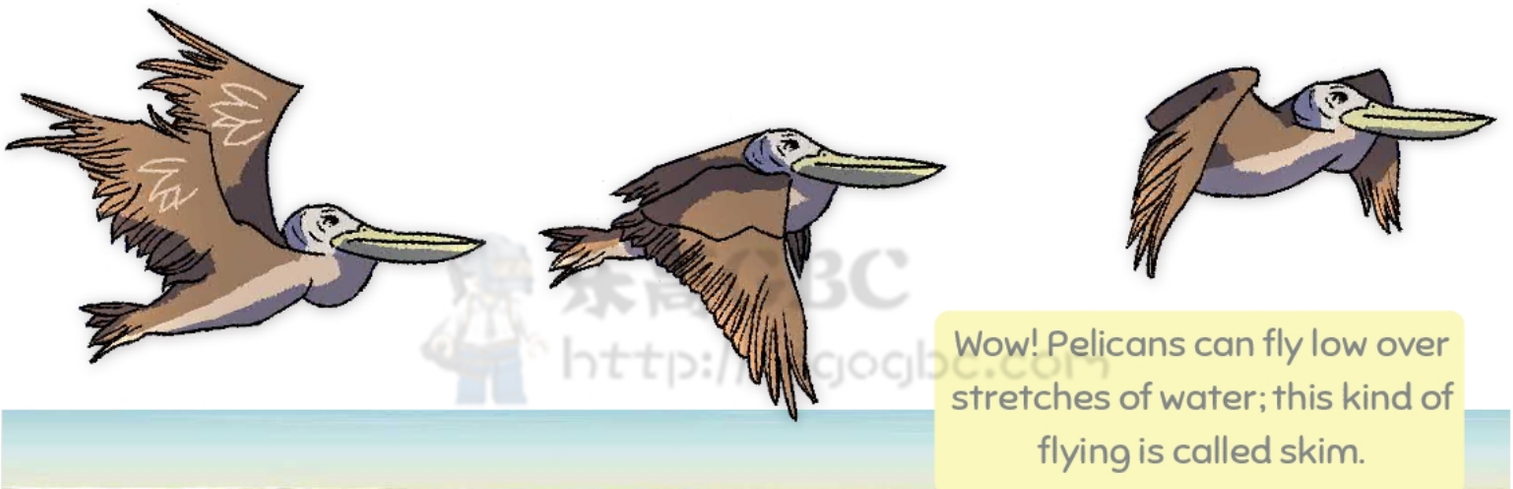
Pelican

Design phase: Flapping wings motion

• Remember to have a **white paper** and a **pencil** to start drawing your ideas!

Looking for inspiration

• Pelicans are **large birds** characterized by a **long beak** and a **large throat pouch**.
• They are found on **coastlines** and also along lakes and rivers.
• Pelicans like **fishing in groups**; they can use their **elastic pouches** to **catch fish**.
• Most of the different pelican species have **pale plumage**; however, there are some exceptions as the **brown pelican** and the **Peruvian pelican**.
• They can **fly for hours** or even days looking for feeding areas.



• On a piece of paper, you can sketch some **ideas** to replicate the wings motion observed in pelicans.

Flapping wings

• **Flapping wings** are used by a wide variety of animals such as birds and bats and a variety of insects to fly both **quickly** and **slowly**.
• Birds flap their wings to **land** and **take off** from anywhere. For example, birds flap their wings at a large angle of attack to push themselves away from the ground during take-off.
• The principle behind the flapping wings motion is: the two wings are flapped to produce both **lift and thrust**, to **overcome gravity**, and to provide a **sustained flight**.

Build phase: Crank-rocker four-bar linkage

- Given the following building instructions, you can build a crank-rocker four-bar linkage.

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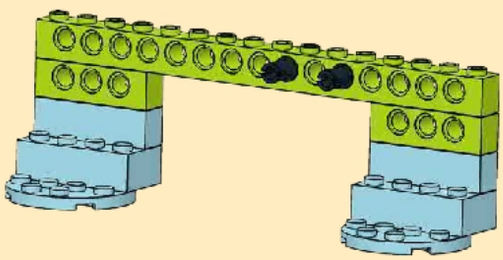

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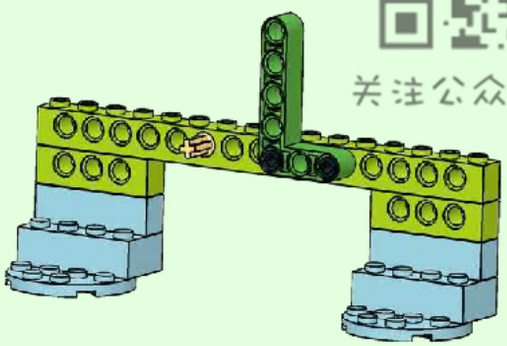

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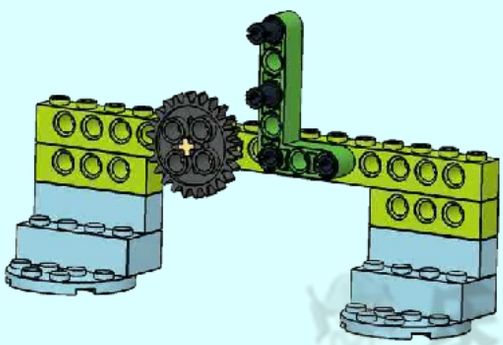

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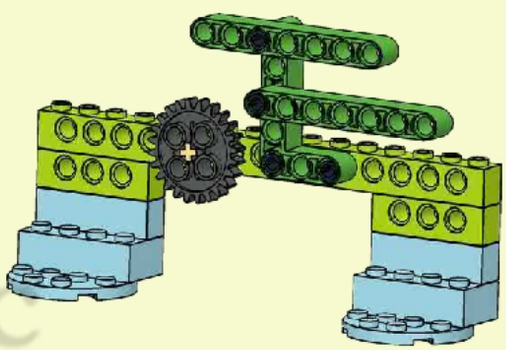

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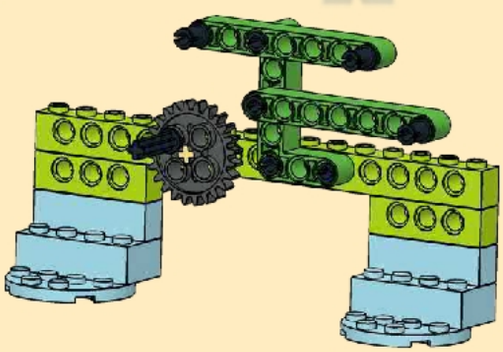

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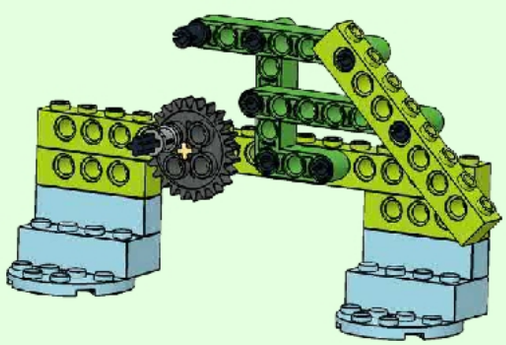

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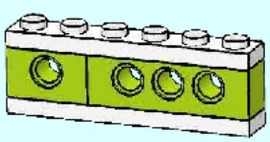

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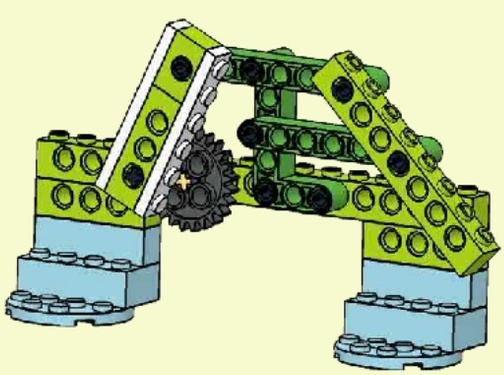
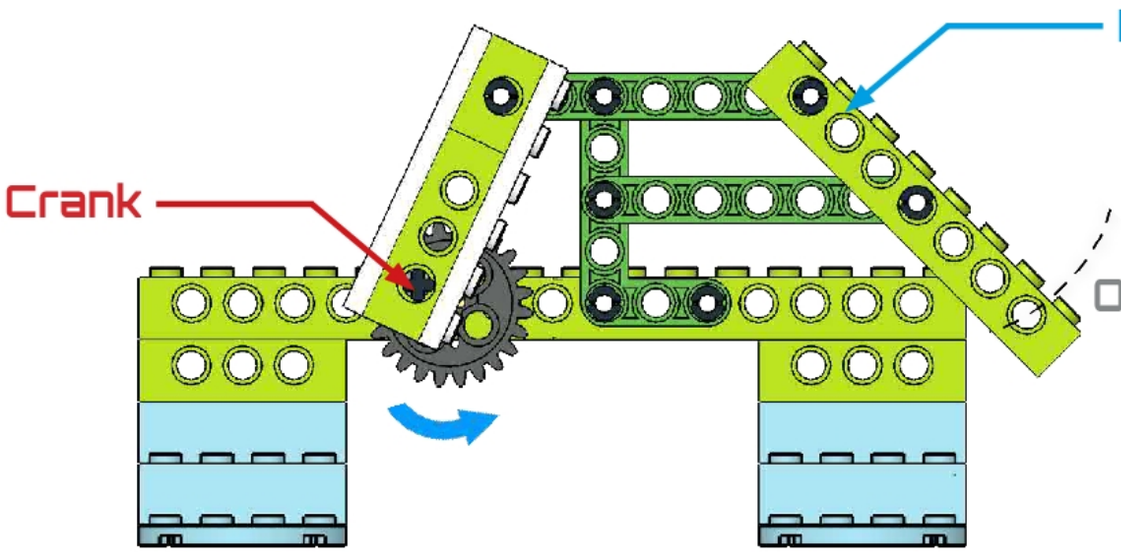


- Spin the gear to see the generated flapping wings motion.



Crank-rocker four-bar linkage

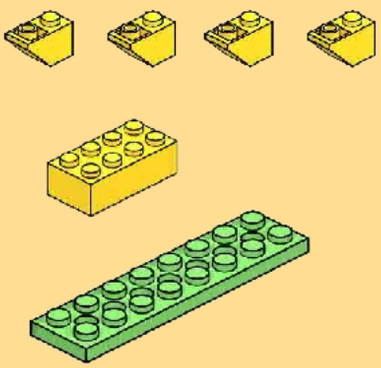
- **Crank:** A side link which revolves relative to the frame is called a crank.
- **Rocker:** Any link which oscillates is called a rocker.
- **Crank-rocker mechanism:** It is a four-bar linkage; if the shorter side link revolves and the other one rocks (oscillates), it is called a crank-rocker mechanism.

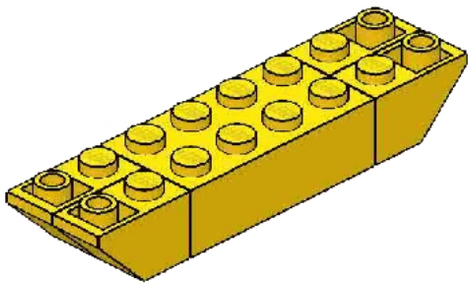
Four-bar linkage variations

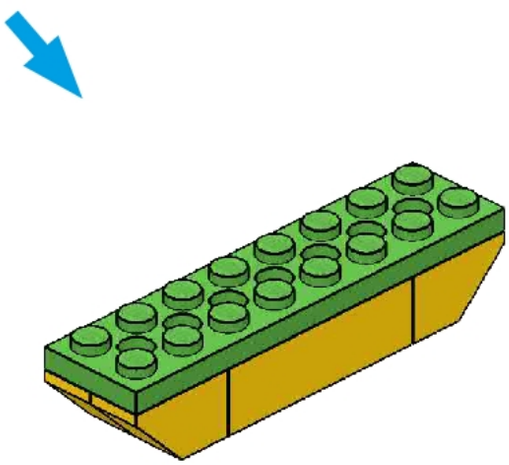
- A variety of useful linkages can be formed from a **four-bar linkage**. Through slight variations, such as changing the characteristics of the pairs or proportions of the bars, you can generate **different kinds of motions**.
- In previous chapters, you have used several variations of a **four-bar linkage** to create different prototypes. All of the following are four-bar linkages:
  - The **Chebyshev's lambda linkage** used in your American rhea, plesiosaurus, sea lion, skier, and astronaut prototypes.
  - The **parallel linkage** used in your frog and turtle prototypes.
  - The **parallel free-joint linkage** used in your dolphin prototype.

