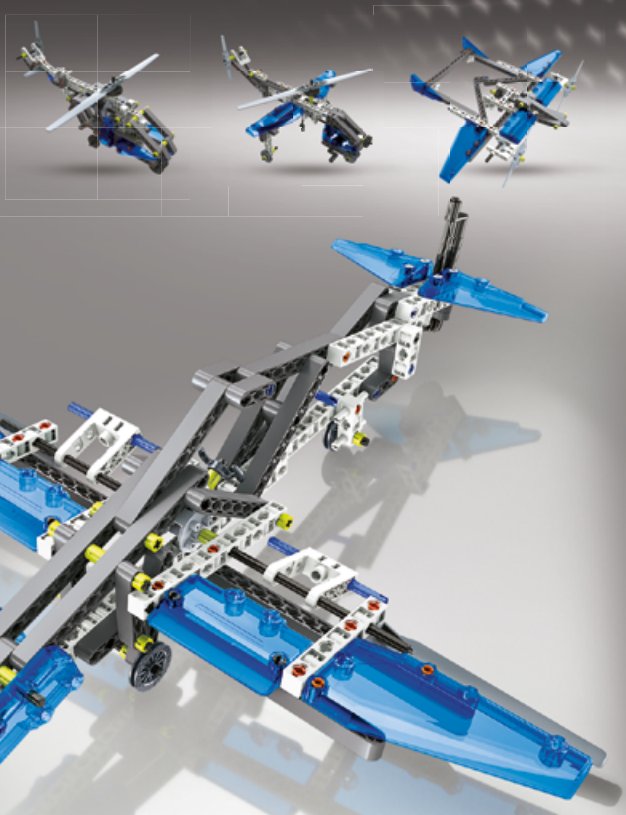
SCIENCE MUSEUM APPROVED

MECHANICS Laboratory

AEROPLANES AND HELICOPTERS

Constructions 1 to 10

1 - Build a simple glider
2 - Make a radar plane
3 - On a mission with a reconnaissance drone
4 - The microlight
5 - The twin-engined aeroplane
6 - The stunt plane
7 - Assemble the first aeroplane in history
8 - Tandem-rotor transport helicopter
9 - Working with a "flying crane" helicopter
10 - The search and rescue helicopter



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Read and keep this booklet for future reference.

TECHNOLOGIC

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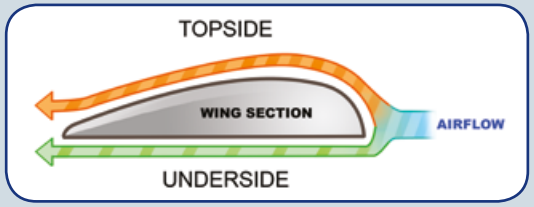
The mechanics of flight

LIFT: is the force that **counteracts gravity,** allowing an aeroplane or helicopter to fly. Because of a **wing's profile,** the air flows at different speeds over the two surfaces of the wing. It flows slower over the **underside** of the wing and faster over the **topside** of the wing. The slower airflow exerts **greater pressure,** producing upthrust.

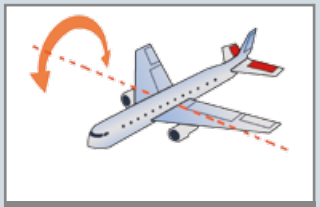


FLYING AN AEROPLANE

To change the **attitude** and **direction** of an aeroplane in flight, the pilot has to control its movement on **three** principal **axes. Rotation** around these three axes is called: **yaw, pitch** and **roll.**

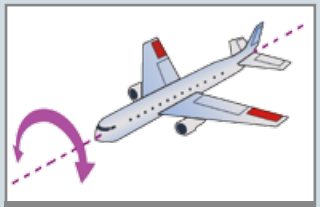
YAW

Yaw is controlled by the rudder, which is adjusted by pushing the pedals. When the right pedal is pushed, the aeroplane rotates to the right. When the left pedal is pushed, the aeroplane rotates to the left.



PITCH

Pitch is controlled by the elevators, which are adjusted by moving the joystick forwards or backwards. The elevators are raised or lowered simultaneously.



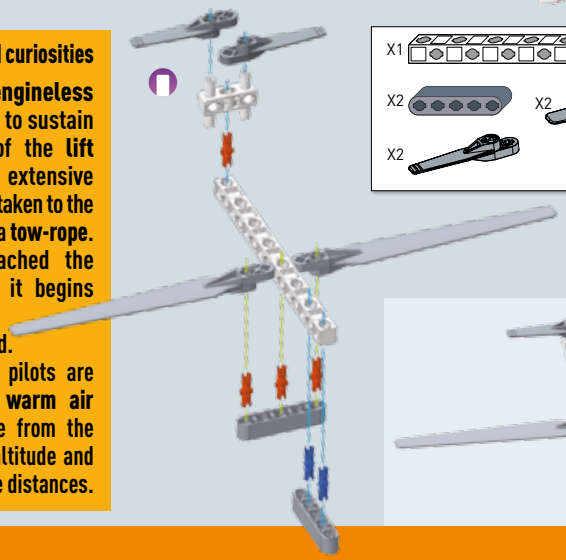
ROLL

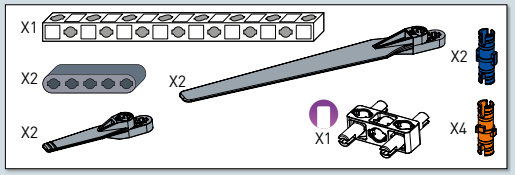
Roll is controlled by the ailerons, which are adjusted by moving the joystick left or right. When one aileron moves up the other one goes down. The joystick may be a bar or a steering wheel.

1 Build a simple glider

Technical facts and curiosities

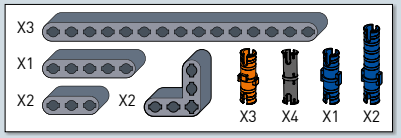
A **glider** is an **engineless** aircraft. It is able to sustain **flight** because of the **lift** generated by its extensive wing surface. It is taken to the desired altitude by a **tow-rope.** Once it has reached the release altitude, it begins **gliding back** towards the ground.
More experienced pilots are able to use the **warm air currents** that rise from the ground to regain altitude and travel considerable distances.





