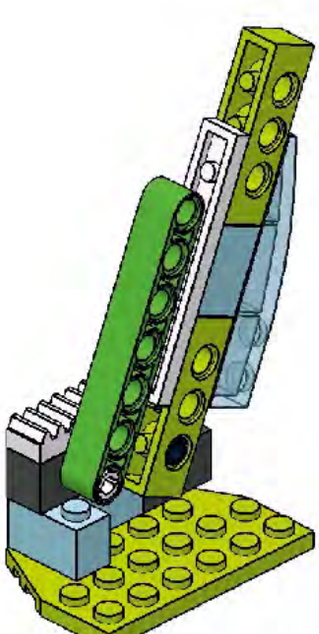

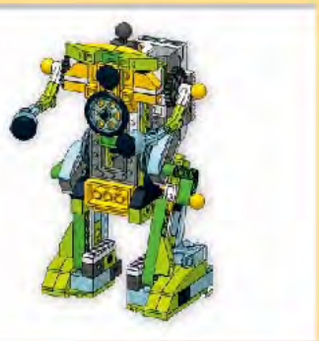

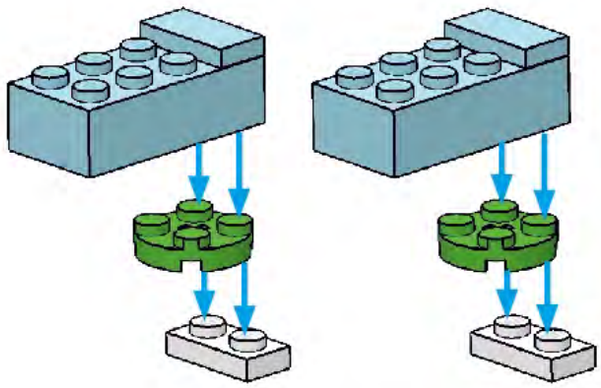

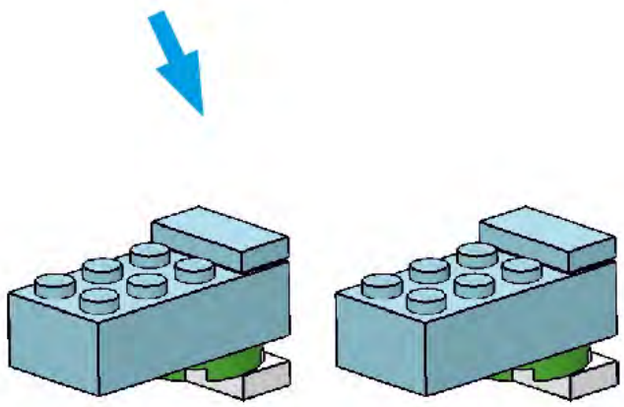

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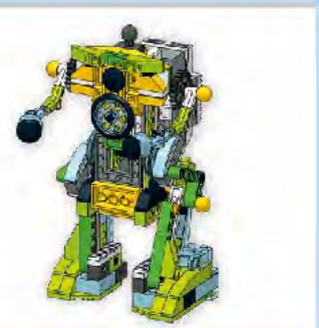

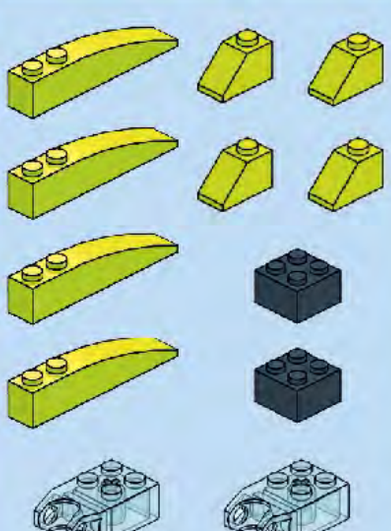

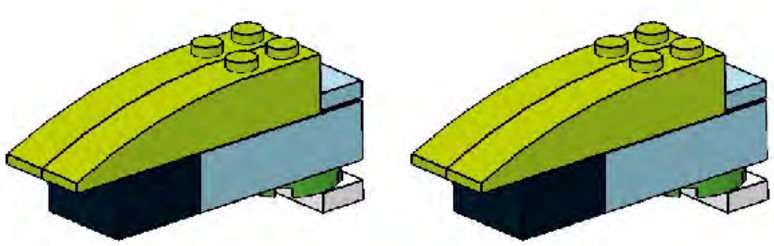

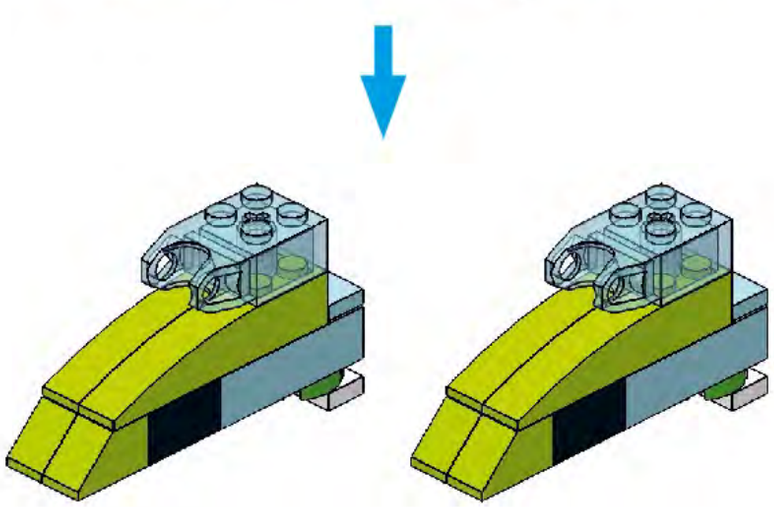

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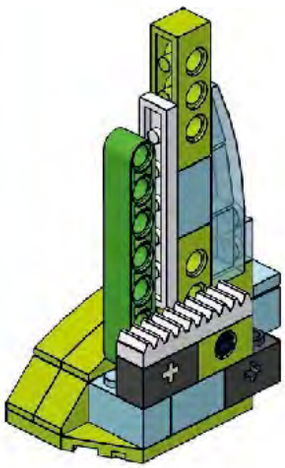