- Now you are ready to build your WeDo pelican 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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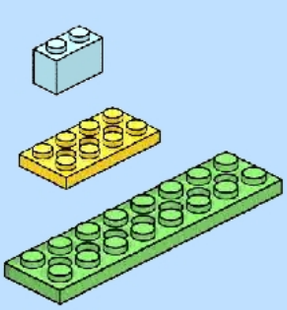

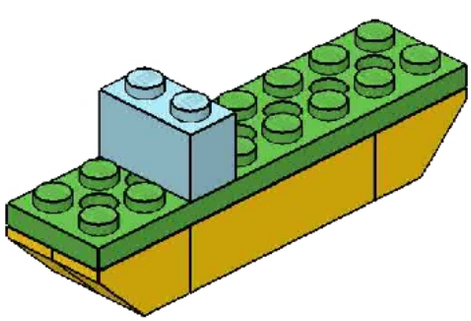

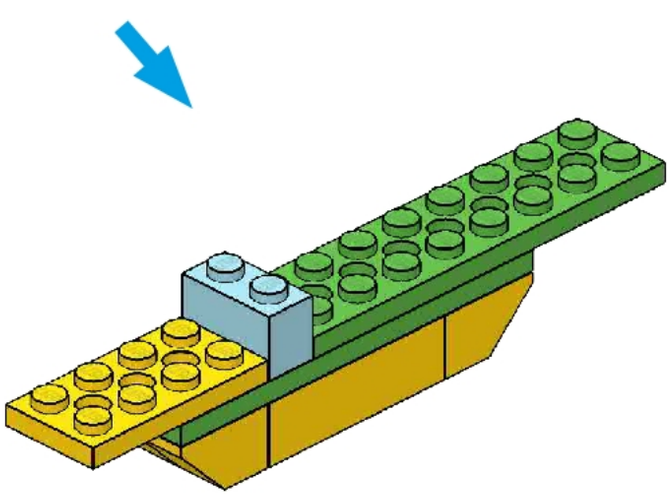

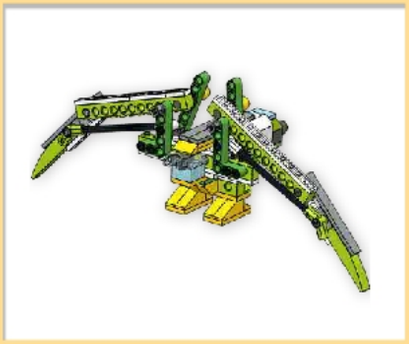

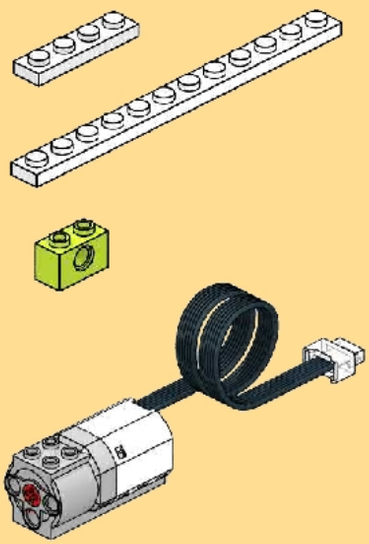

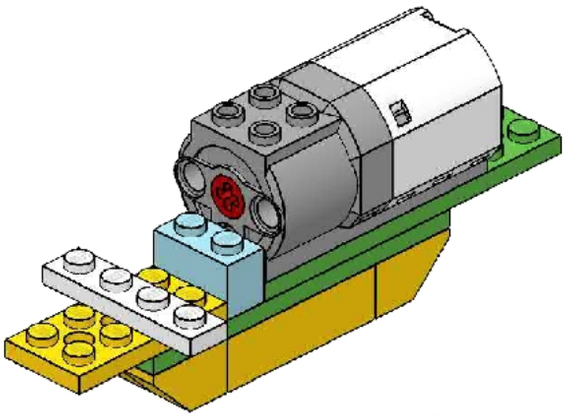

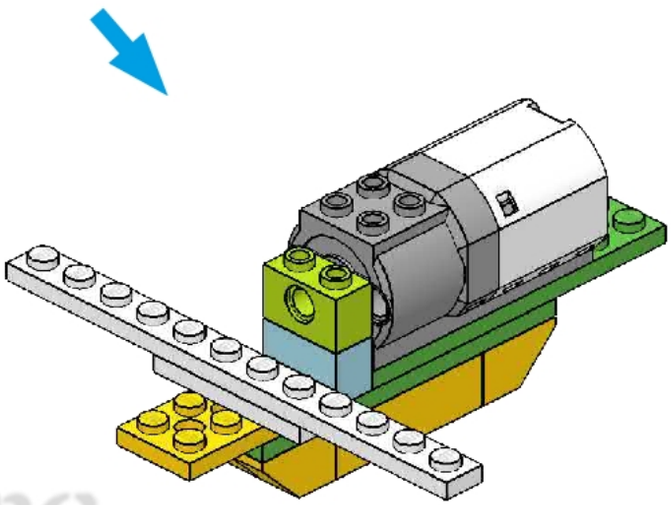

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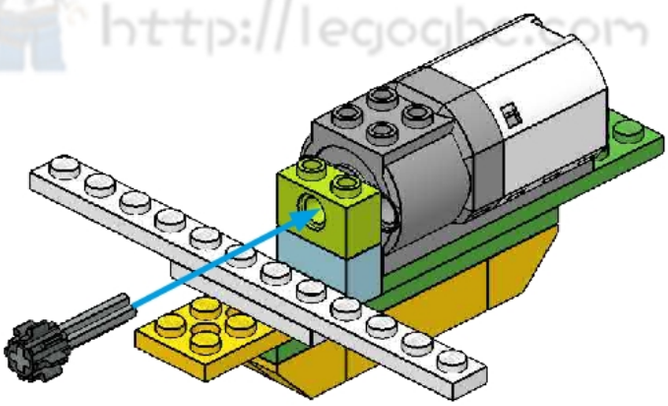
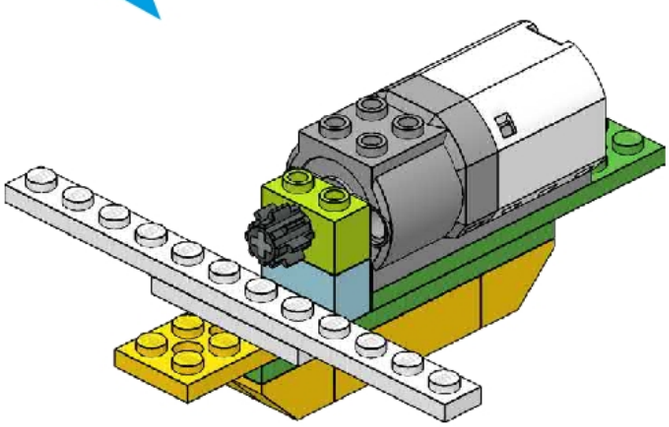
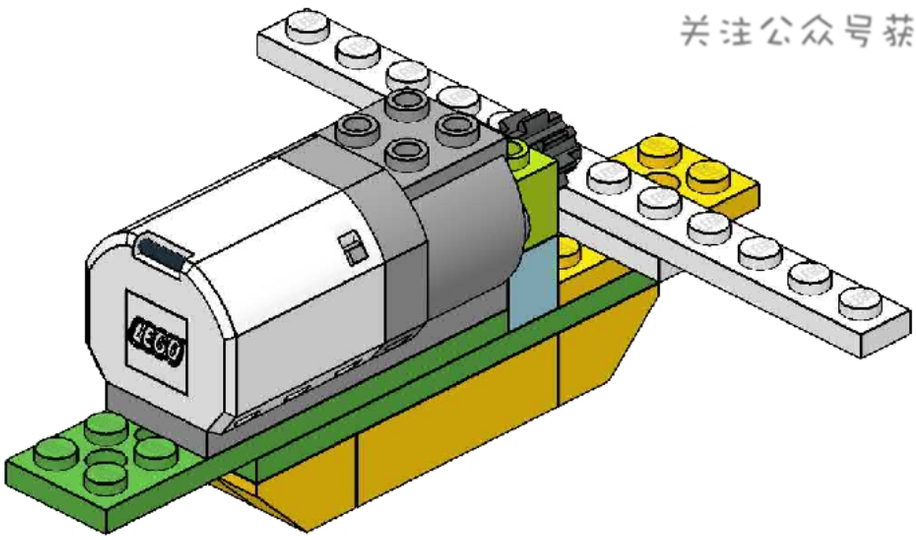
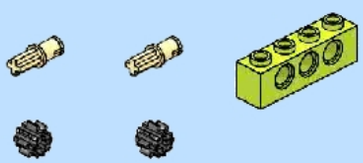




Flip your prototype 180 degrees to have the same view.





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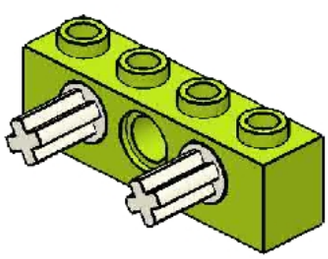

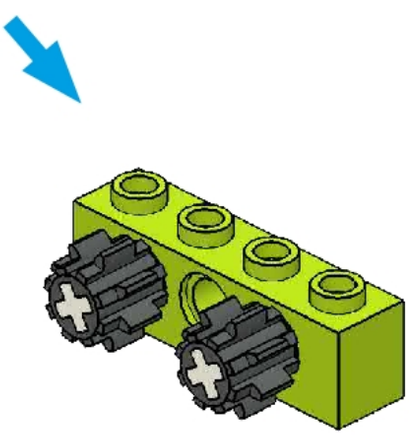

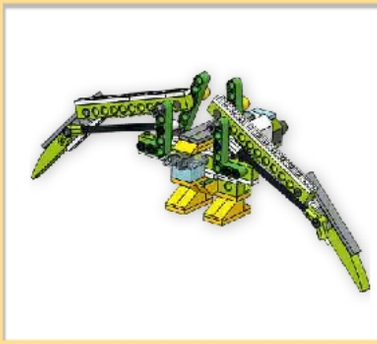

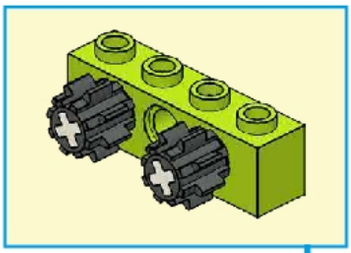

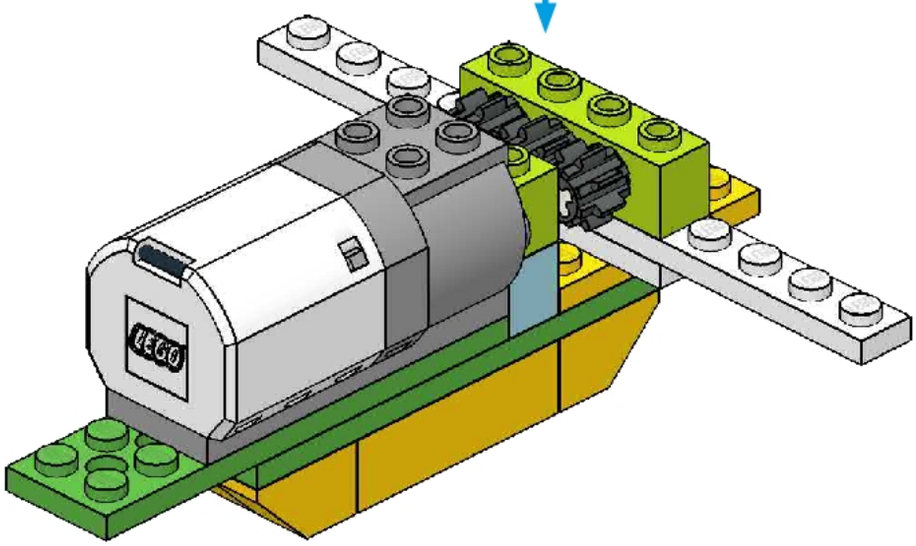

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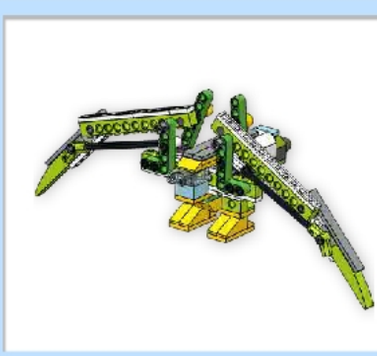