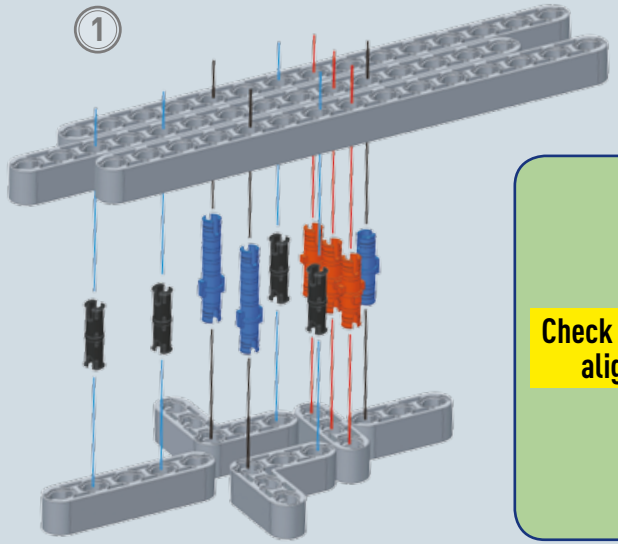
Final assembled model

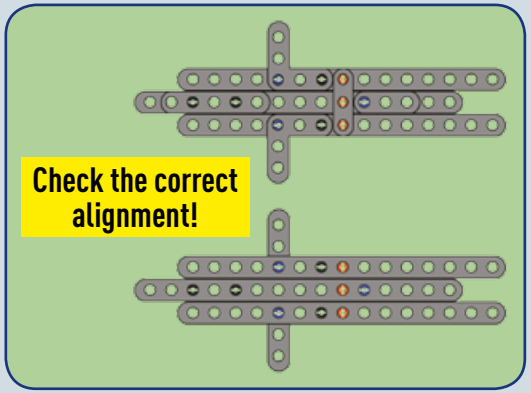
2 Make a radar plane

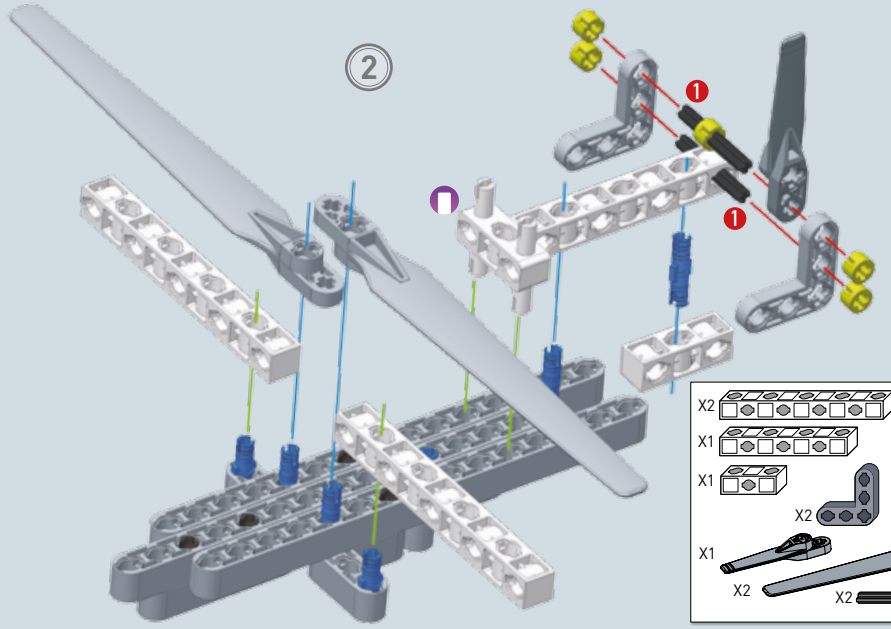


Technical facts and curiosities

A radar plane is usually a standard **cargo plane,** that has **been modified** by the **Armed Forces** with the addition of an impressive **radar dome** of about **18 metres,** mounted on the fuselage. The radar makes it possible to **identify** the position and speed of fixed and moving objects several kilometres away.







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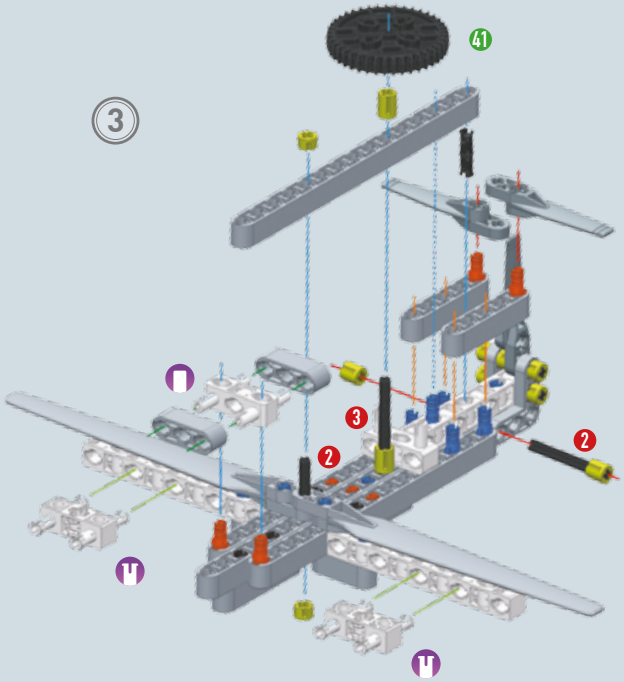
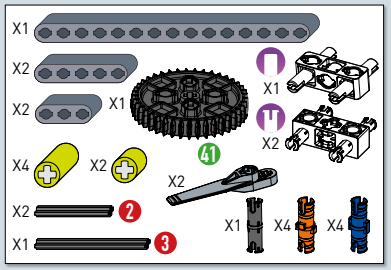
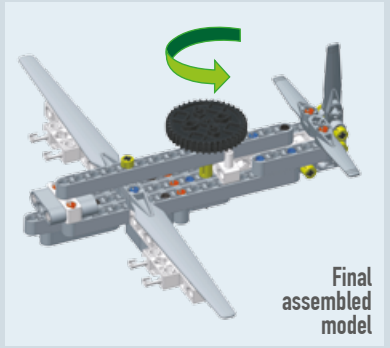
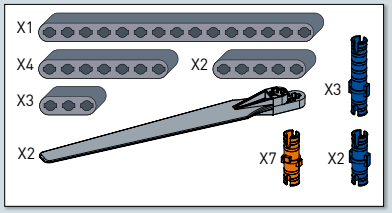
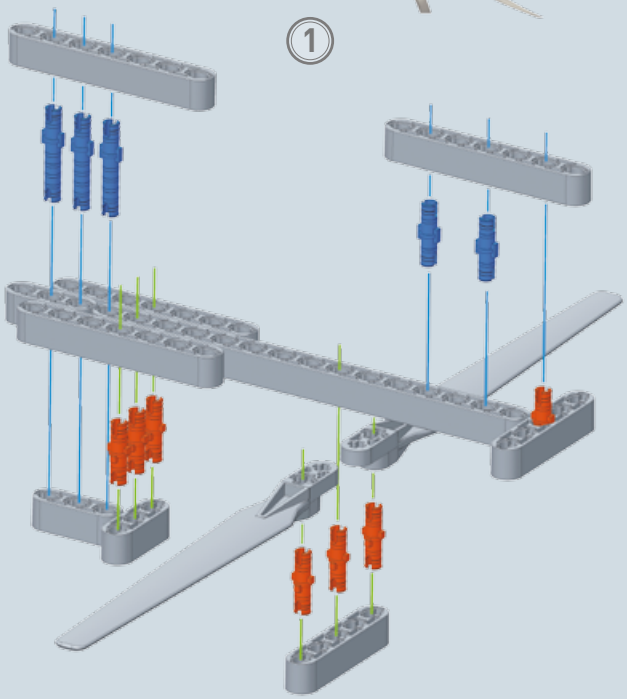






3 On a mission with a reconnaissance drone



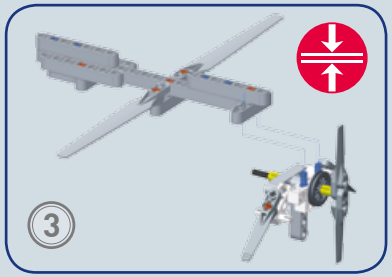


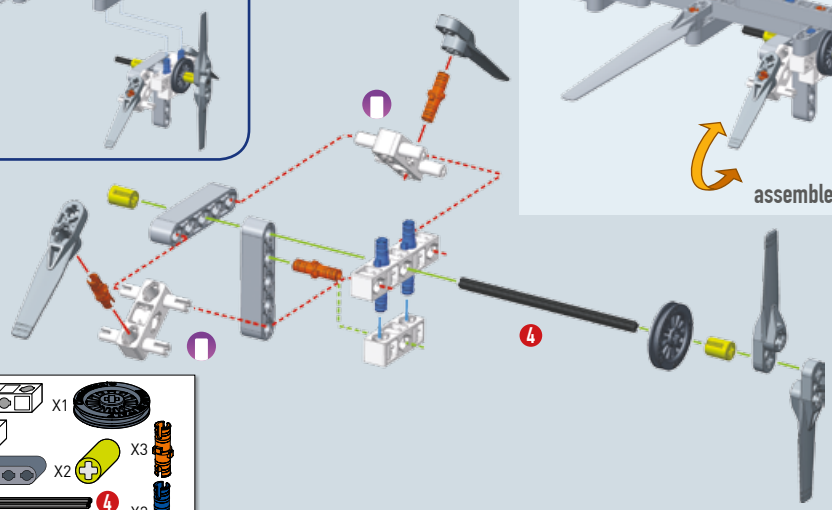
Technical facts and curiosities

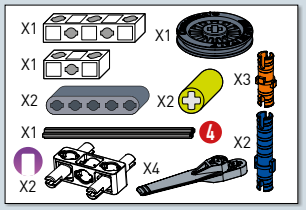
A **reconnaissance drone** is an **unmanned** aerial vehicle. It is remote-controlled by a pilot from a **ground station,** with the support of an observer. Drones make it possible to carry out missions in dangerous areas **without risk to the pilot.**