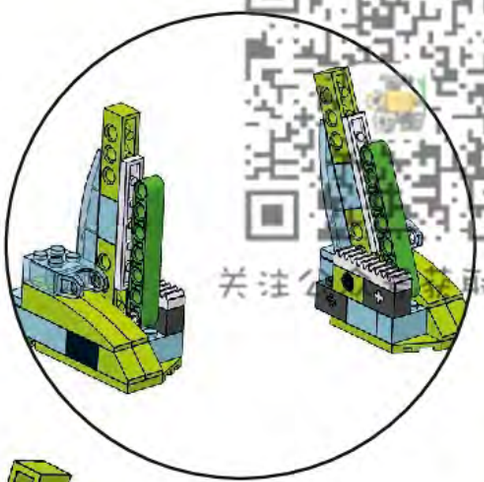

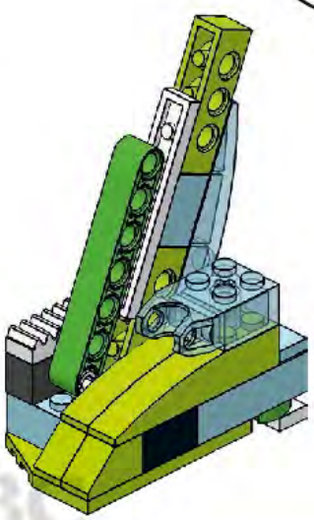

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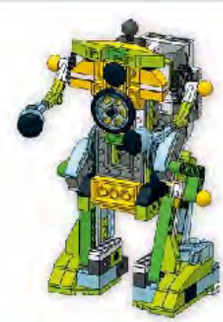

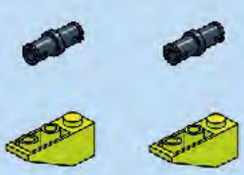

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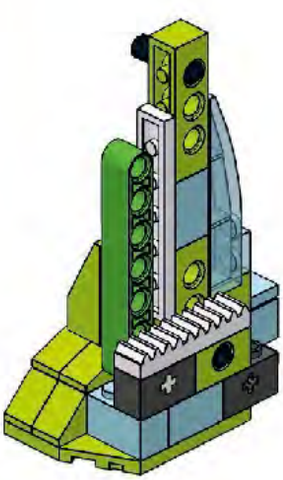

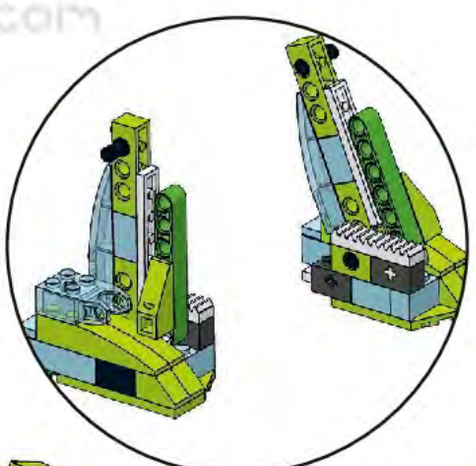

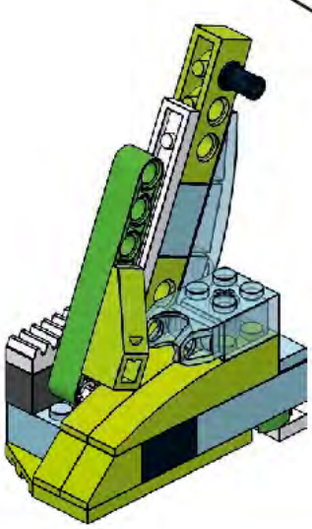

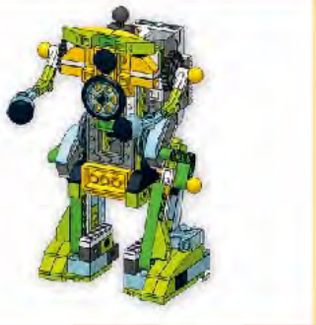

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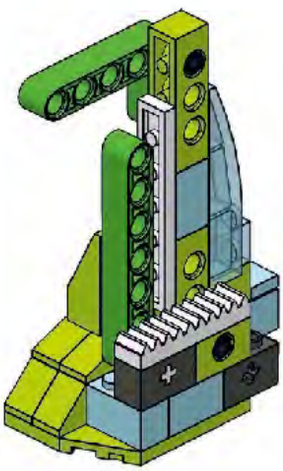

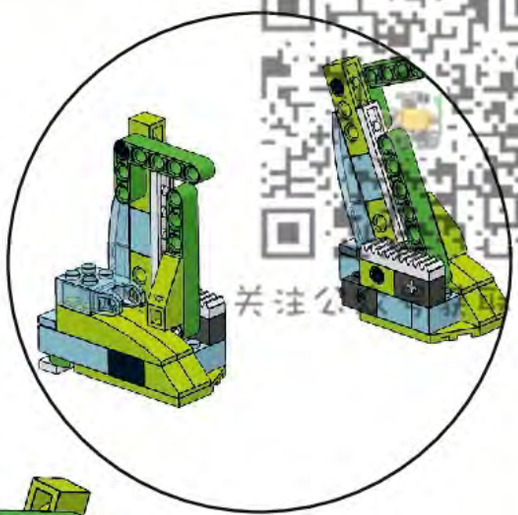

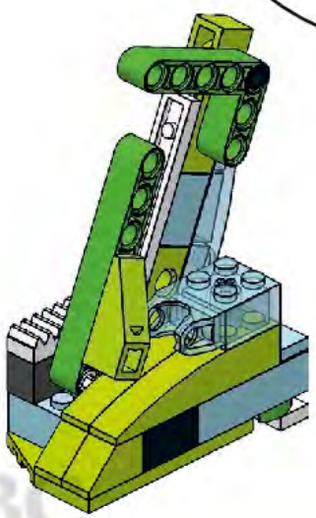

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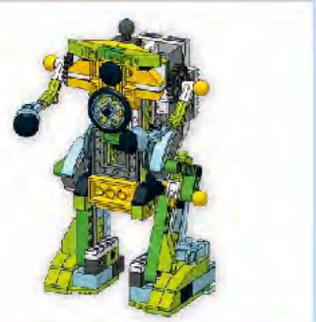