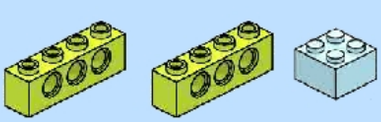

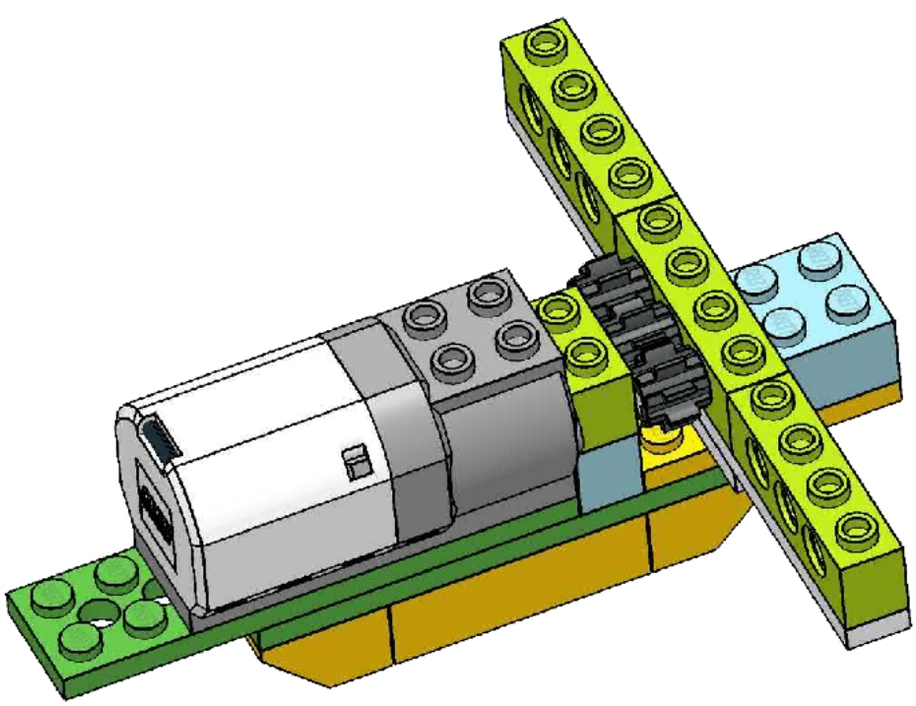

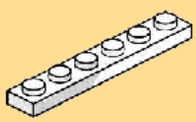

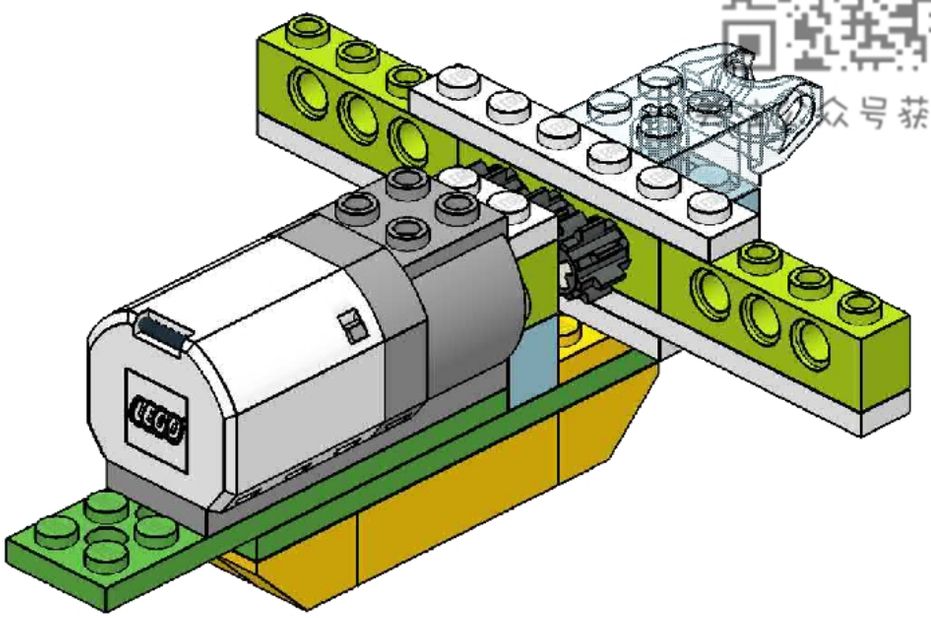

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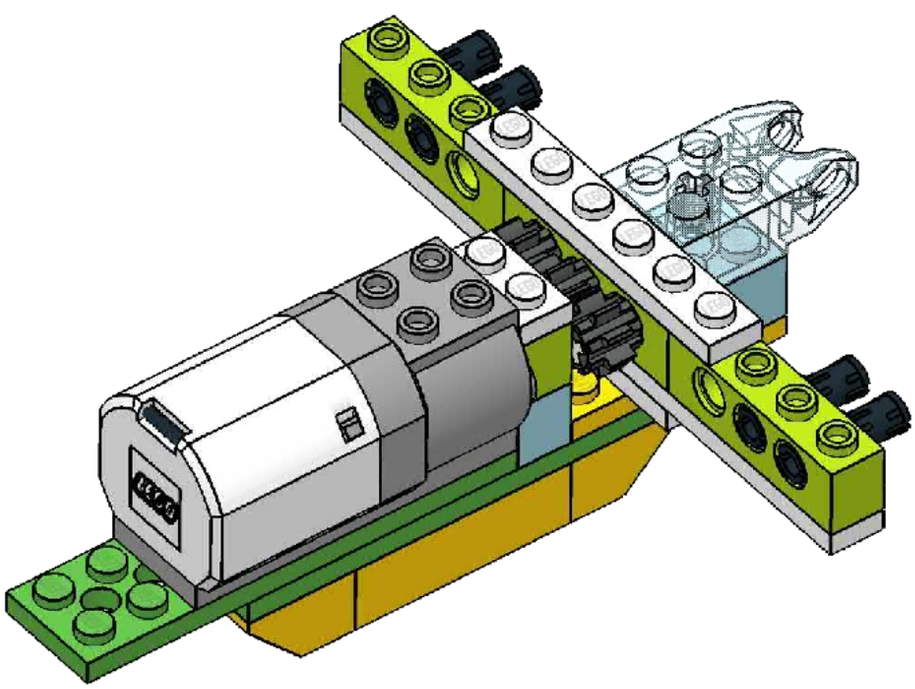

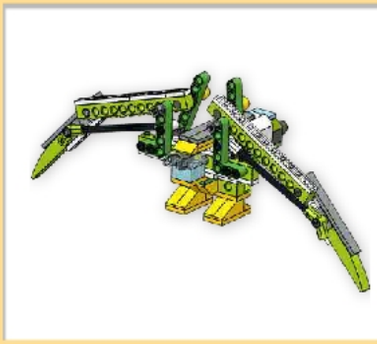

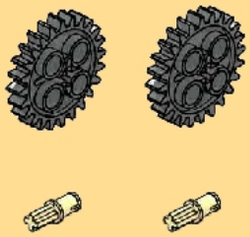

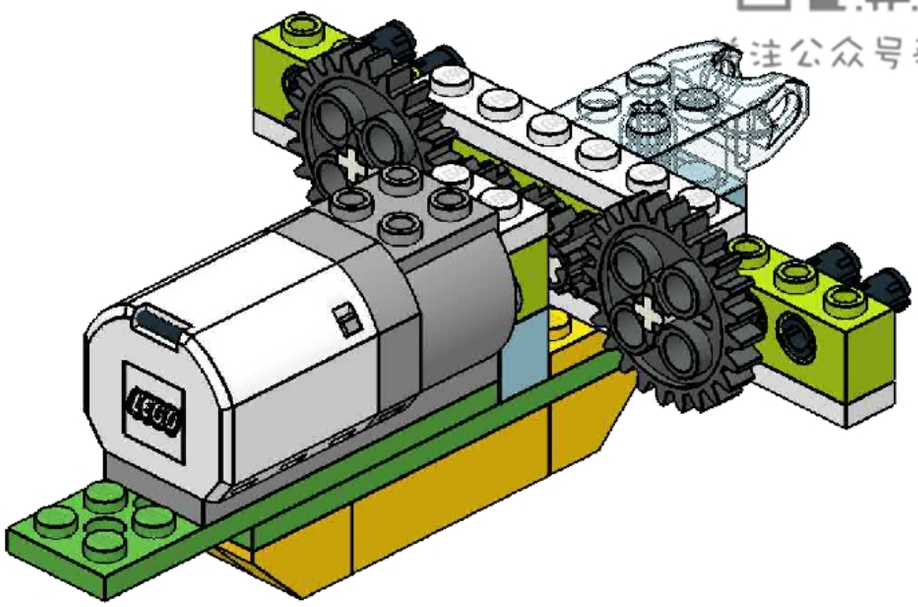

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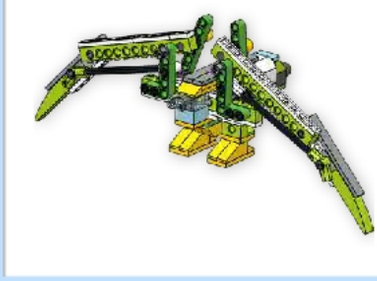
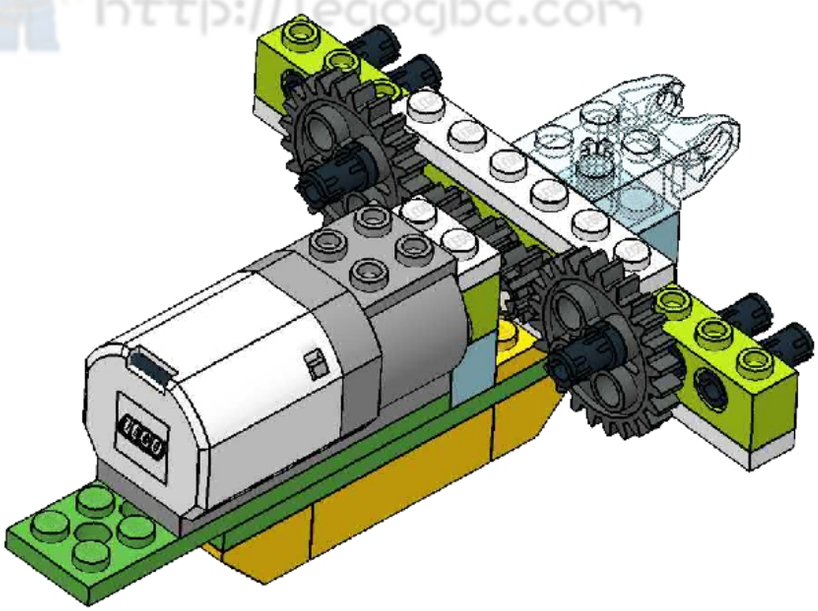
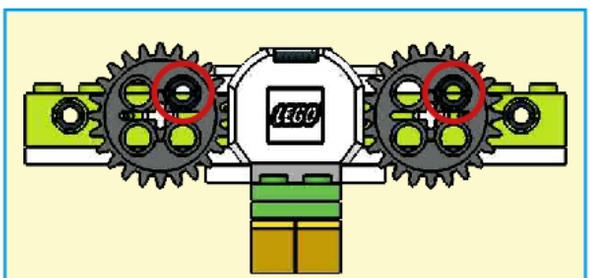
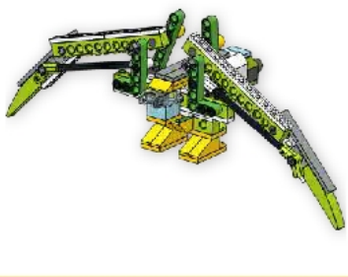
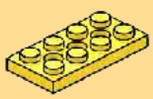


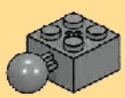




Be careful! The pelican uses an "in-phase" motion, meaning that one of the axles is in the exact same position of the other one.







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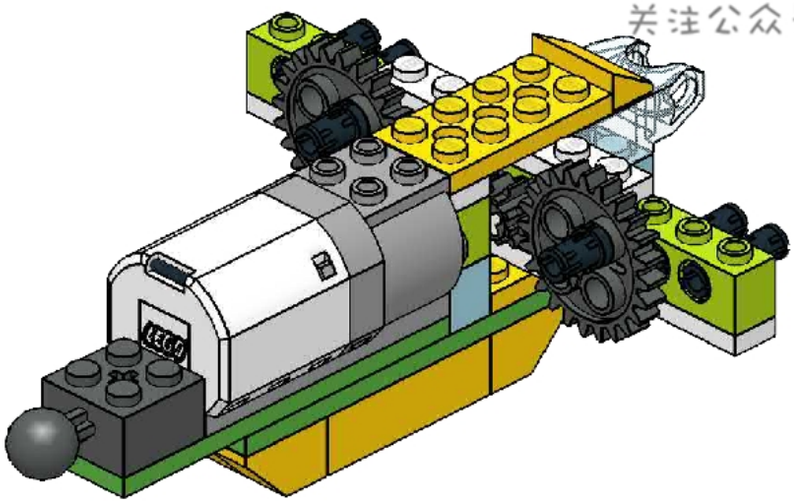

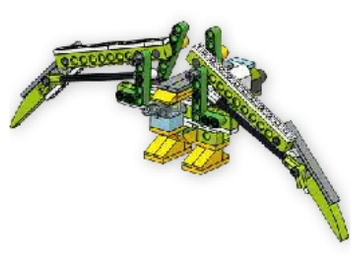

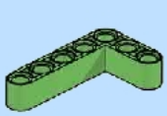

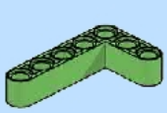

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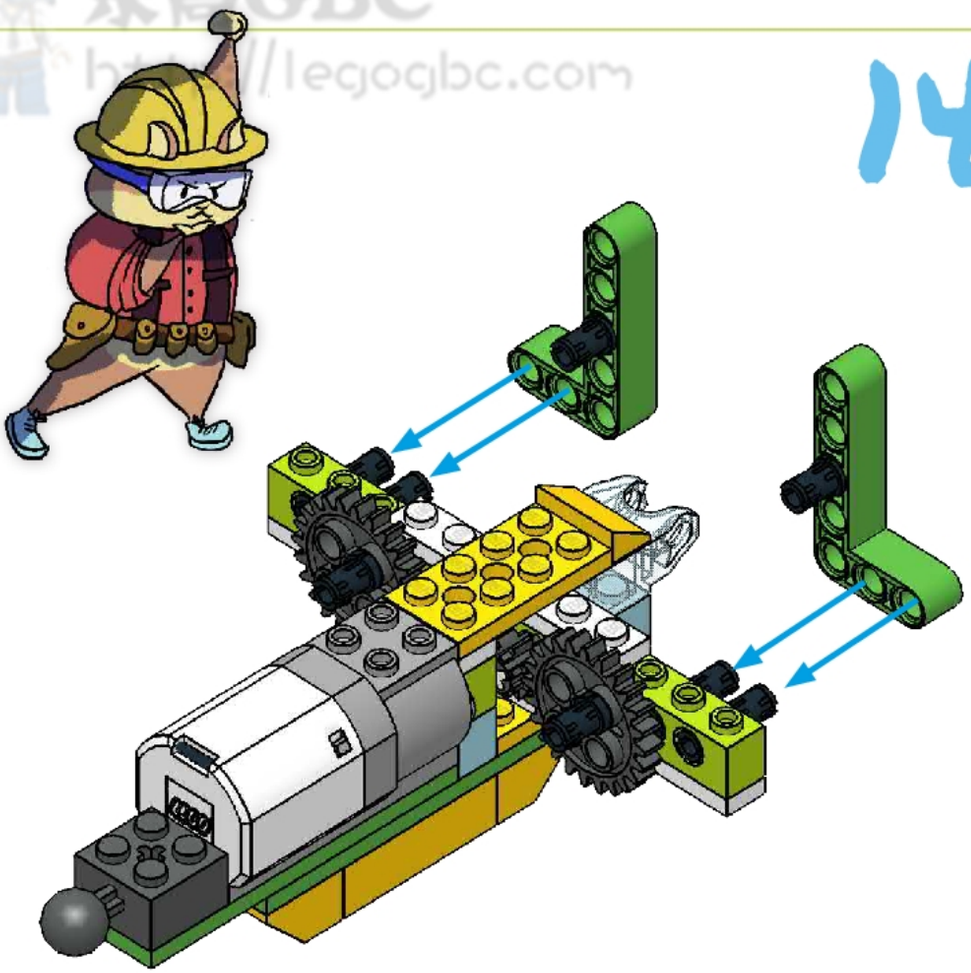