1:1 2

1:1 3

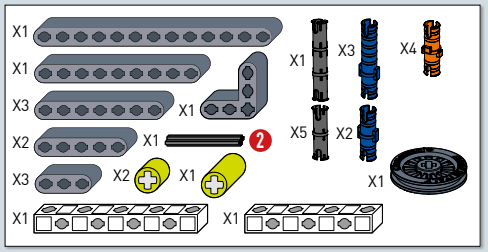


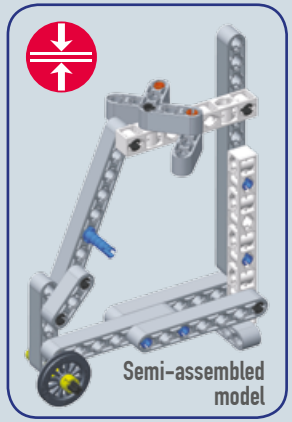


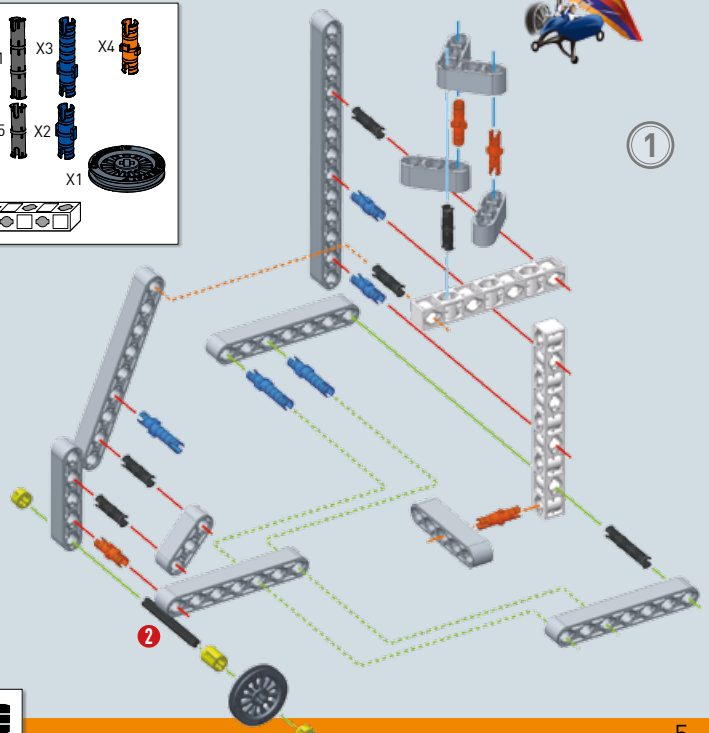


1:1 4

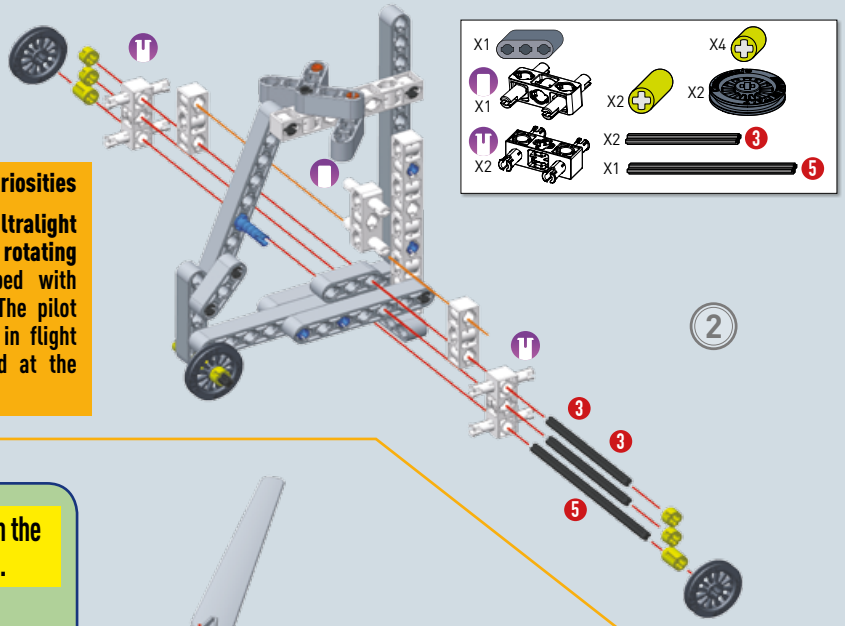
4 The microlight







1:1 2

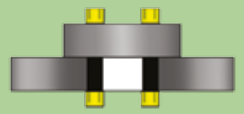


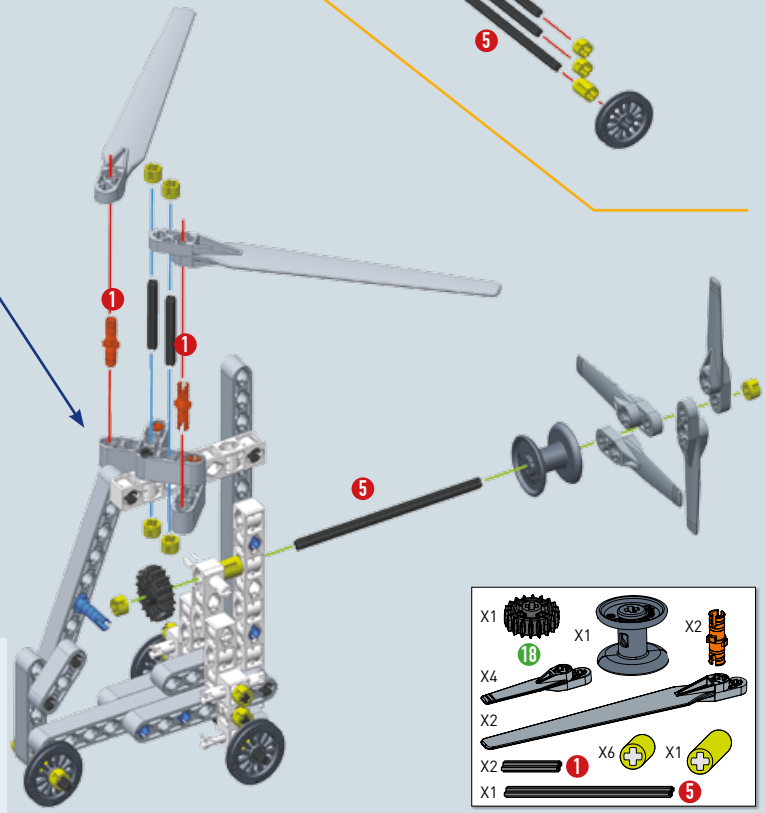
Technical facts and curiosities

A **microlight** is an **ultralight aircraft** driven by a **rotating propeller** and equipped with a flying **delta** wing. The pilot is able to manoeuvre in flight through a **bar** located at the front.

2

Lock the wing with the rods as shown.





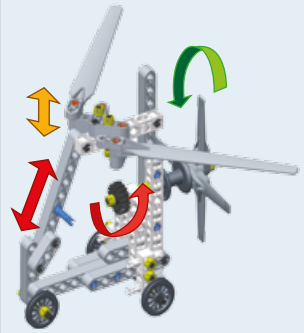
3

1:1 1

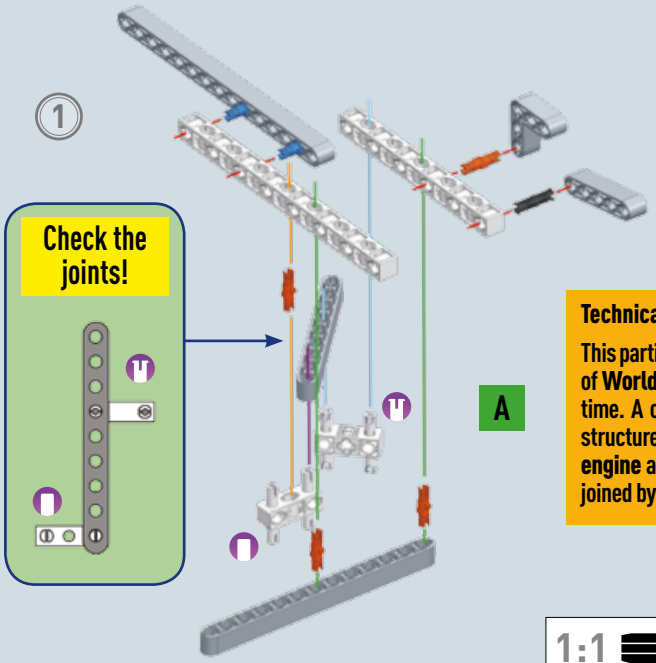
1:1 3

1:1 5

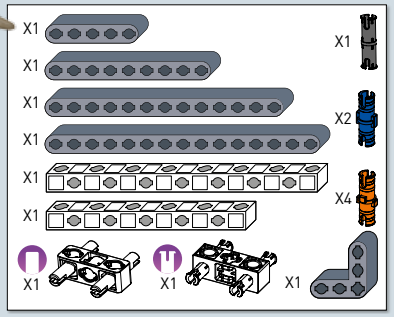
Final assembled model



5 The twin-engined aeroplane



Check the joints!