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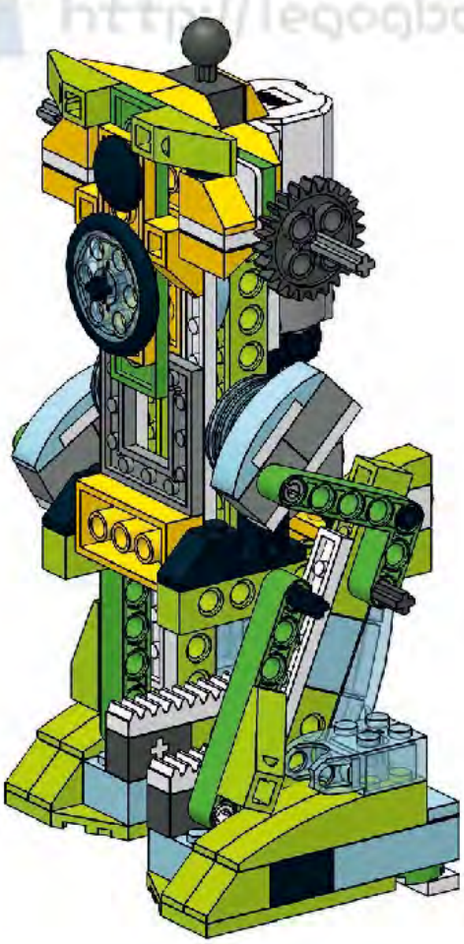

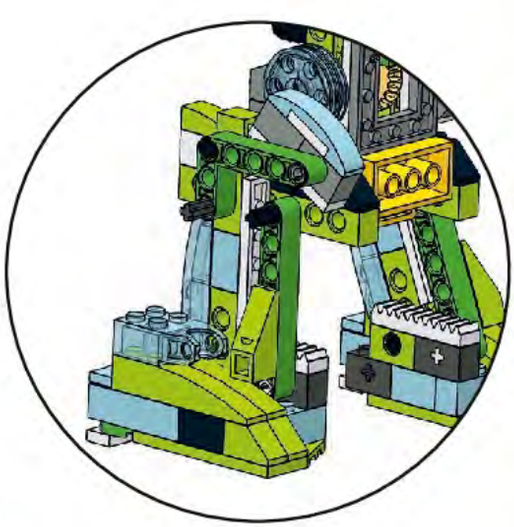

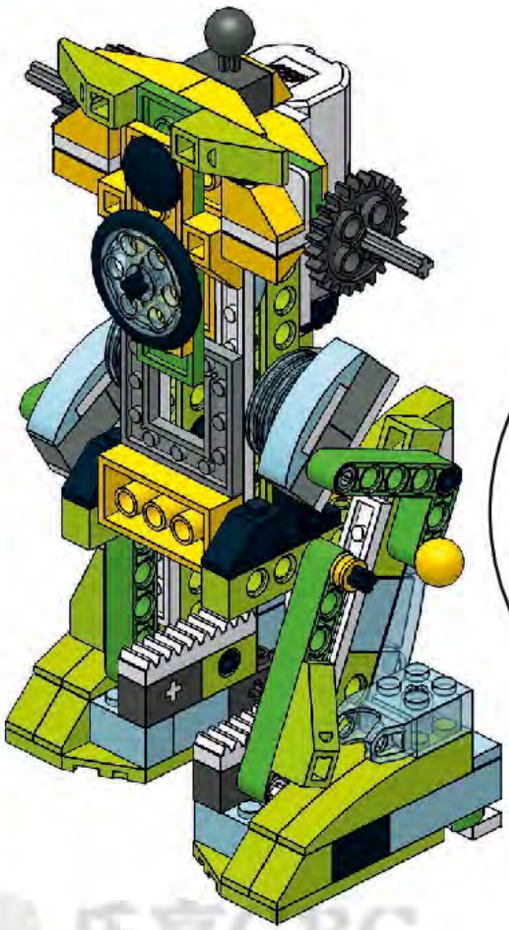

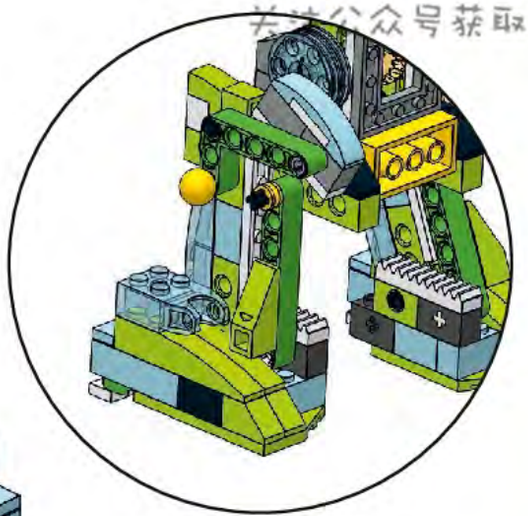

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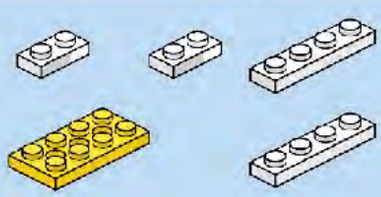