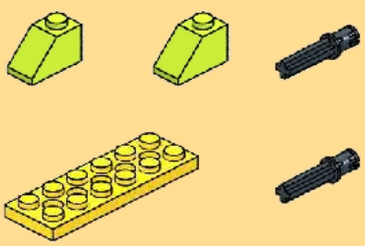

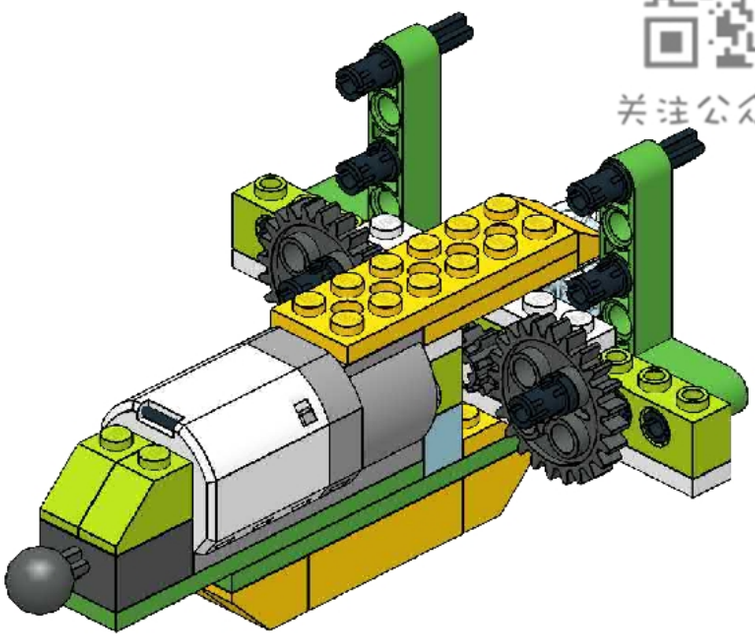

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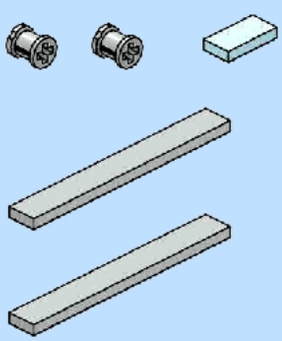

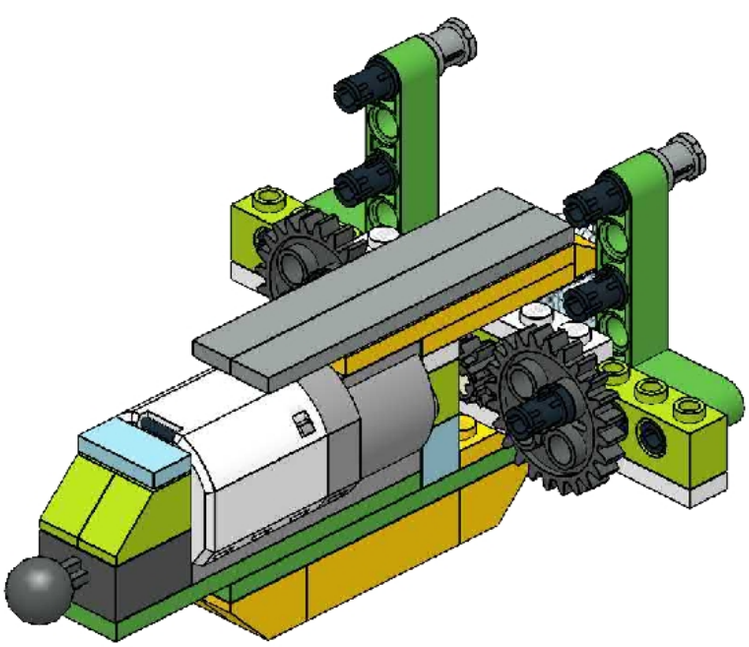

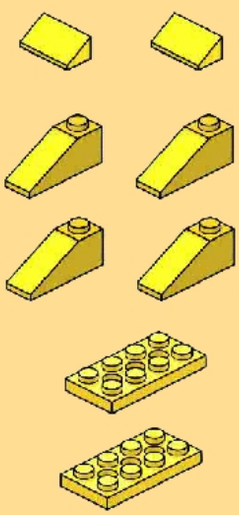

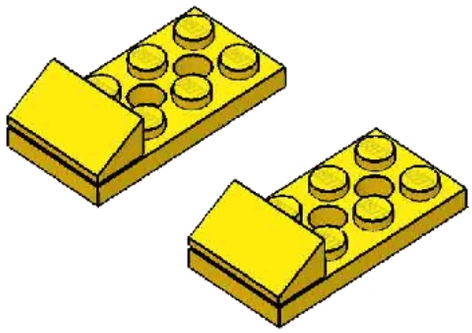

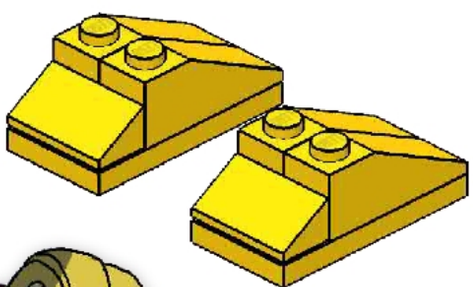

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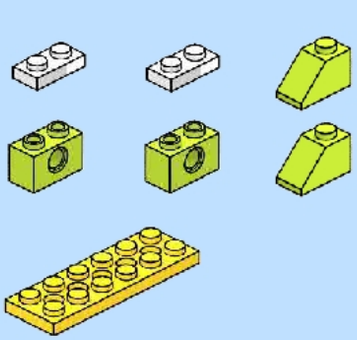

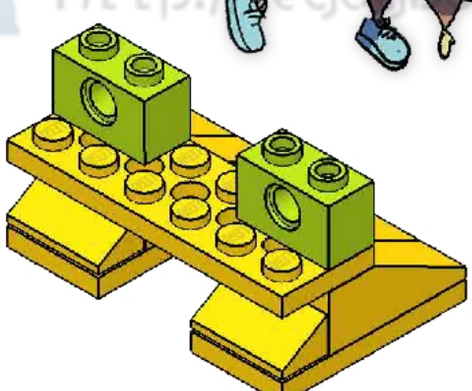

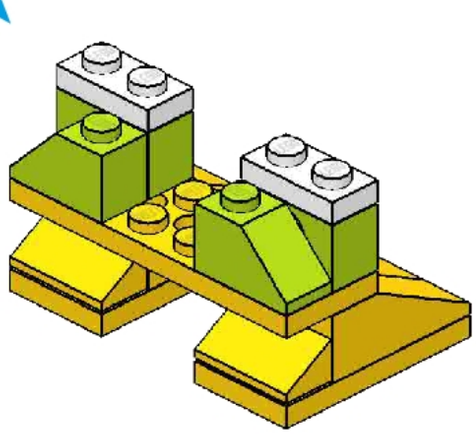

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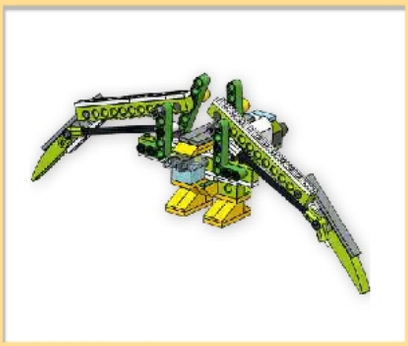

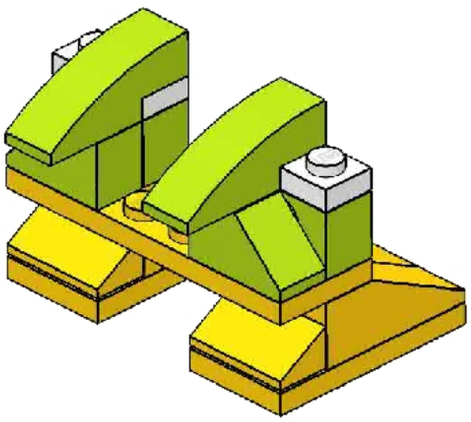

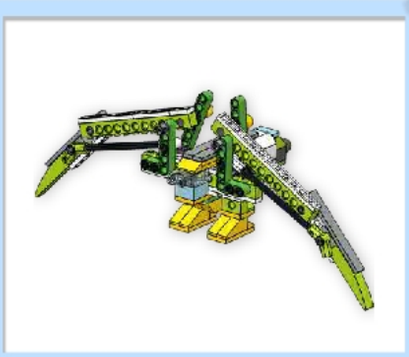

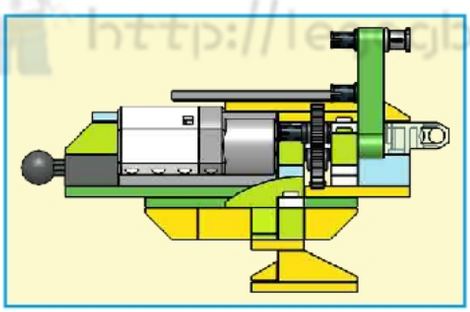

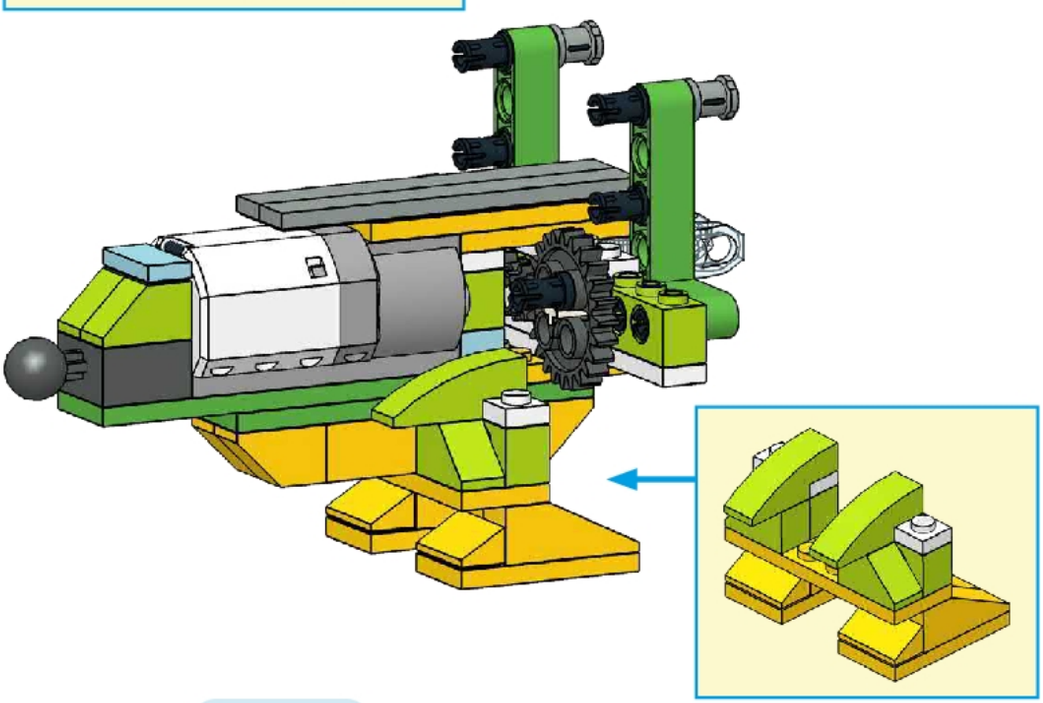

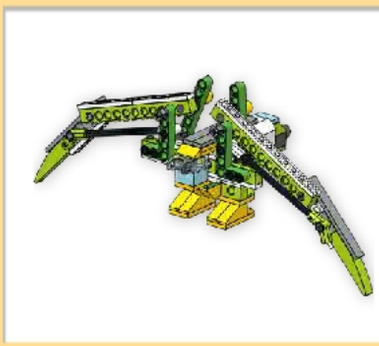

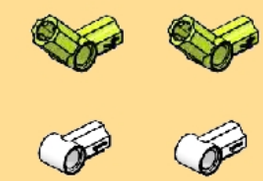

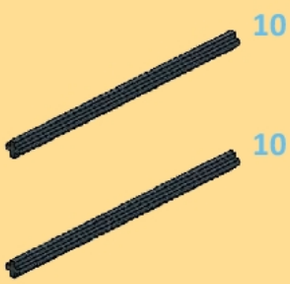

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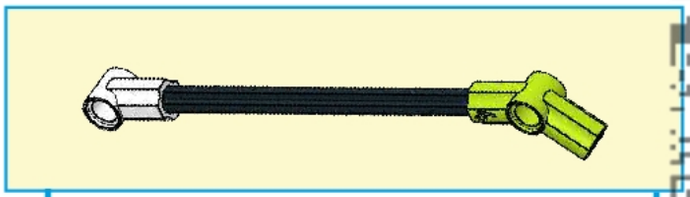

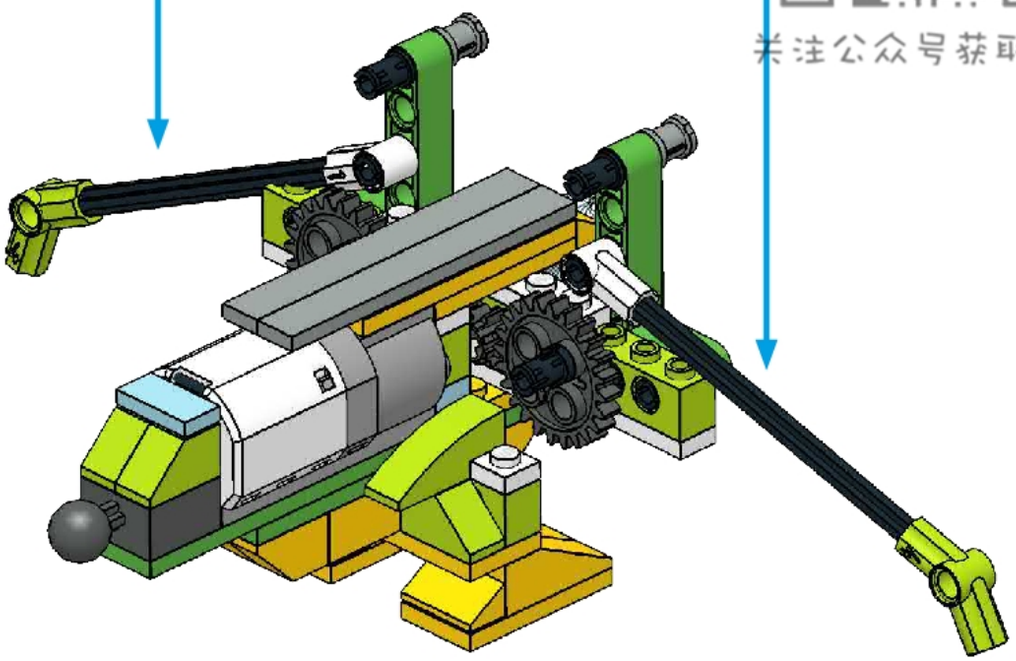

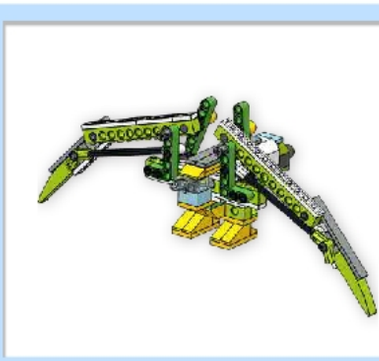

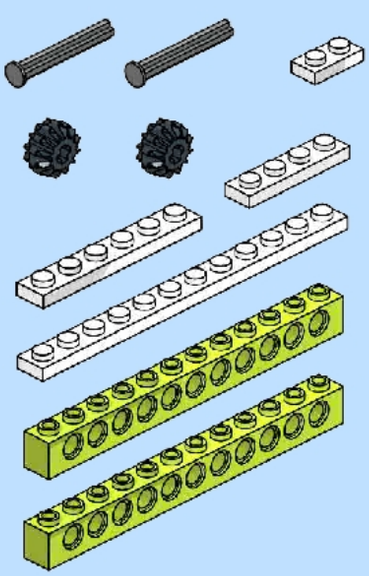

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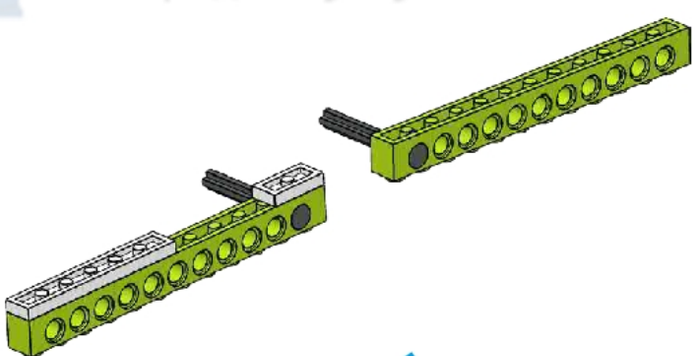