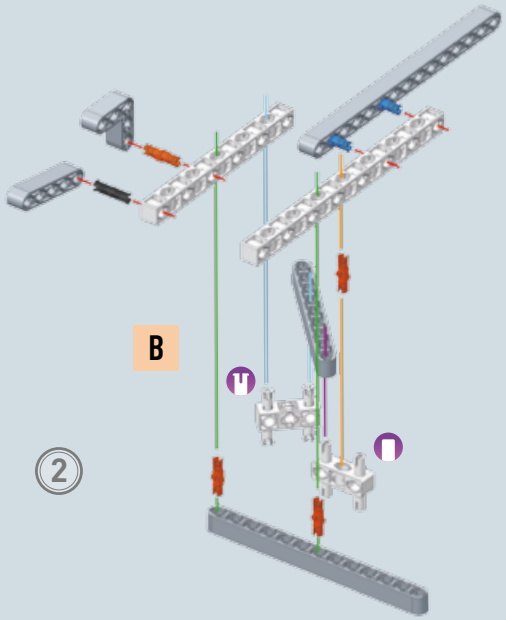


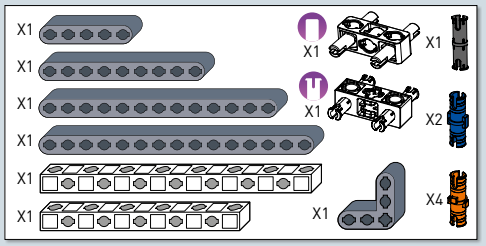
Technical facts and curiosities

This particular model was developed at the beginning of **World War II**, using innovative technology for the time. A clearly visible feature is the **"twin-boom"** structure. On each boom was mounted a **powerful engine** and a front **propeller**. Later the booms were joined by a single horizontal stabiliser.

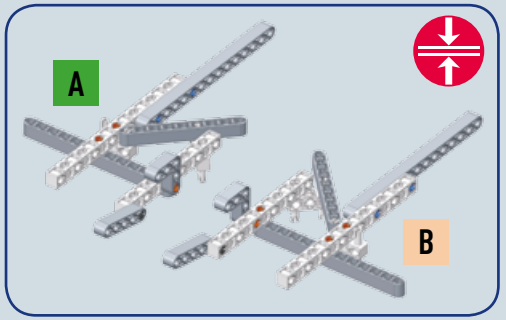
1:1 2

1:1 3



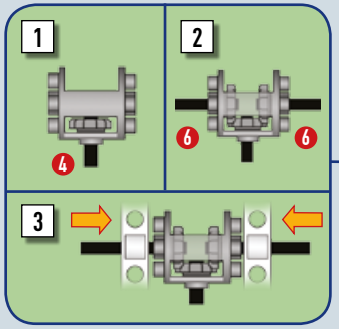


Make the second wing a mirror image of the first.

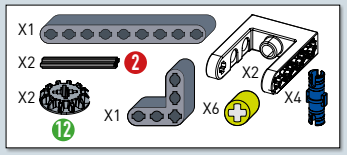


3

To simplify the construction process, first make the transmission system by attaching the three rods to the cage. Then join the two halves of the aeroplane by passing the rods through the right holes!



1:1



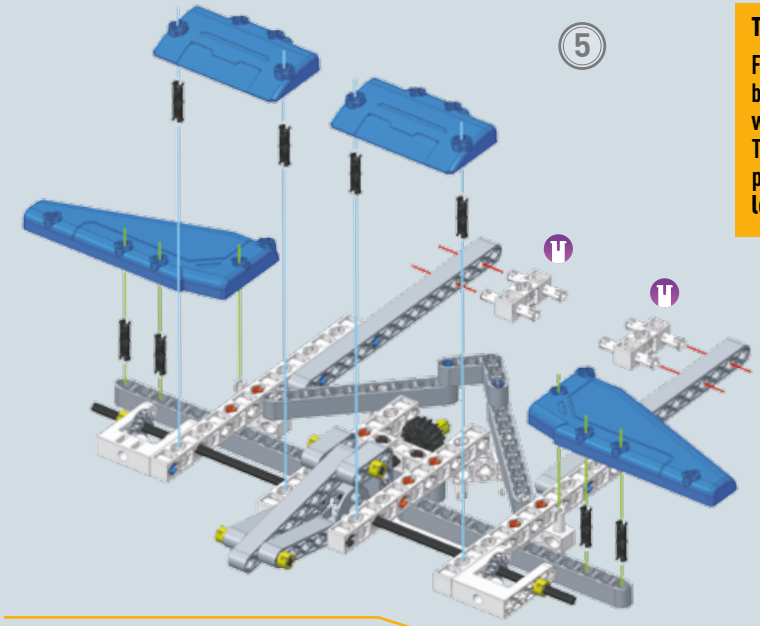
4

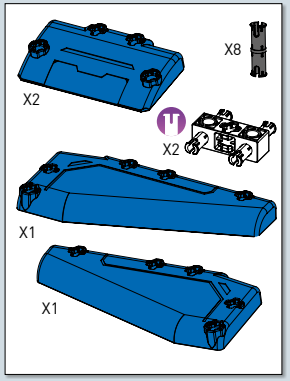
Check the positioning!

1:1

1:1

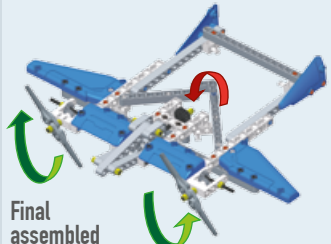
5





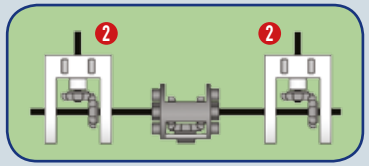
Technical facts and curiosities

Formerly the booms were joined by an **elongated trapezoidal wing**, with the **cockpit** at the centre. The **"twin-boom"** configuration provided the pilot with an **excellent view.**



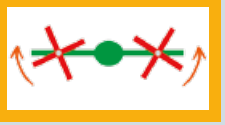
Final assembled model

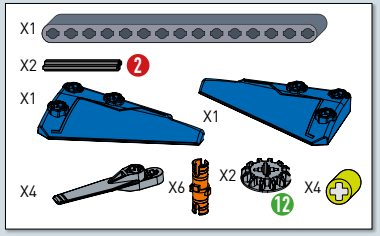
6



Technical facts and curiosities

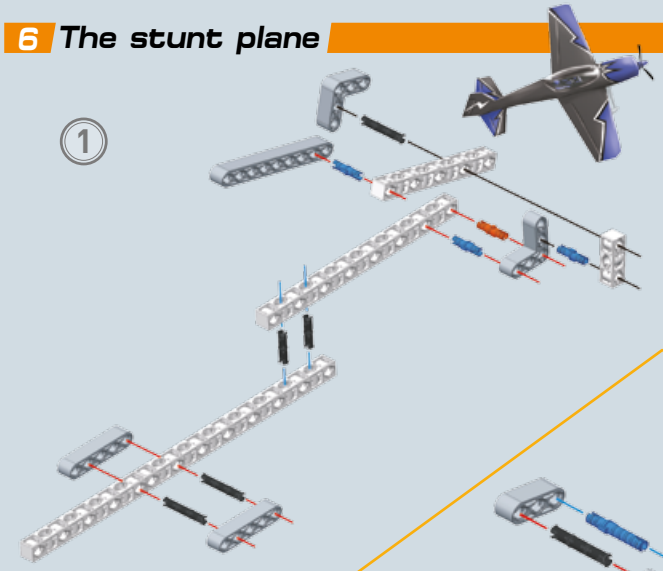
The propellers are mounted in a **counter-rotating configuration.** Therefore they rotate in opposite directions to each other.