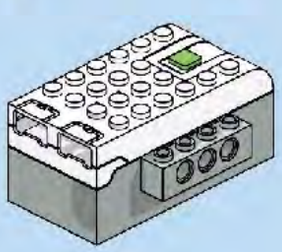

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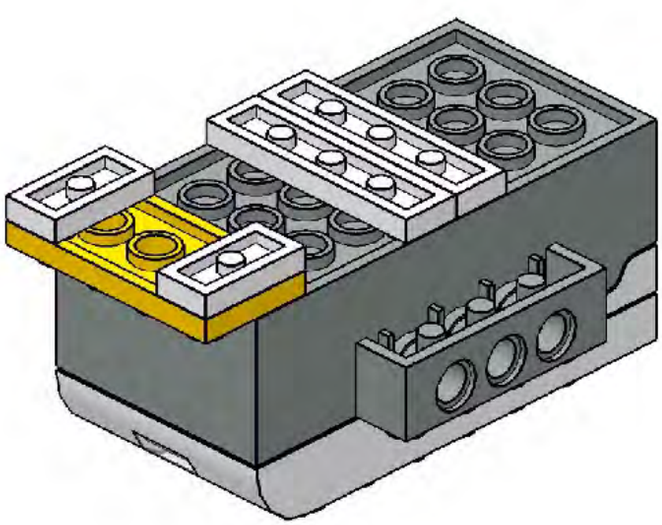

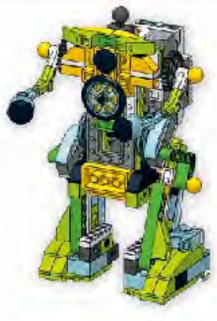

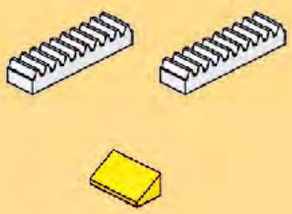

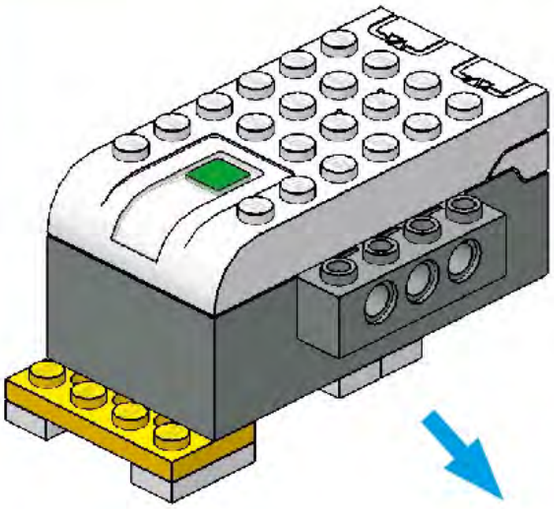

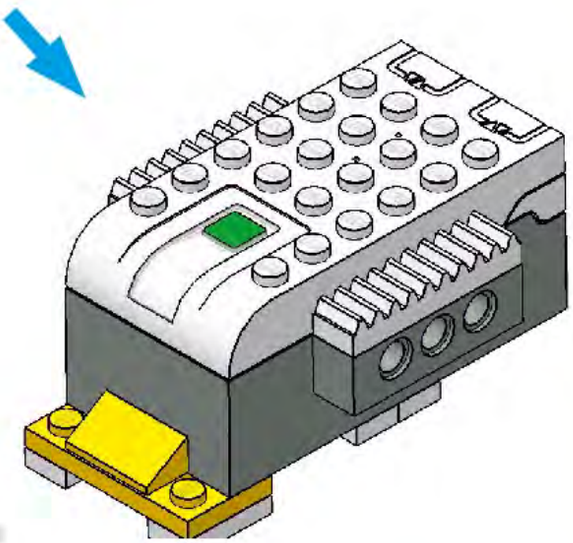

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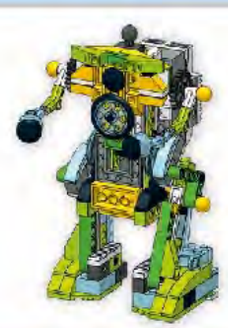