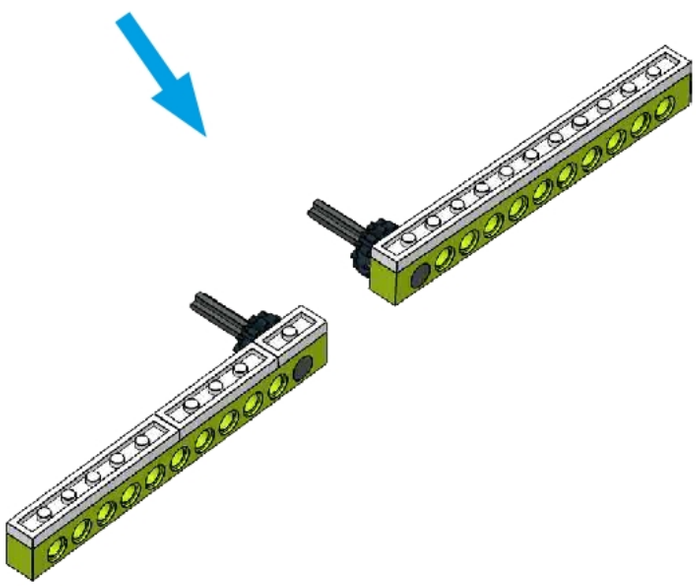

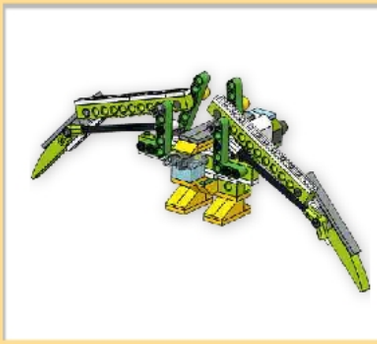

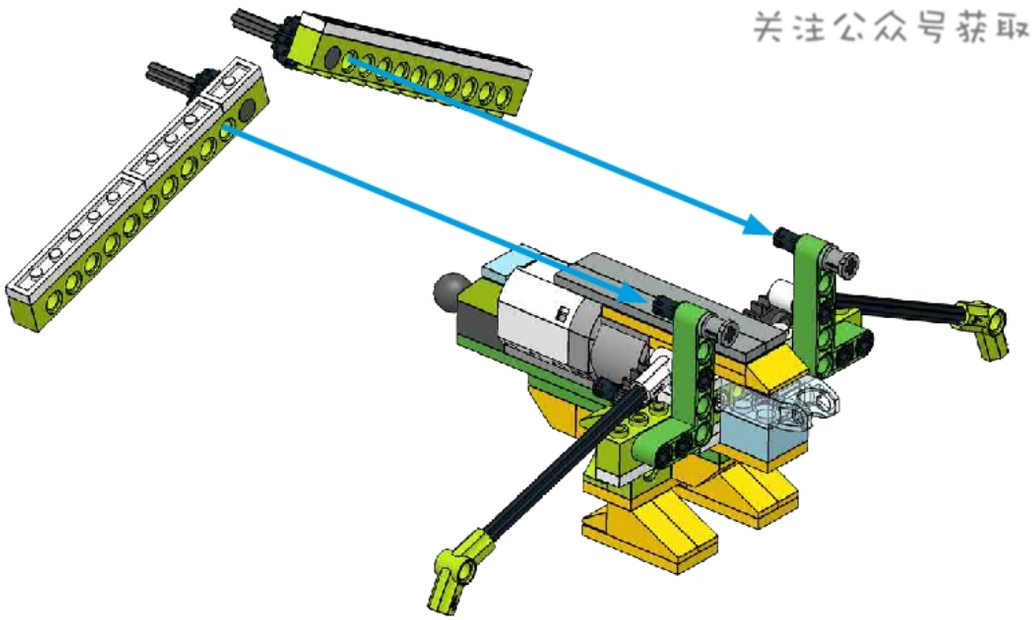

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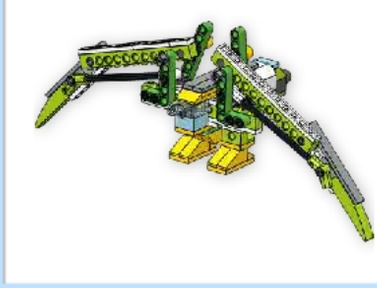

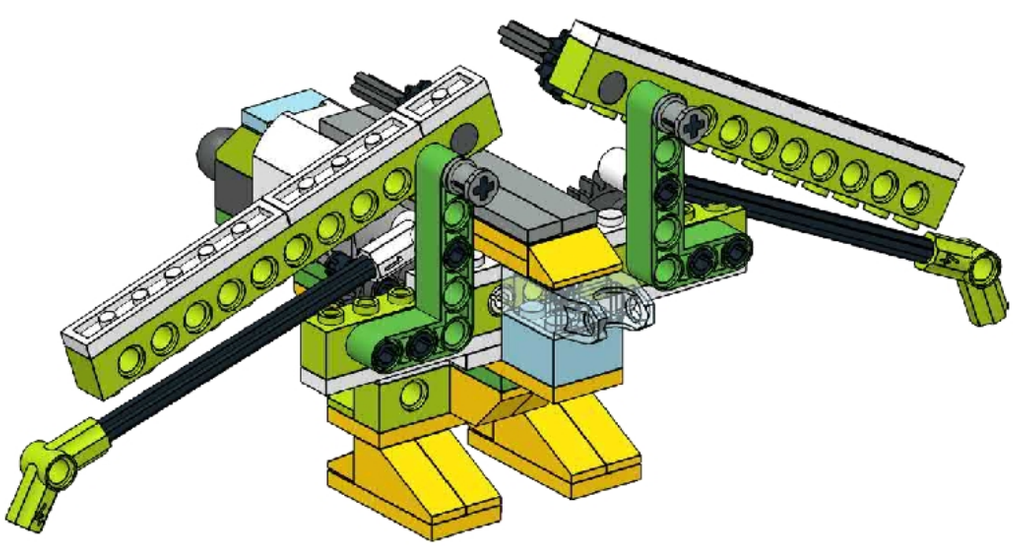

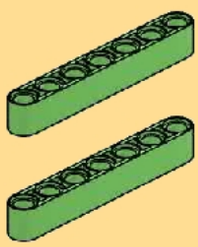

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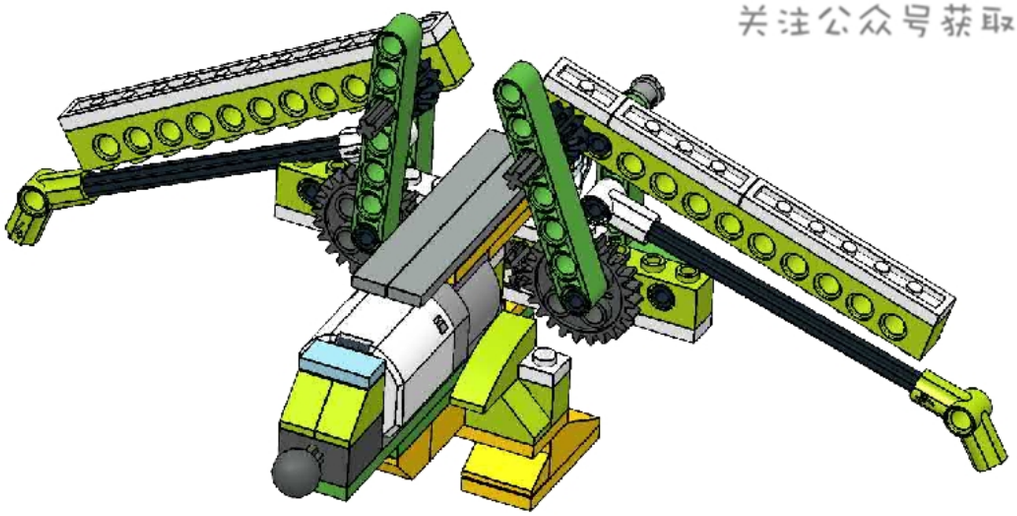

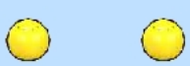

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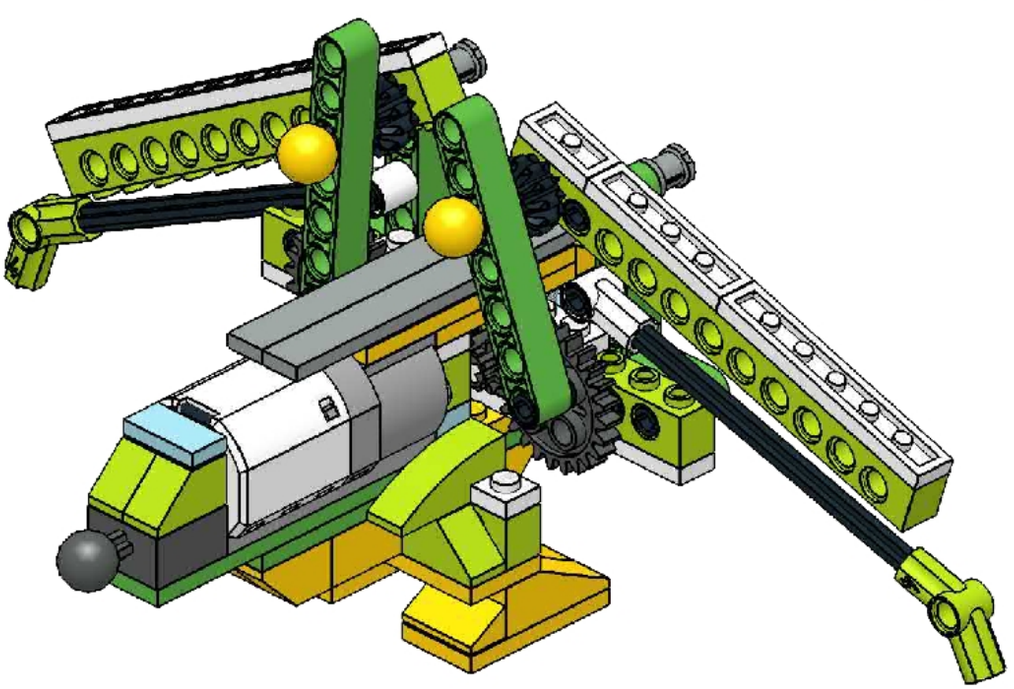
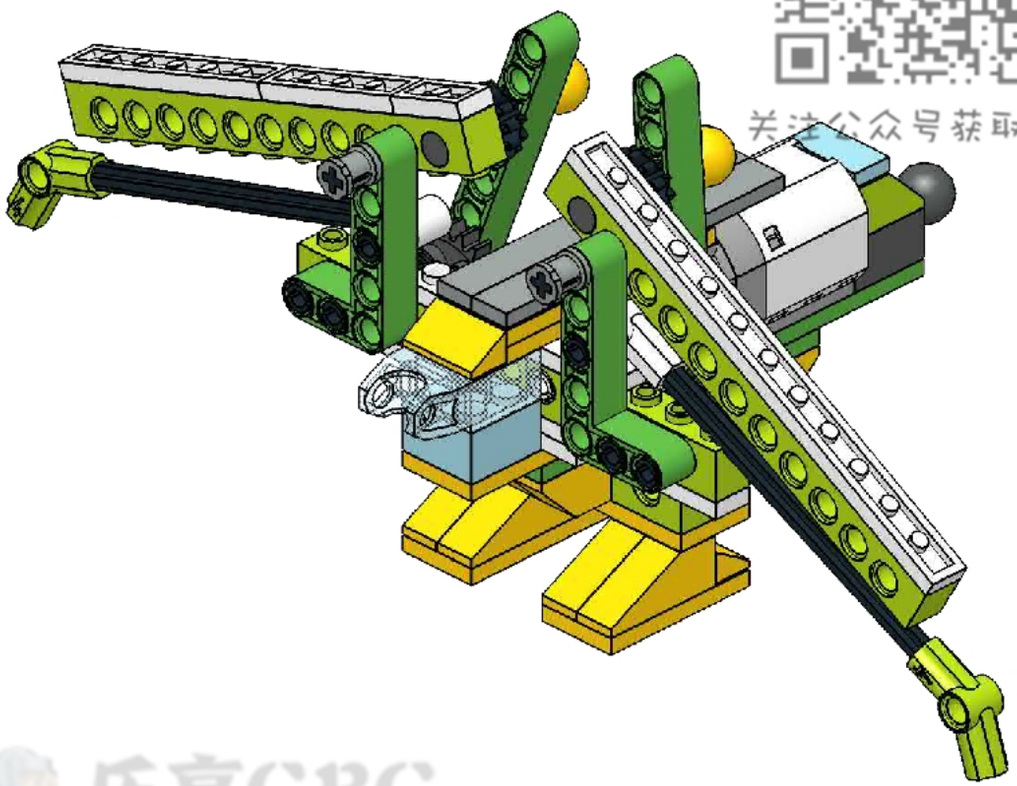


Flip your prototype 180 degrees to have the same view.