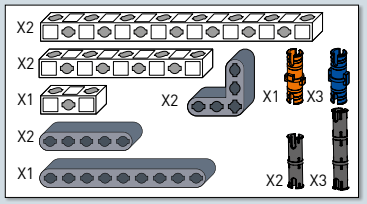


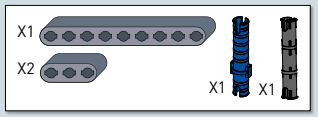


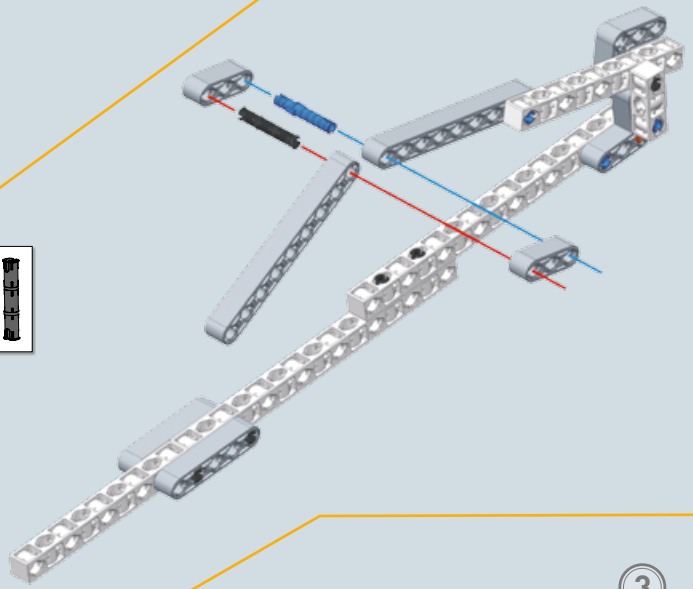
1:1

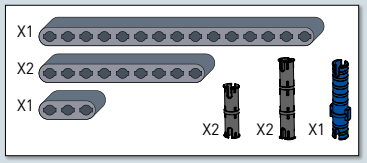
6 The stunt plane

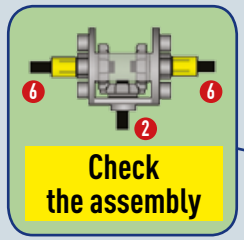


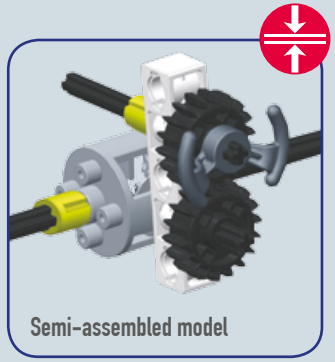






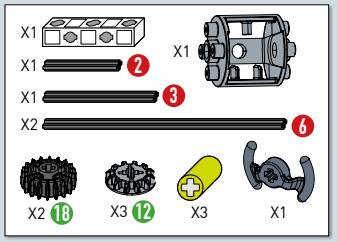


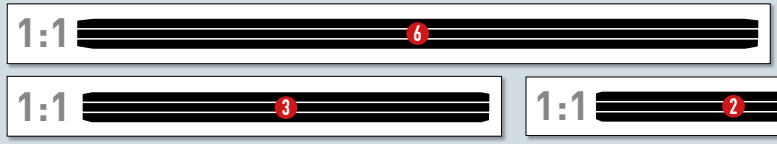


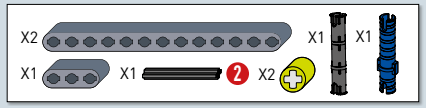


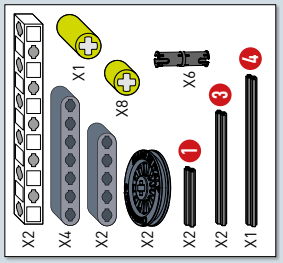
Technical facts and curiosities

Aerial acrobatics call for **extraordinary manoeuvring skills** on the part of the **pilot**. Aerial acrobatics are usually carried out as part of a **sporting**, competition by one or more aeroplanes, but they can also be used for **training** purposes or for **military displays**.









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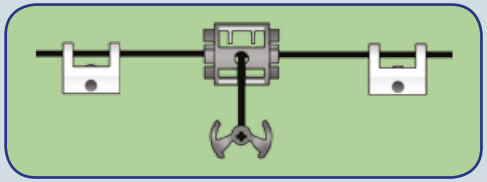
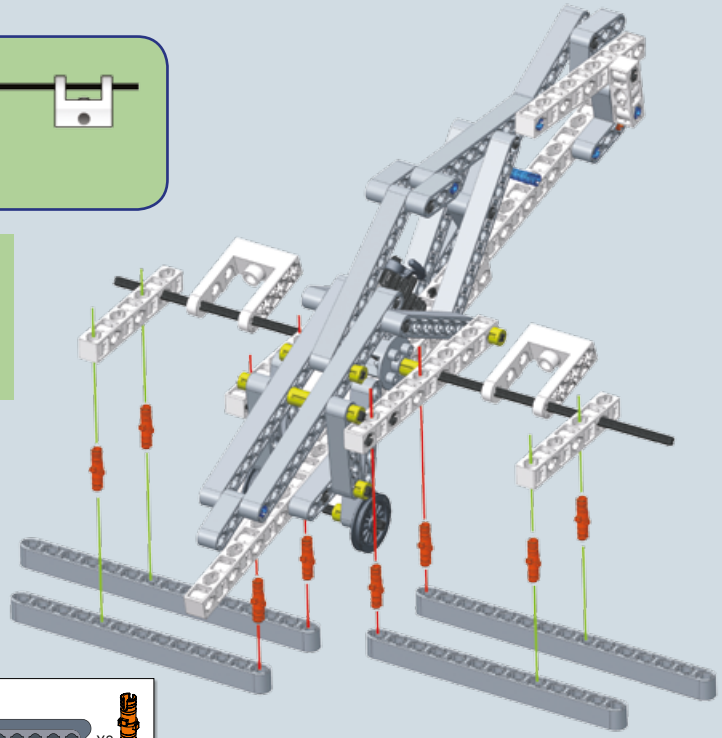


When you insert the ailerons, (transmission modules), check that they are correctly aligned with the position of the steering wheel, as shown.



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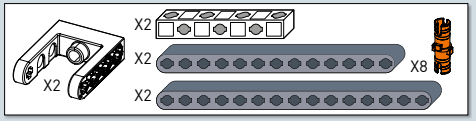
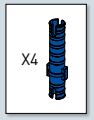


Technical facts and curiosities

The aeroplanes that take part in **competitions** or **air shows** are specially designed to perform stunts, and are usually equipped with a very powerful **single engine**. They are built using a **low-wing** configuration, i.e. a wing mounted at the **bottom** of the **fuselage**. This gives the aircraft **less stability** but the **greater manoeuvrability** needed to perform the most spectacular stunts.



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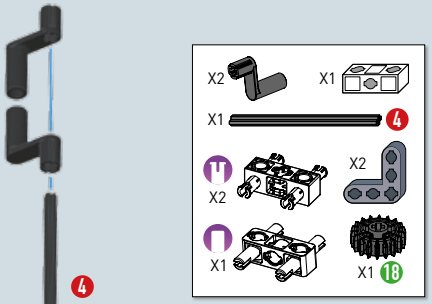
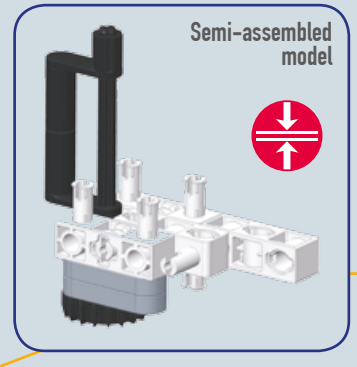


Technical facts and curiosities

Stunt planes have two long **ailerons** that take up the entire length of the wing. By correctly manoeuvring the **ailerons** and the **tail rudder** it is possible to perform spectacular acrobatic manoeuvres, such as the **roll**, or horizontal spin.