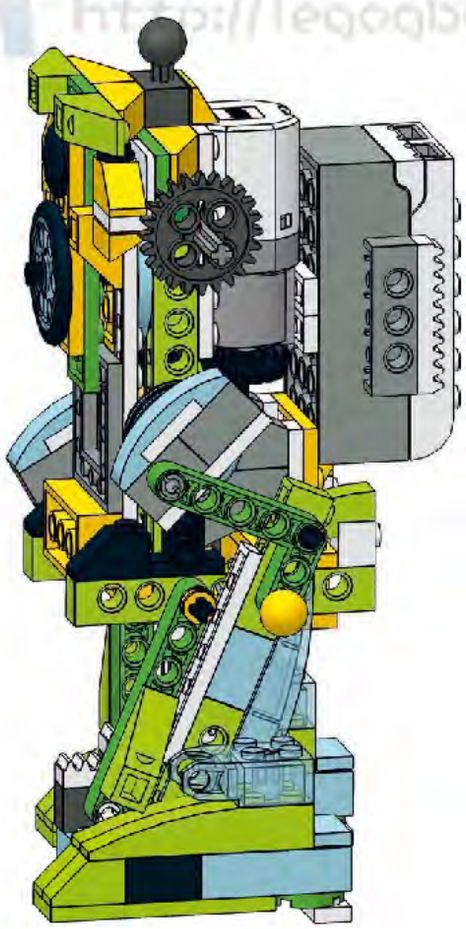

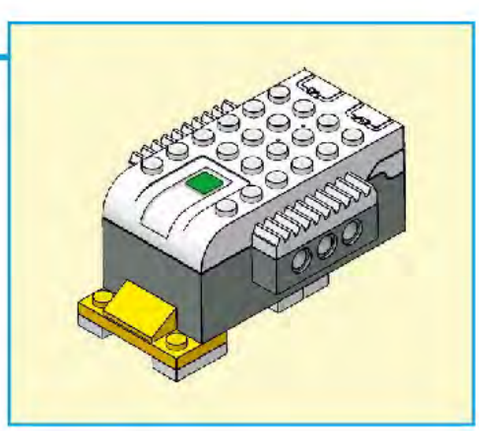

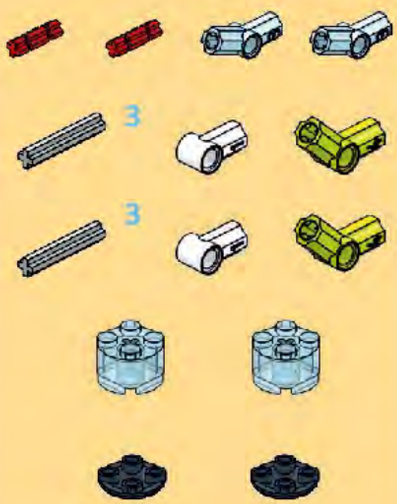

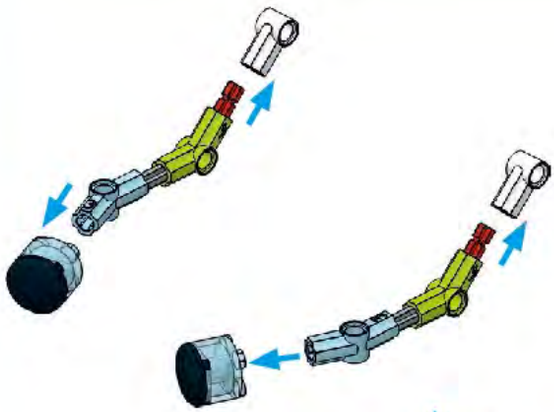

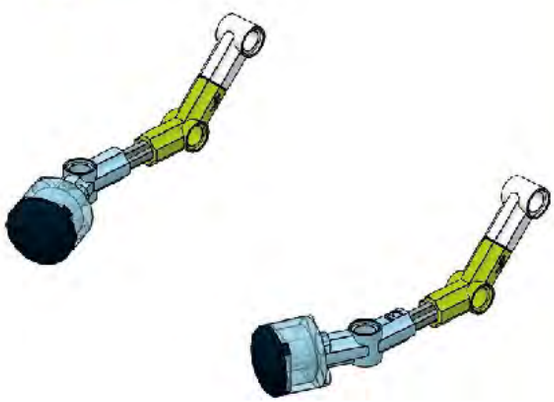

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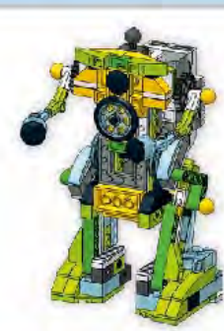