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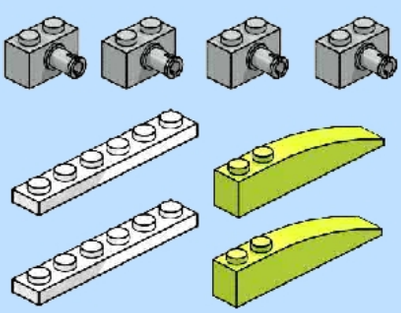

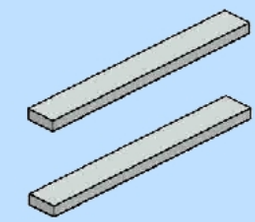

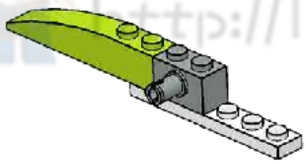

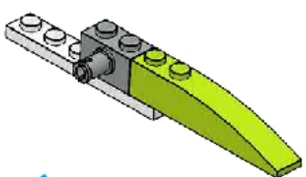

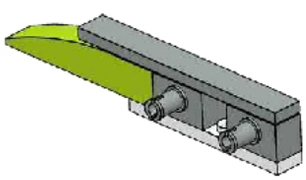

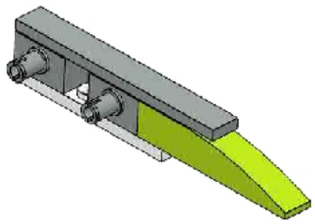

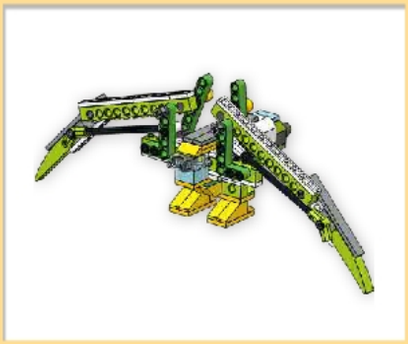

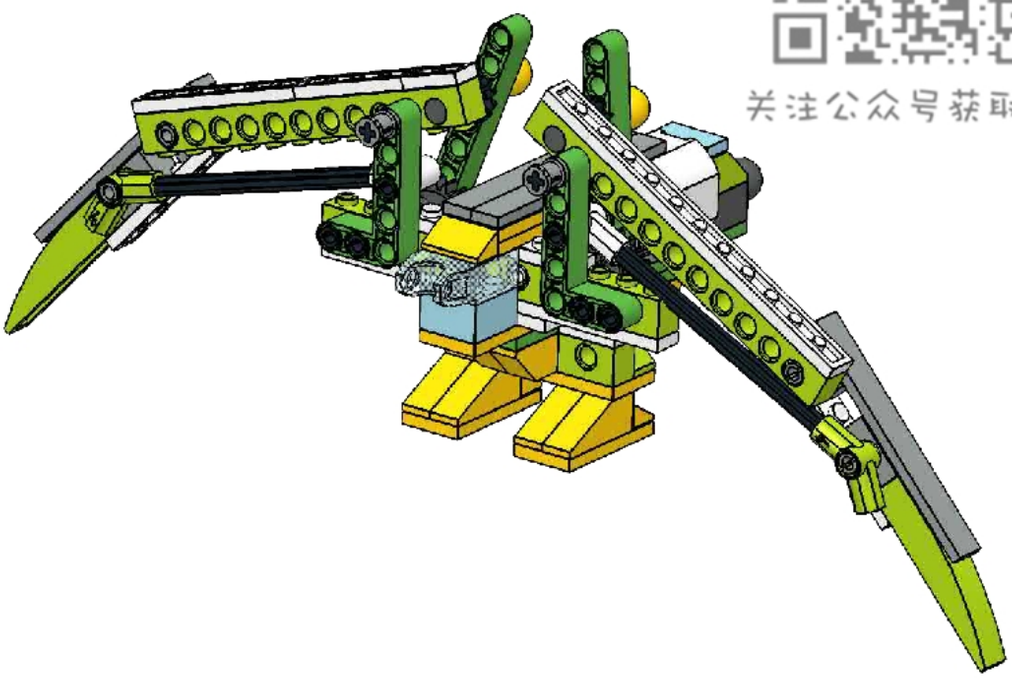

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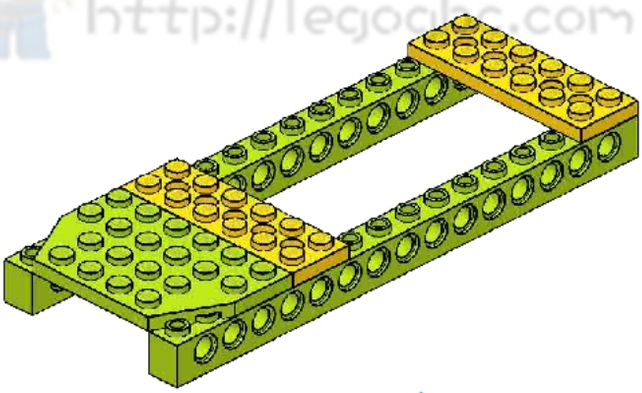

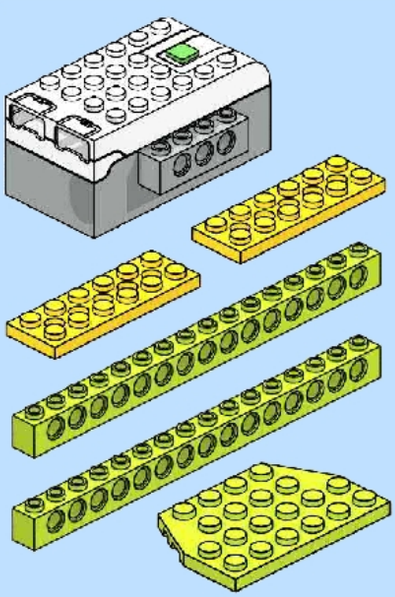

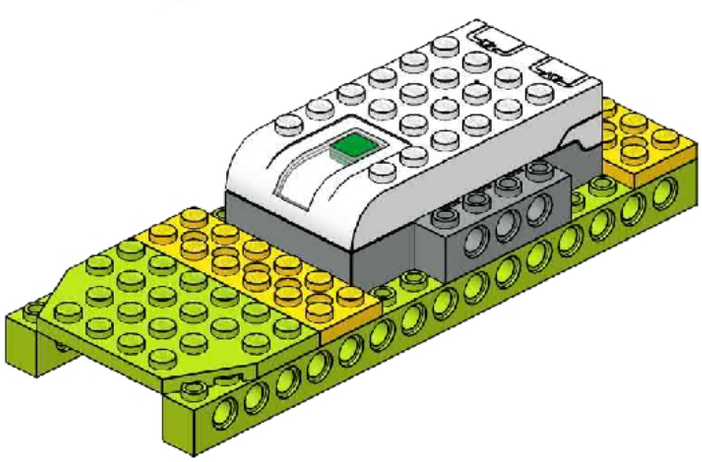

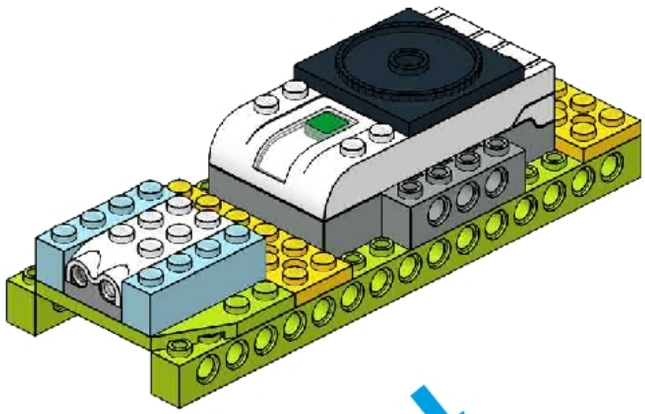

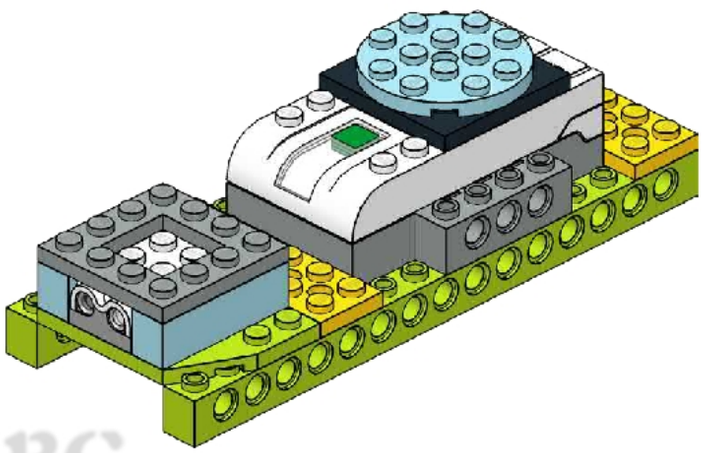

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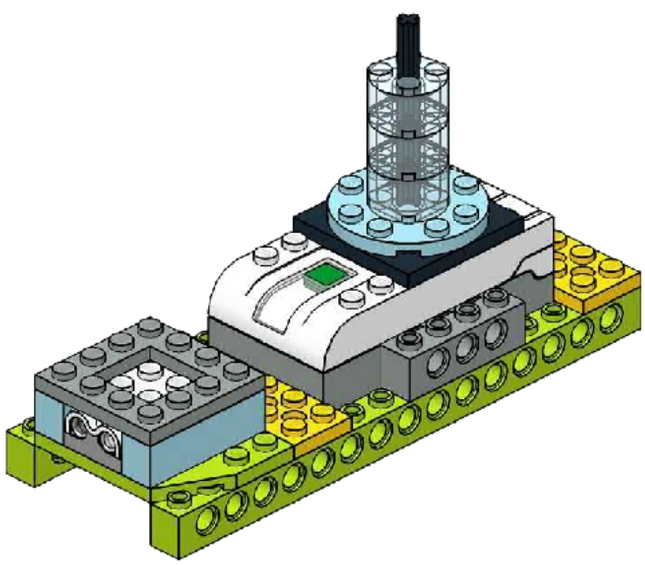

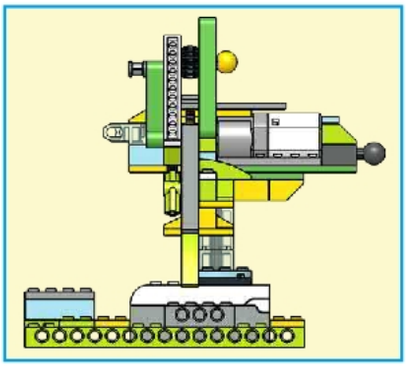

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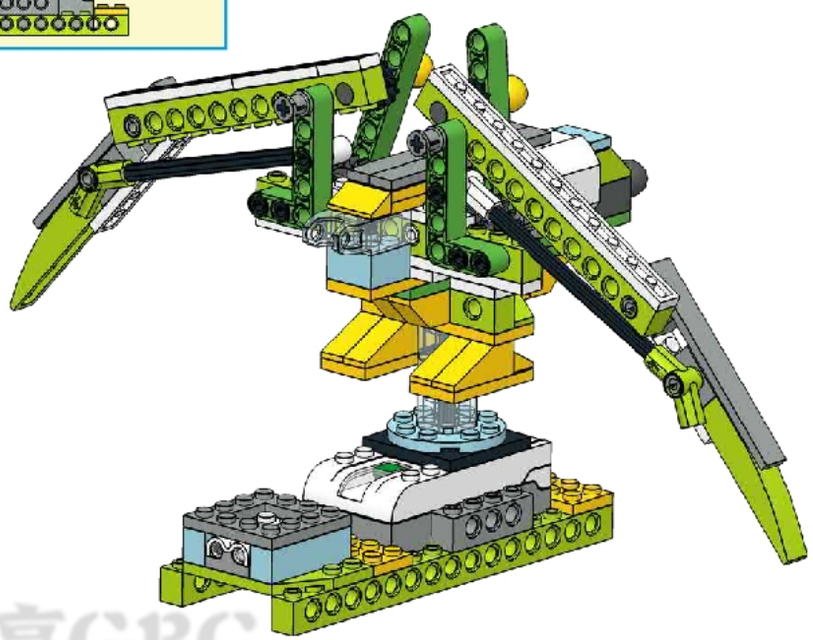

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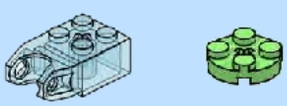