9



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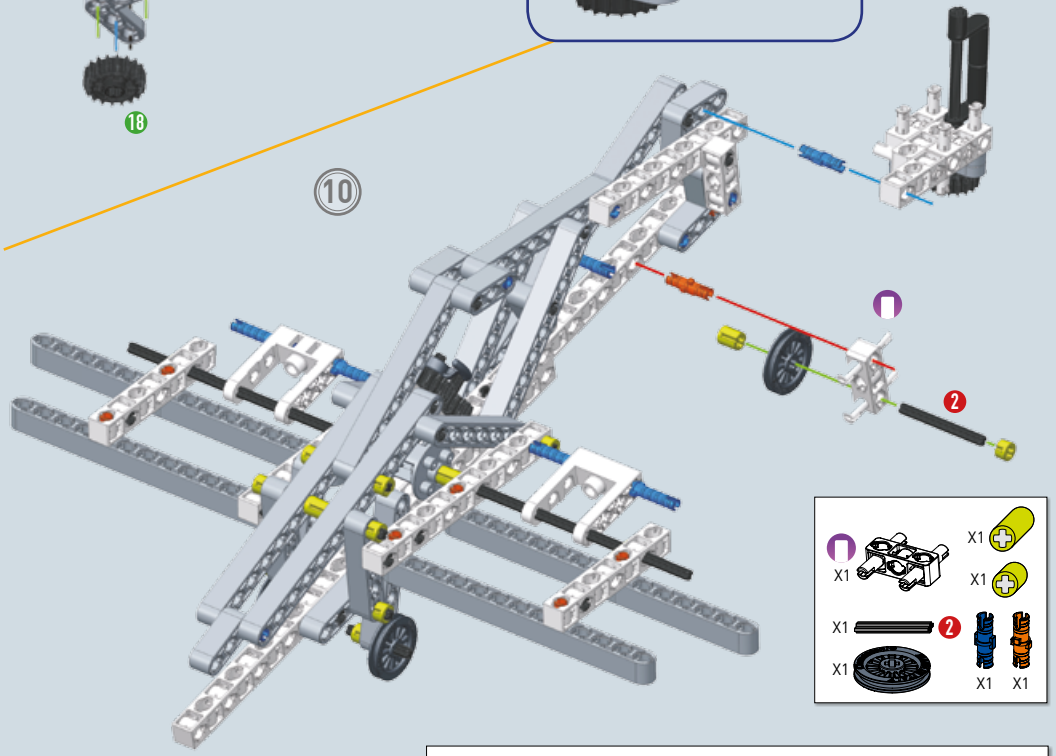

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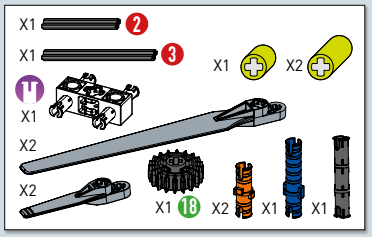
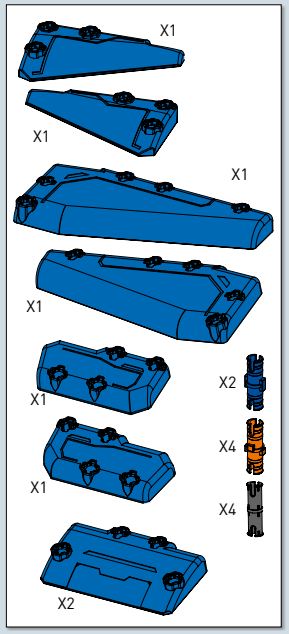
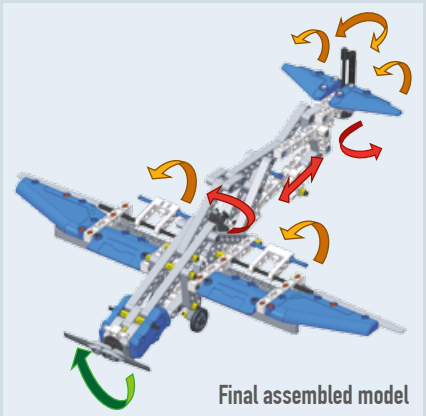


11

Technical facts and curiosities

A **stunt plane** can reach speeds of **225 knots**. The knot (denoted by **kn**) is the unit of measurement used for **aerial and nautical navigation**. **1 knot** is equal to **1.852 km/h**. Therefore **225 knots** corresponds to about **400 km/h**.





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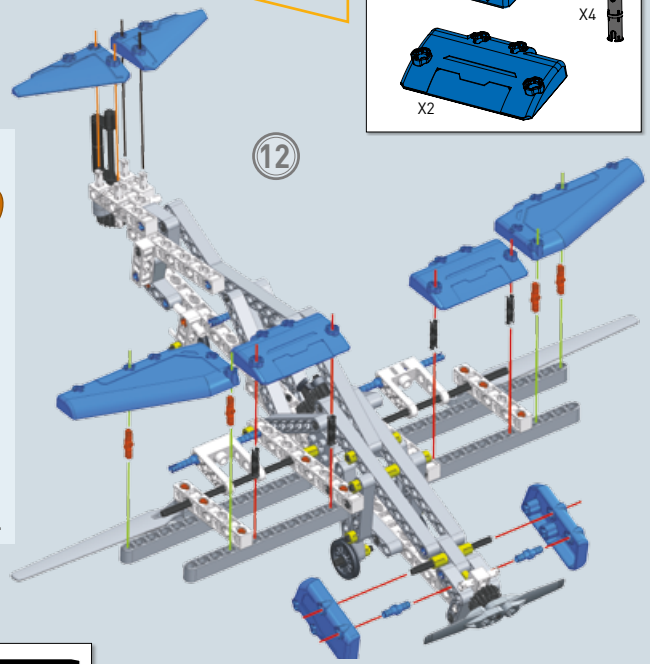

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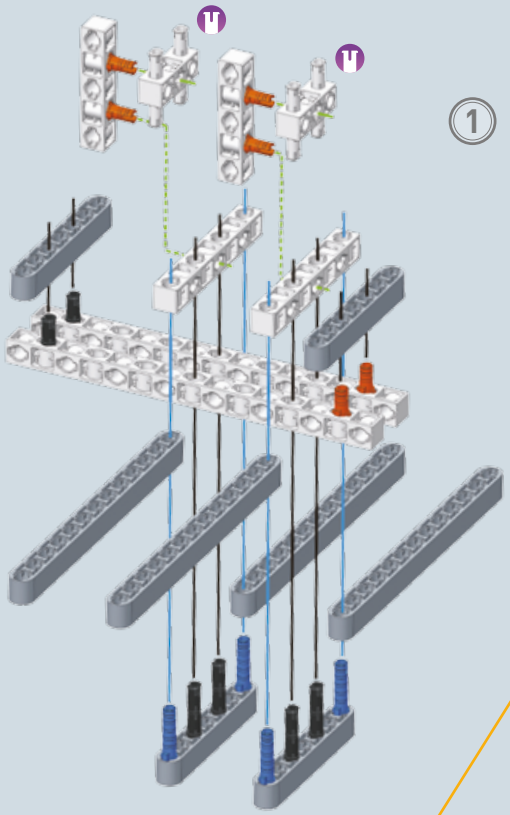
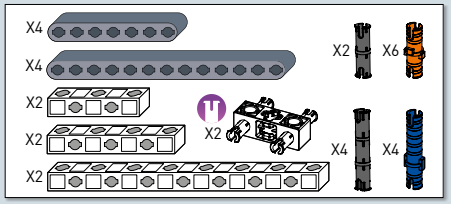
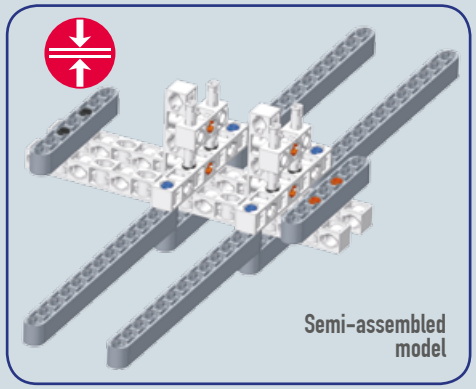
7 Assemble the first aeroplane in history

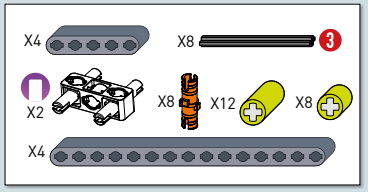


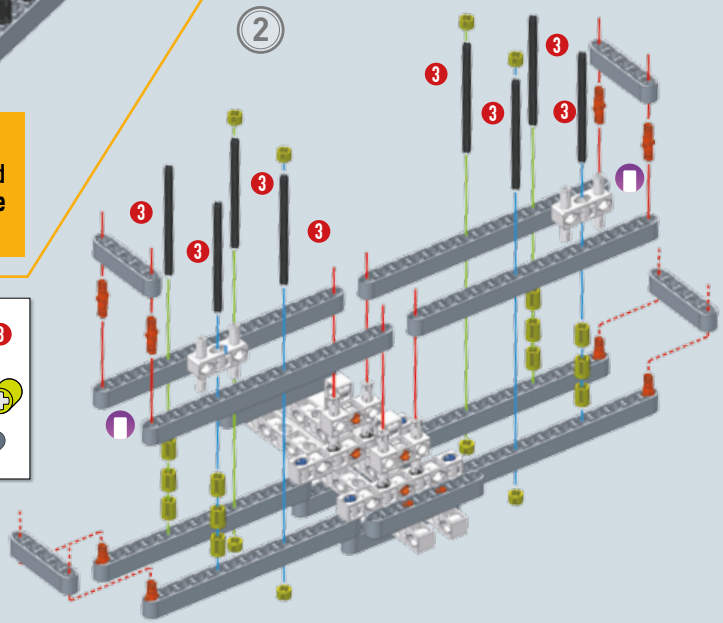




Technical facts and curiosities

The **Wright Flyer I** was designed and built by two brothers, **Wilbur** and **Orville Wright**, in the early **20th century**.