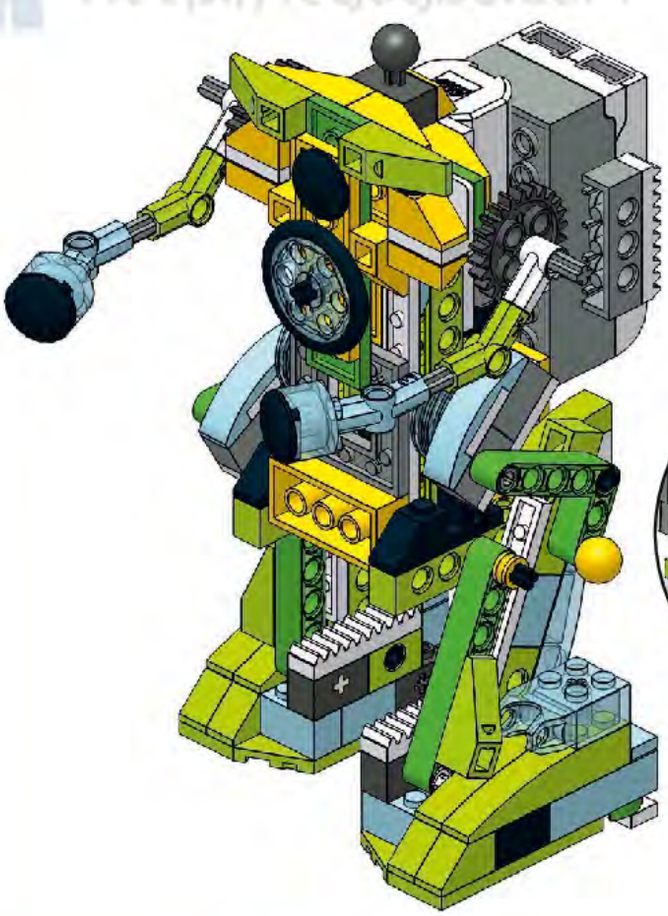

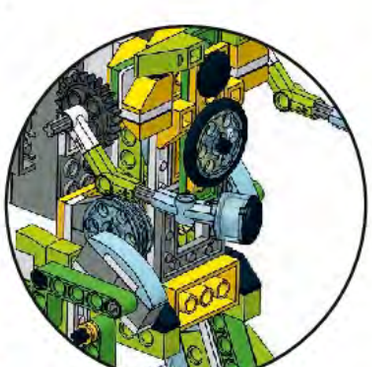

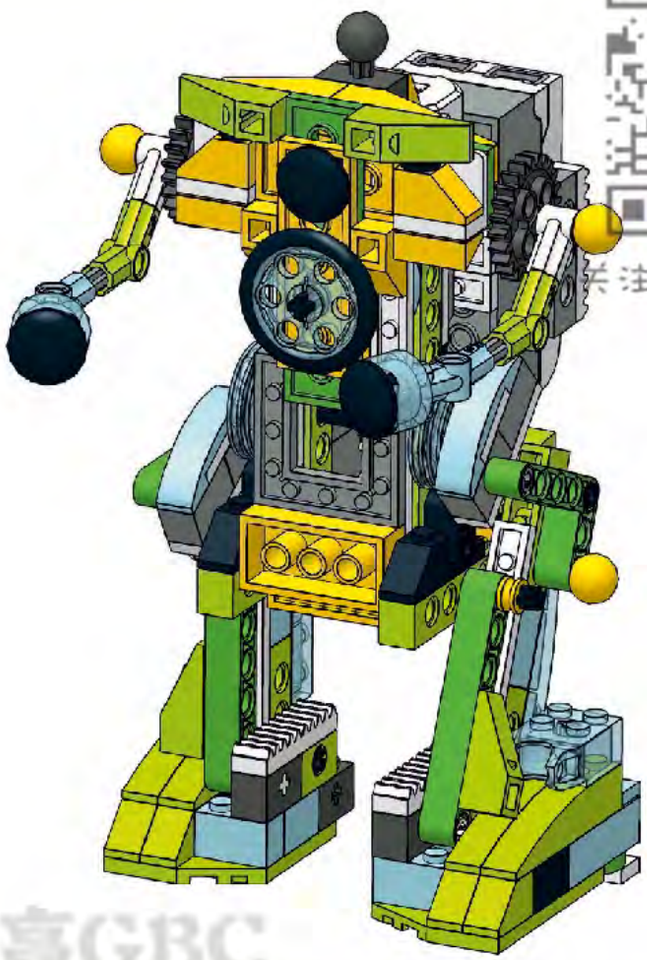

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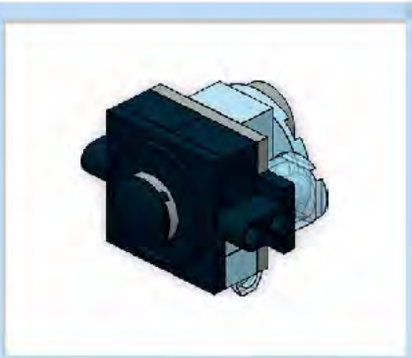

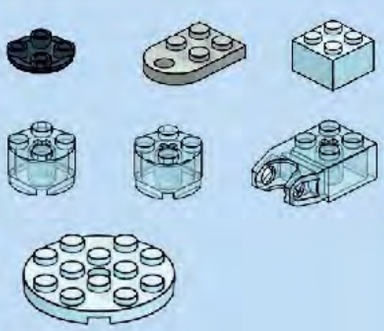

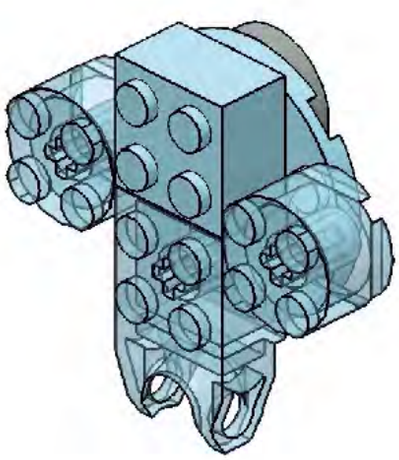

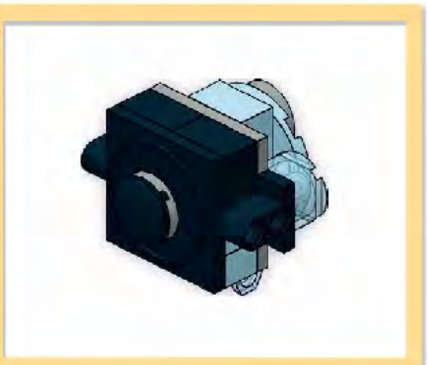

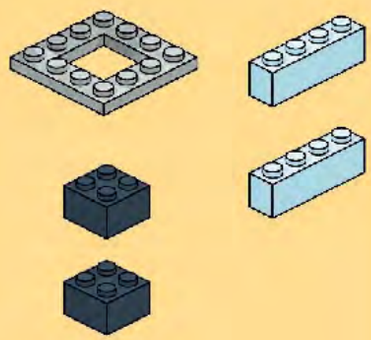

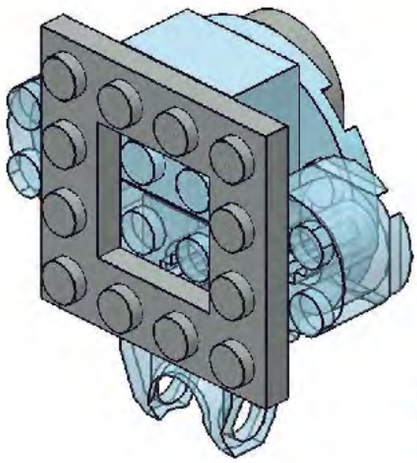

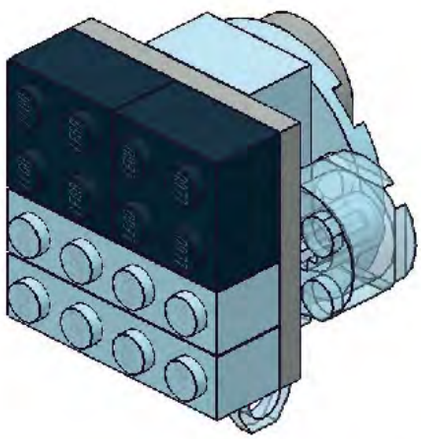

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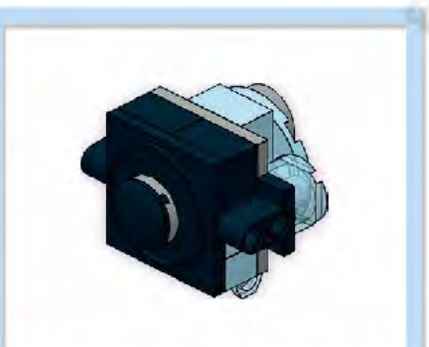