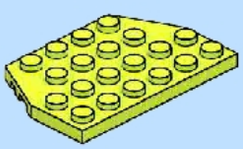

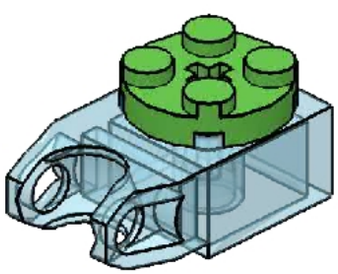

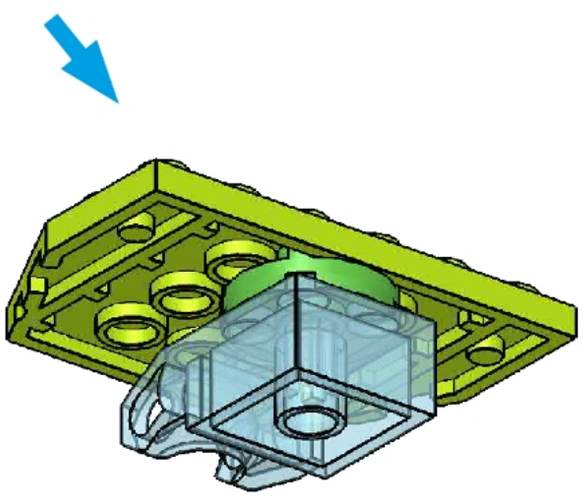

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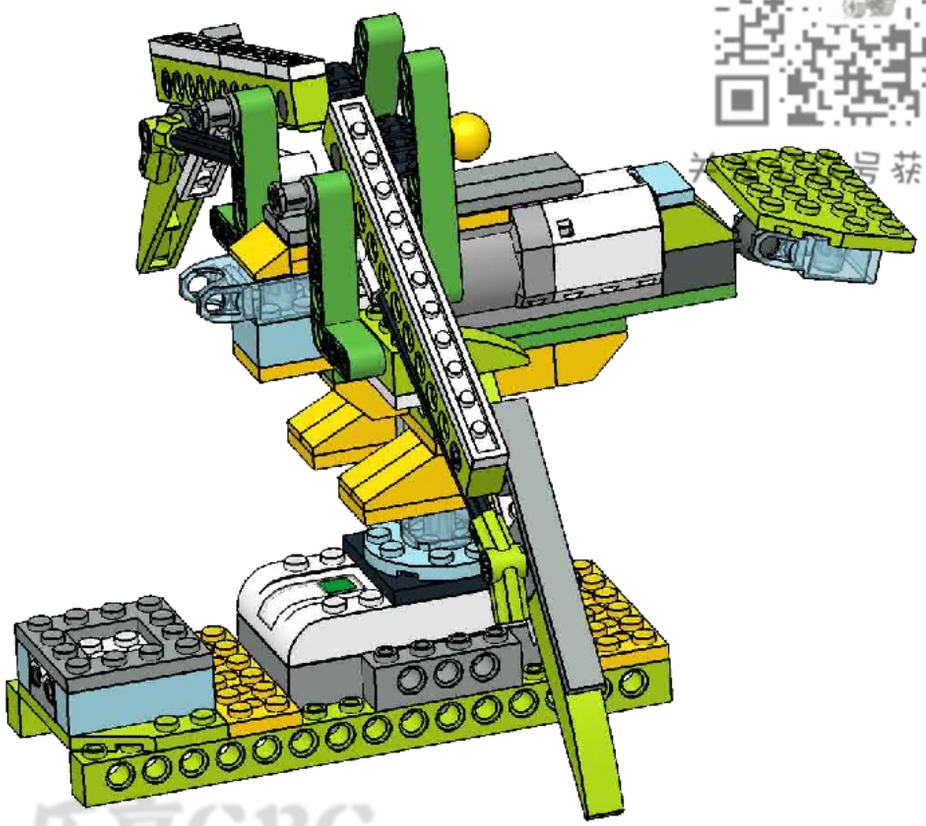

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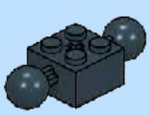

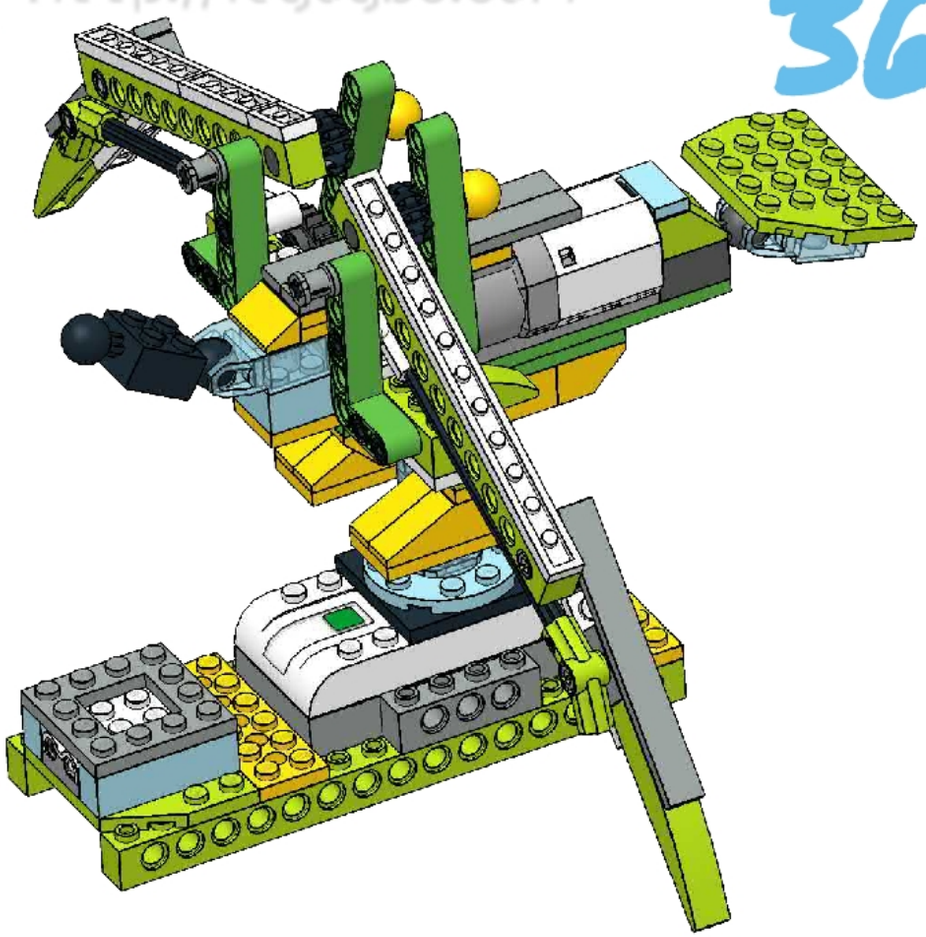

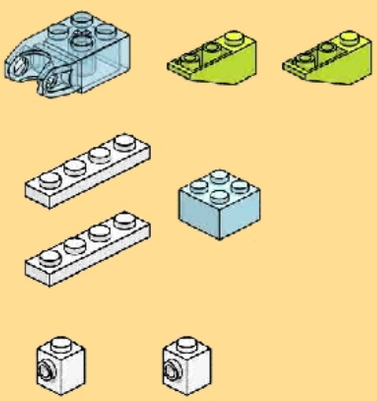

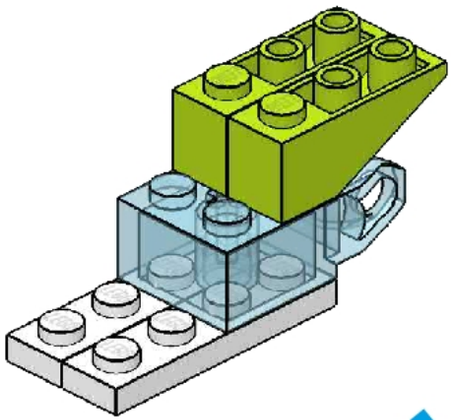

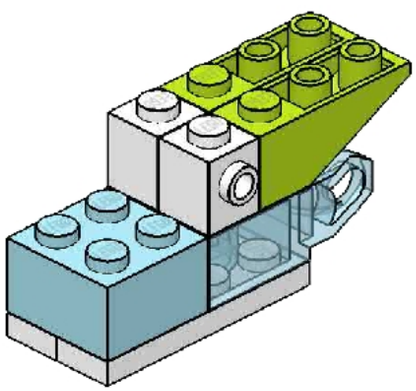

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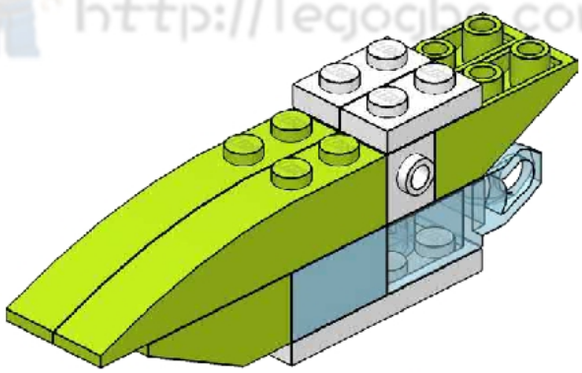
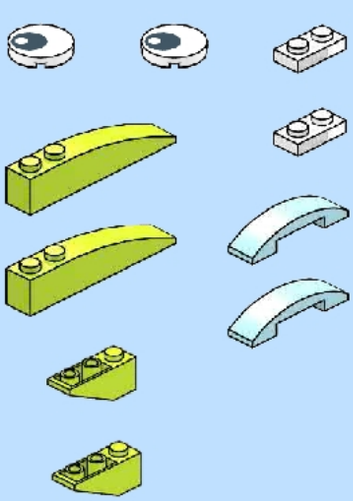
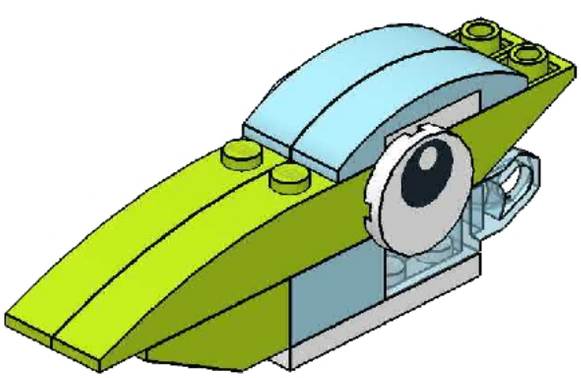
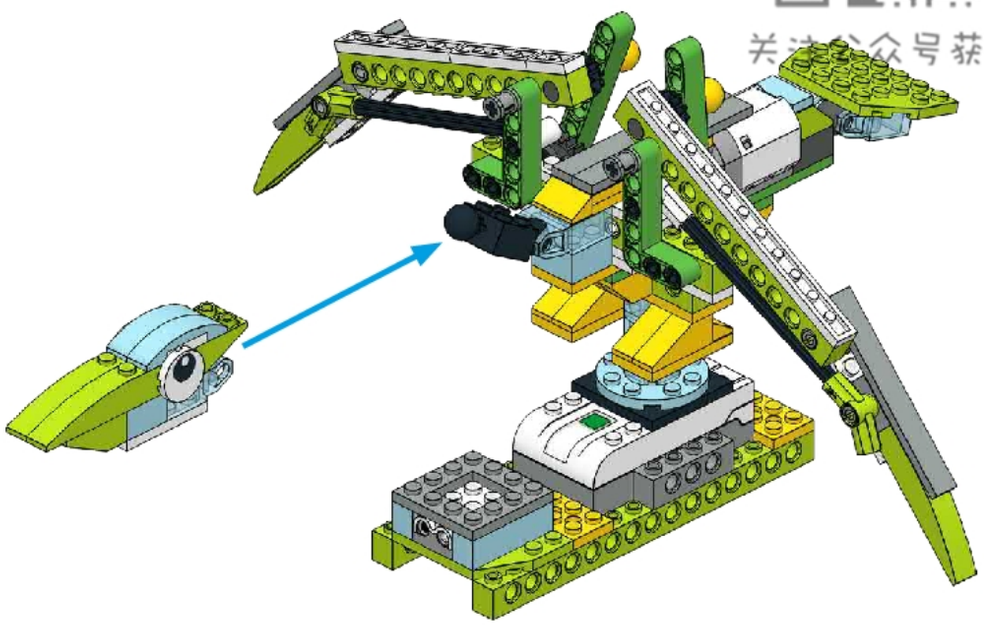
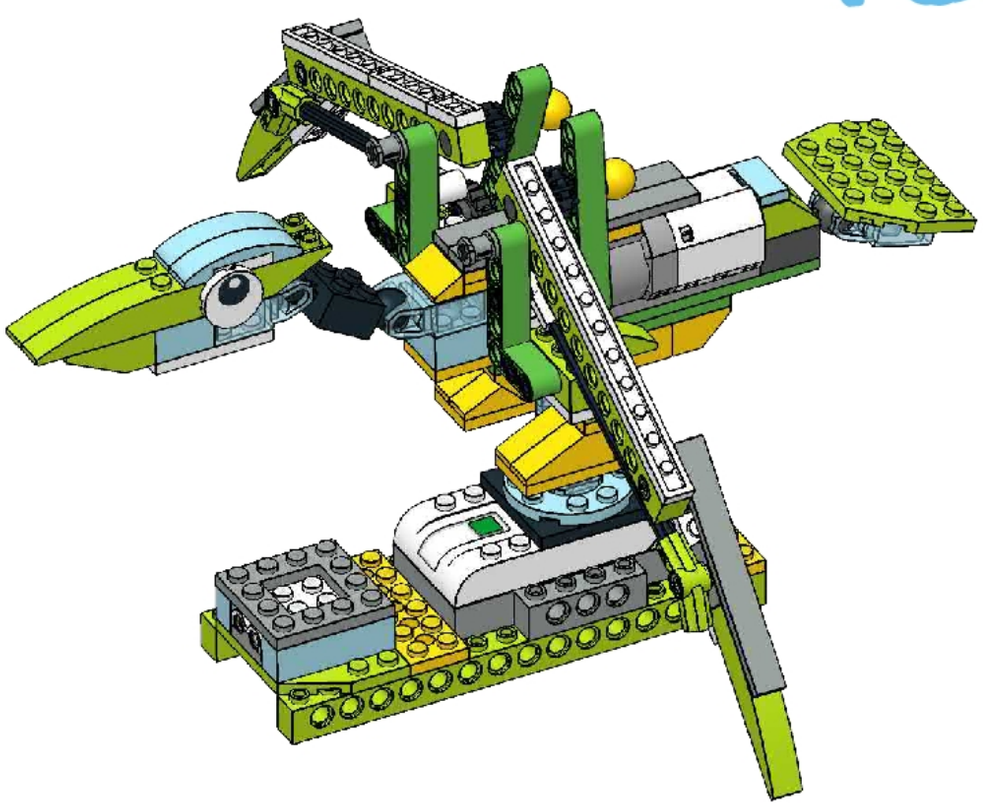










• Before going to the next phase, you can identify the mechanisms you are using in your pelican prototype.