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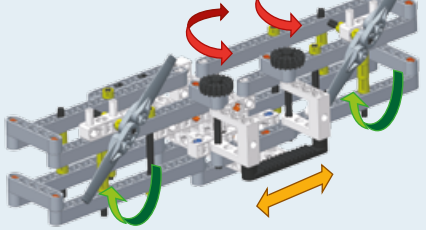
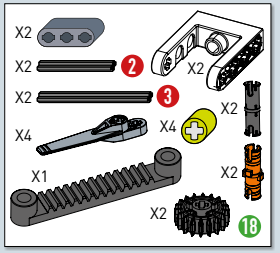


Final assembled model



Technical facts and curiosities

On **17th December 1903** it became the first motorised vehicle heavier than air to sustain **controlled flight**, It travelled a distance of **36 metres** in a time of **12 seconds**.

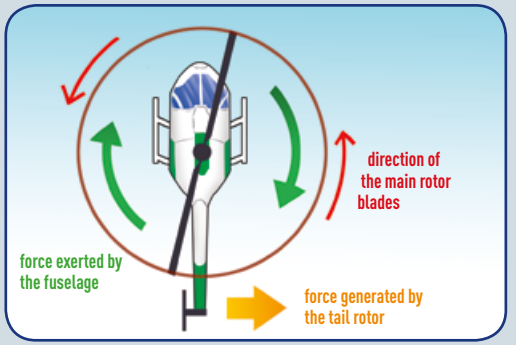
The mechanics of a helicopter's rotor

FLYING WITH A HELICOPTER

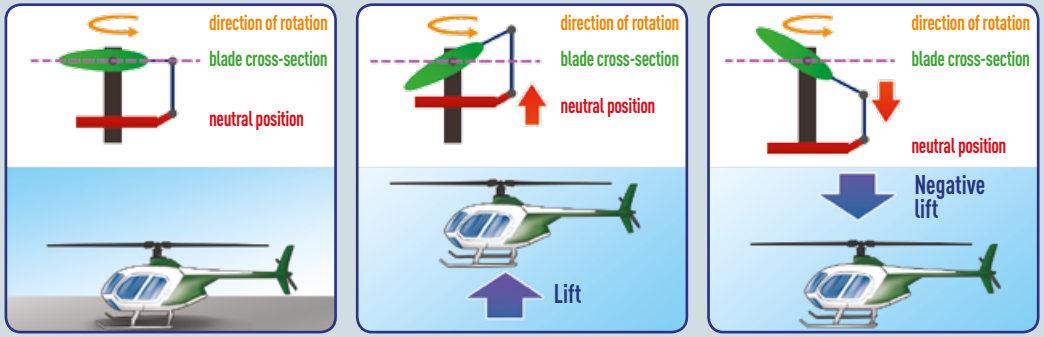
The force that allows a helicopter to fly is called **lift**. It is generated by a **rotary wing** called a **rotor**. The rotor is formed of a **rotating axis** to which two or more **blades** are attached.

Main rotor and tail rotor

The **main rotor** allows the helicopter to lift into flight. However, a second rotor, called a **tail rotor**, is needed to keep the **fuselage** straight. In helicopter flight, the **third law of motion** comes into play (for each action there is an equal and opposite reaction): the rotating **action** of the **blades** produces an **opposite reaction** on the entire fuselage, causing it to rotate in the opposite direction. The **tail rotor** produces a force which opposes and offsets the force acting on the fuselage. Without this second rotor, the helicopter would start to spin uncontrollably.



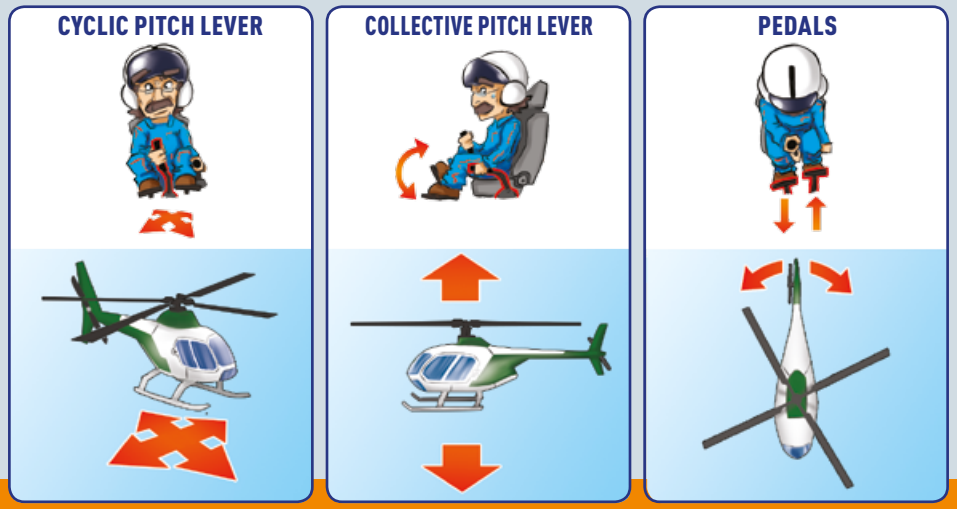
An essential piece of equipment for the helicopter pilot is the **swash plate**. Mounted around the rotating axis, it is connected to the blades and free to move up or down in order to generate **lift**.



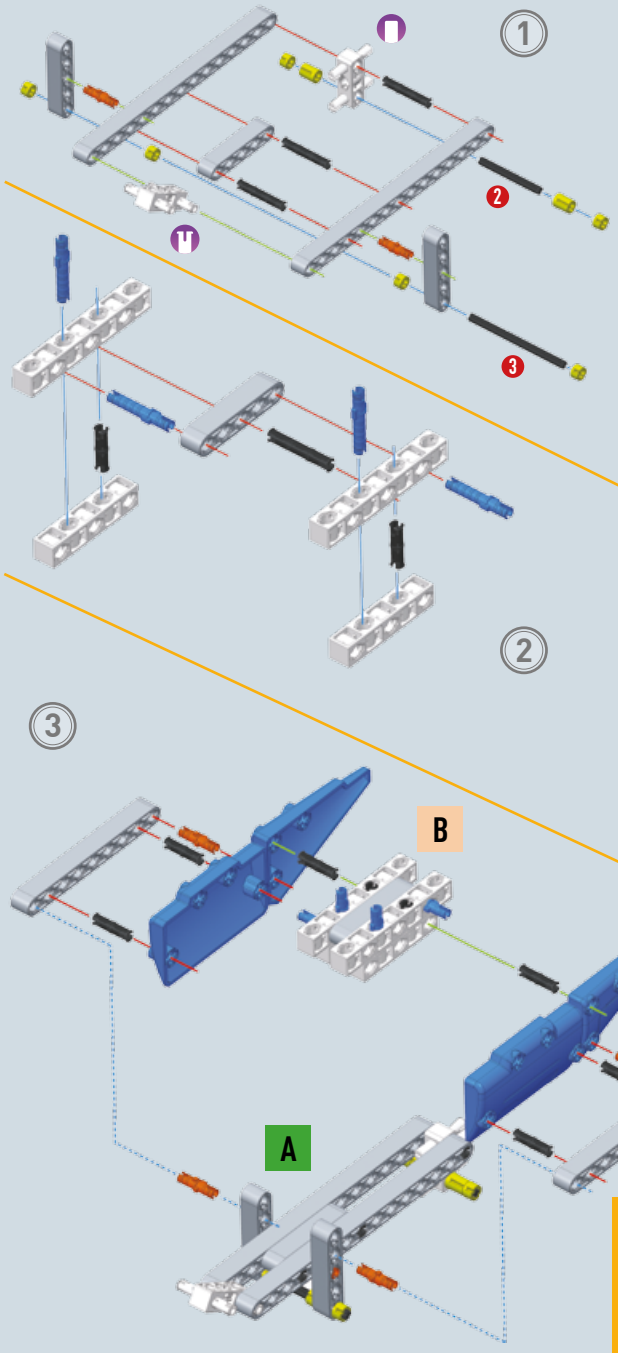
The pilot can also **tilt** the **swash plate**, resulting in **rotor disk tilt**. This creates two distinct areas of **lift**, driving the helicopter towards the area of **lower lift**.