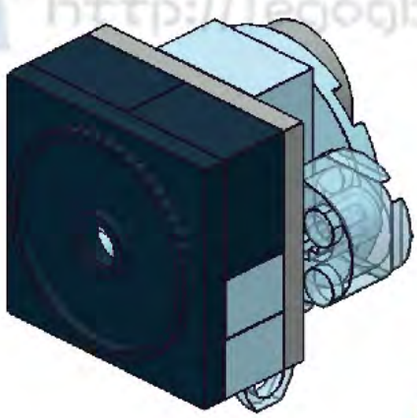

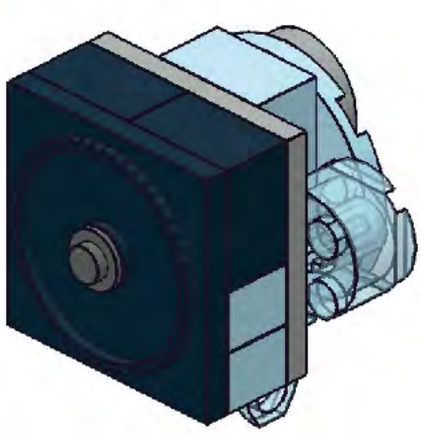

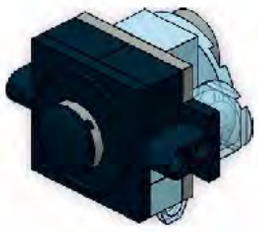

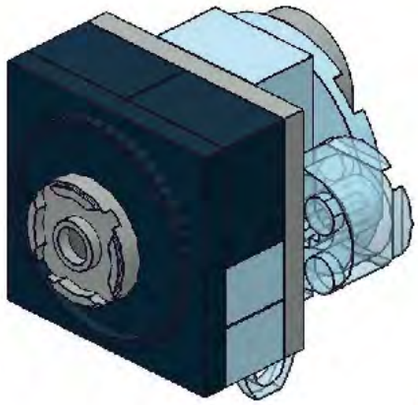

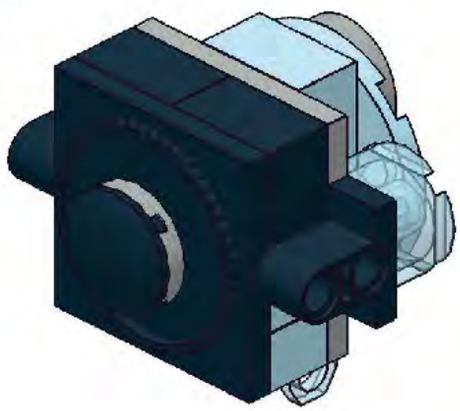

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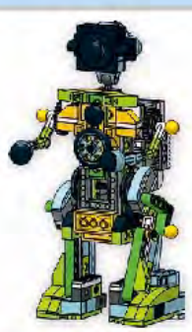

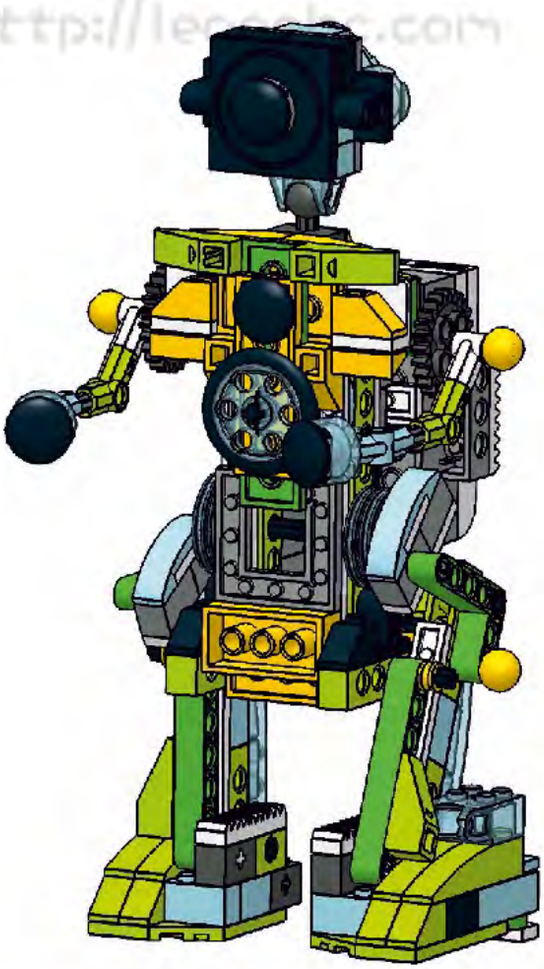

- Before going to the next phase, you can identify the mechanisms you are using in your astronaut prototype.
- Can you predict how your astronaut prototype will move by only seeing the model?
- How many gears are you using in your astronaut prototype?
- How many legs does your astronaut prototype have?