• Can you predict how your pelican prototype will move by only seeing the model?

• How many gears are you using in your pelican prototype?

• How many wings does your pelican prototype have?

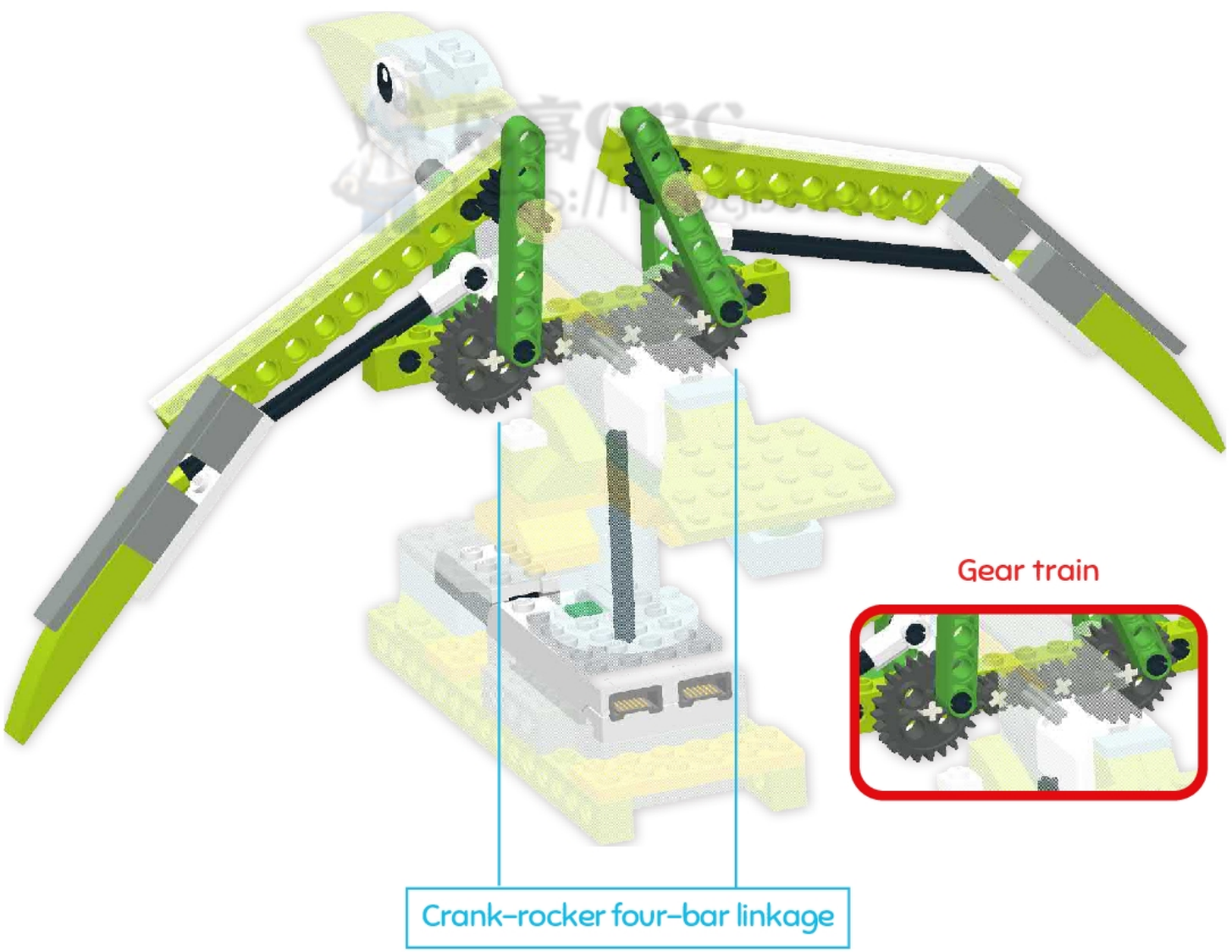
Design features

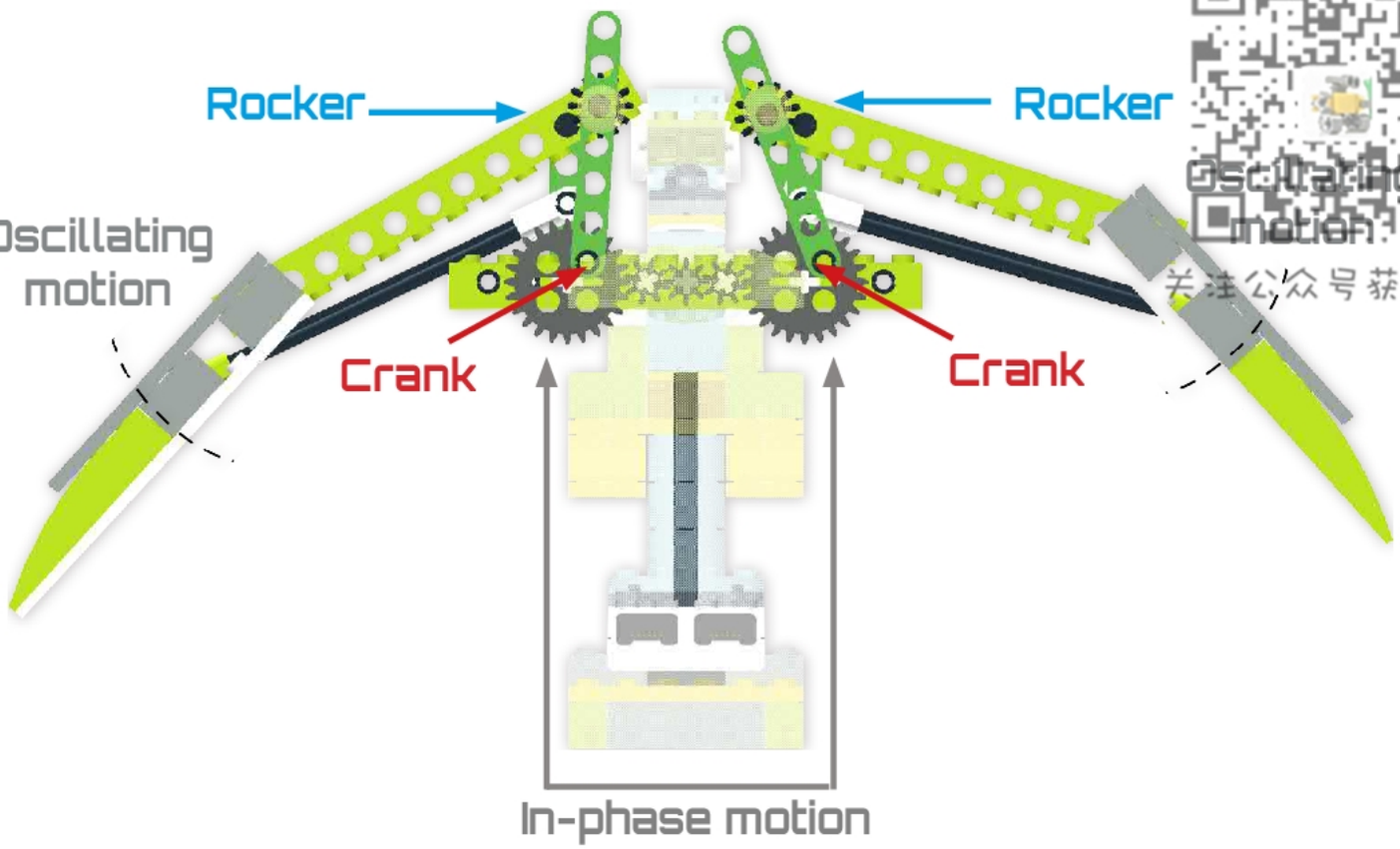
• Your pelican uses the motor to drive its two legs.

• Can you identify the gear train and the crank-rocker four-bar linkage?

• Can you identify the driver gear and the follower gear in the gear train mechanism? Keep in mind that the driver gear is the one that is assembled directly to the motor.

• Are the two wings in an in-phase motion?





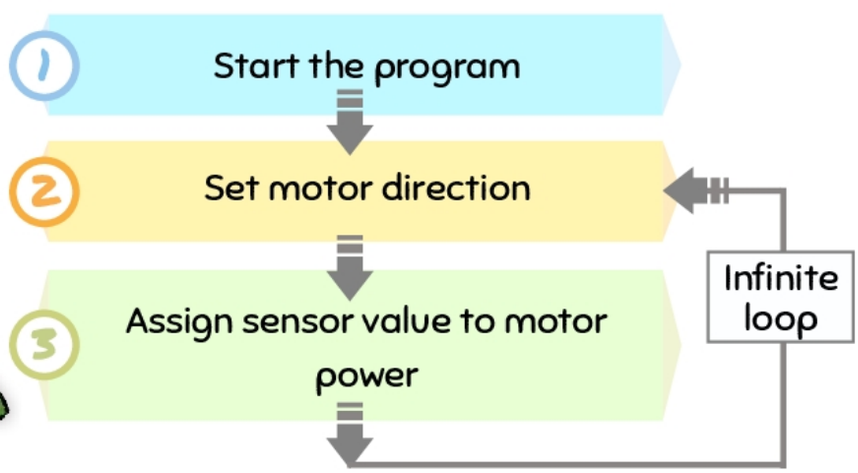
Program phase: Power control by sensor

• In this section, you will explore the use of the distance sensor to control the motor power of your prototype.

• The program idea consists of moving the wings of your pelican depending on the value of your sensor.

• In a more detailed way, your pelican will move their wings slower as an object (your hand) approaches the distance sensor. The wings will move at maximum power when there is no object in front of the distance sensor.

Flowchart



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

How should I modify the program if I want the pelican to perform an opposite behavior?

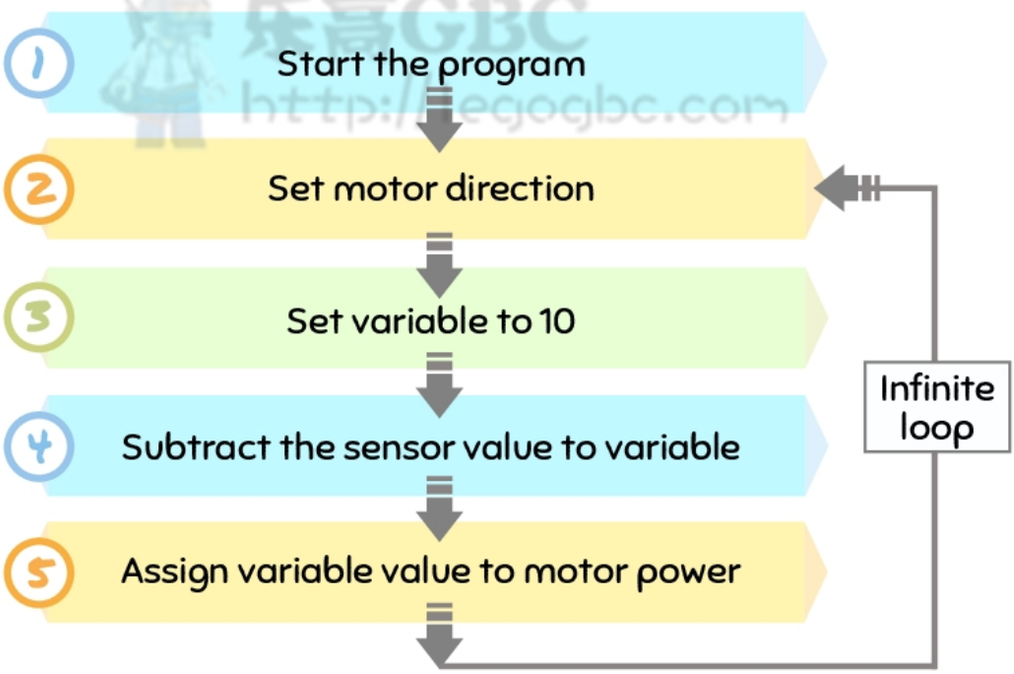
Changing the logic

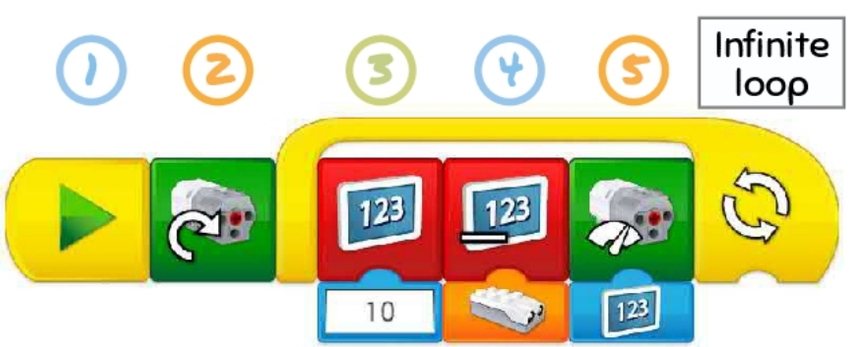
• What should you do to program your pelican so it can perform an opposite behavior?

• The new program idea is: your pelican will move the wings faster as an object (your hand) approaches the distance sensor. The wings will stop when there is no object in front of the distance sensor.

• You need to use a variable to develop this new program. As usual, let's start with the flowchart first:

Flowchart





Test phase: Getting closer and further

• 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: Does the motor direction matter?

• Do the wings of your pelican move differently if you change the rotation of your motor from clockwise to counter clockwise?

TEST 2: Changing the logic

• Execute the first program developed in the program phase. Then, execute the second program developed in the program phase. How differently does your pelican perform in both programs?

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

• Modify the position of your pelican wings to perform an out-phase motion and execute your program. Is the motion more similar or different from an actual wings motion observed in birds?

Document & share phase

• Remember to collect all your notes, videos, and photos to report your findings and results.
• Record a video of your pelican performing the two programs developed in the program phase. How different are they?
• Record a video of your pelican moving using an out-phase and an in-phase motion to compare the wings motion.

Enhancing the experience

• **Build:** Instead of using the distance sensor to control the wings motion, you can replace it with the tilt sensor.
• **Programming:** Program different motor power depending on the position of the tilt sensor. The flapping wings motion can be used when your tilt sensor is facing down. To emulate gliding motion, just set the motor power to 0.