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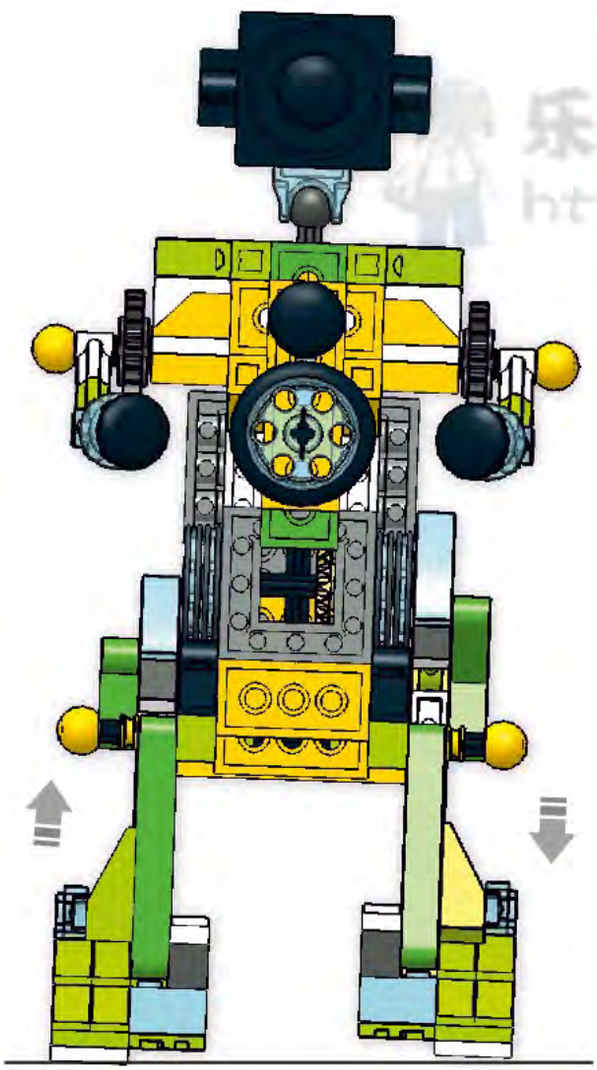
Design features

- Your astronaut uses the motor to drive its two legs.
- Can you identify the bevel gears and the parallel Chebyshev's lambda linkage?
- Can you identify the driver gear and the follower gear in the bevel gear mechanism?
- Are the two legs in an out-phase motion? You can check this by the position of the legs. In an out-phase motion, one leg should be in the opposite direction of the other one.



Out-phase motion

Program phase: Motor ramp stopping

• In this section, you will explore the use of ramp stopping for your motor.

• The **program idea** consists of moving your astronaut forward decreasing its speed until the astronaut will start moving first very fast, and it will continue decelerating until reaching zero power. Similarly to the skier program, you will be using a **variable** to develop the program.

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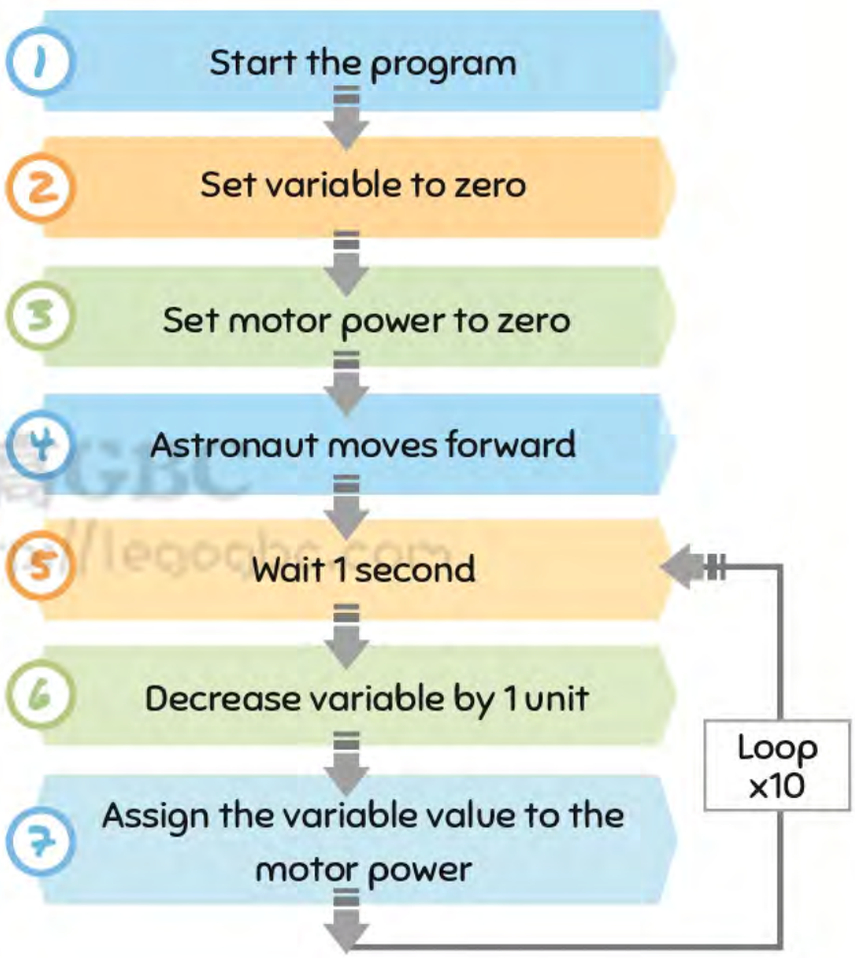
Flowchart

• Tasks 1, 2, 3, and 4 are called **initial conditions** since they are only **executed once** at the beginning of your program.

• Tasks 5, 6, and 7 are executed 10 times, taking the **motor power** from a value of **10** to a value of **0**.



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• The flowchart indicates **7 tasks**. Therefore, you assign a **programming block** for **each task**:

Test phase: Decelerate motion

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• Remember to verify the **communication** between your WeDo software and your WeDo hub before you start testing your prototype.

• Start testing your prototype by executing the program developed in the **program phase** by clicking the **"Start"** block.

TEST 1: Finding the right motor direction

• Identify in which direction your motor has to rotate to make your astronaut move forward ward and backward.

TEST 2: Increasing or decreasing the deceleration rate

• You can accelerate or decelerate your **motor ramp stopping** by increasing or decreasing the wait time (task 5).

TEST 3: From out-phase motion to in-phase motion

• Modify the position of your astronaut legs to perform an **in-phase motion** and execute your program. How differently does your astronaut move?

Document & share phase

• Remember to collect all your **notes**, **videos**, and **photos** to report your **findings and results**.
• Report your findings and results from the **three tests** performed in the **test phase**.
• Record a video of your astronaut moving using an **out-phase** and an **in-phase** motion to compare how different the motions are.

Enhancing the experience

• **Build:** You can add a sensor to your astronaut prototype so it can interact with the environment.
• **Programming:** Program the sensor added to your astronaut prototype.