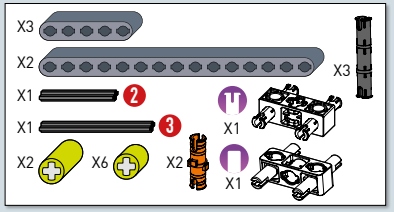
FLYING A HELICOPTER

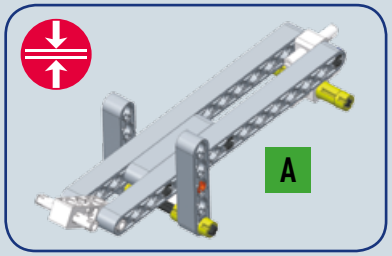
Flying a helicopter requires great coordination because the pilot must operate three main controls at the same time: the **collective pitch lever** for vertical flight, the **cyclic pitch lever** for horizontal movement, and the **pedals** to change the direction of the fuselage.

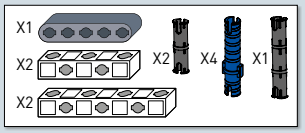


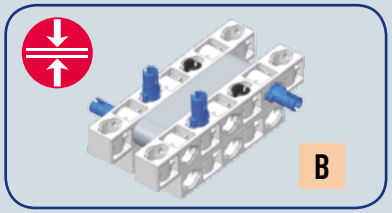
8 Tandem-rotor transport helicopter

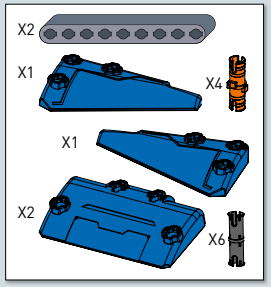












Technical facts and curiosities

The tandem-rotor transport helicopter is a heavy-duty aircraft that is mainly used by the **Armed Forces**. However, it is also used as a **fire-fighting aircraft**.

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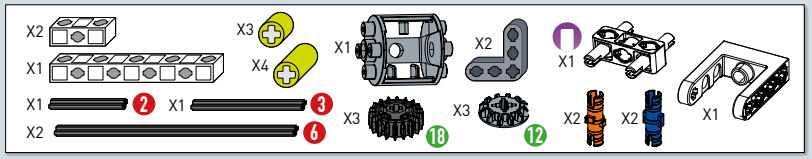

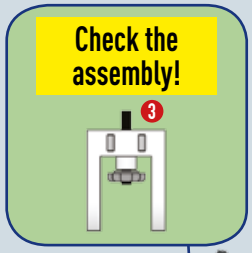

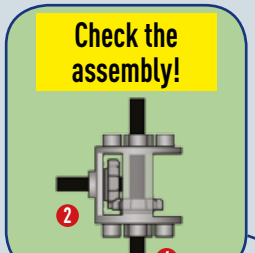

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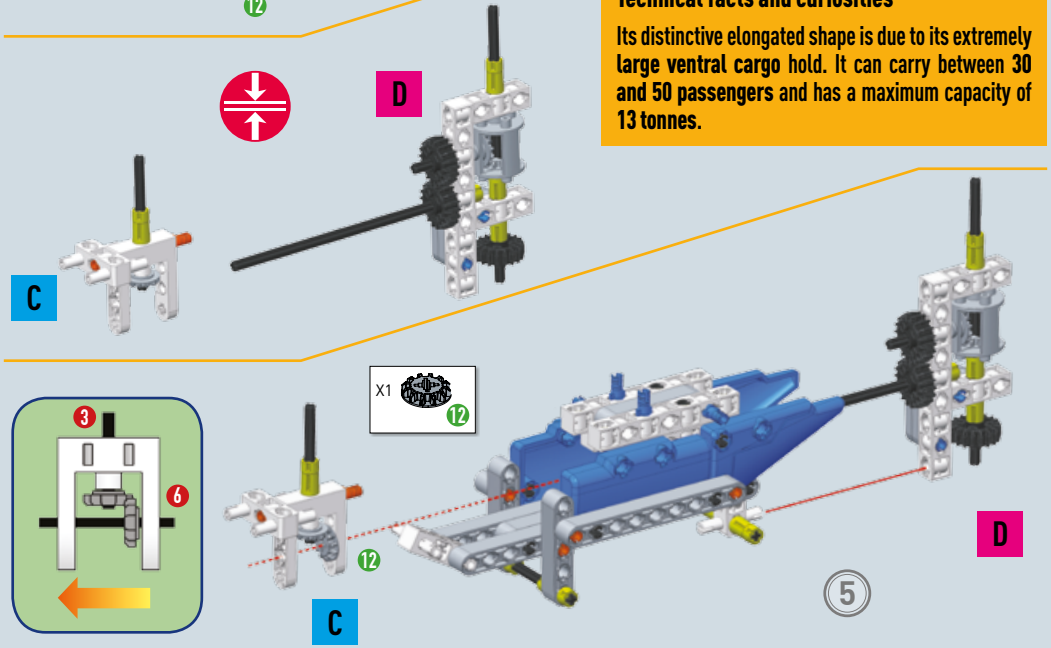
Technical facts and curiosities

Its distinctive elongated shape is due to its extremely **large ventral cargo** hold. It can carry between **30 and 50 passengers** and has a maximum capacity of **13 tonnes**.



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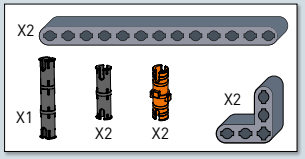

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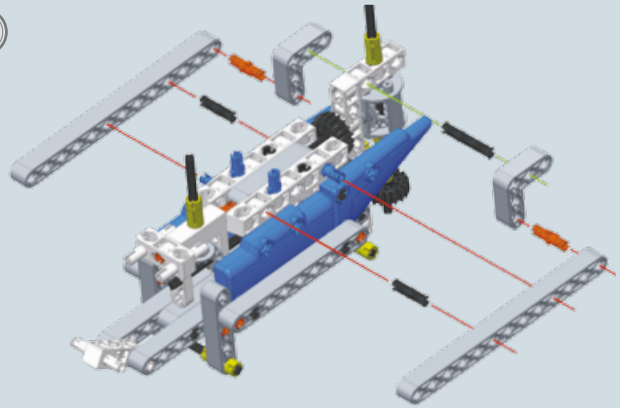
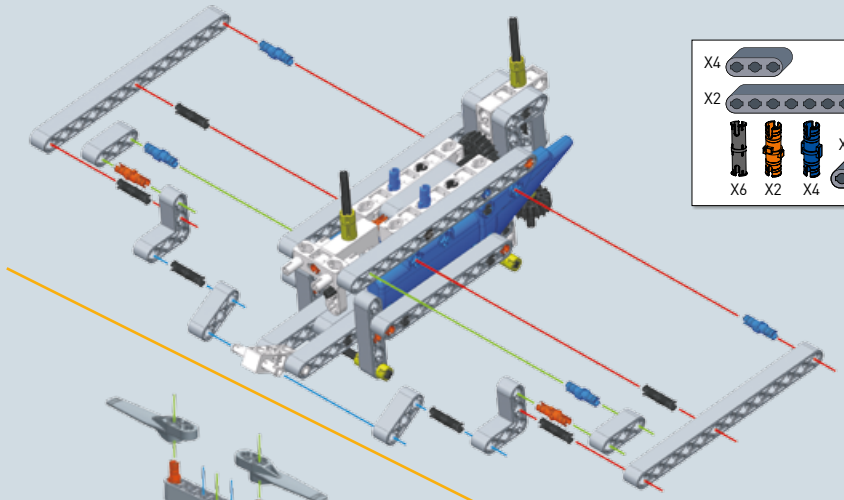


Technical facts and curiosities

What distinguishes it from standard helicopters is **its tandem rotor**: The two rotors are **counter-rotating**. Therefore, one rotates **clockwise** while the other rotates **anti-clockwise**. This arrangement stabilises the helicopter without the need for a **tail rotor**.



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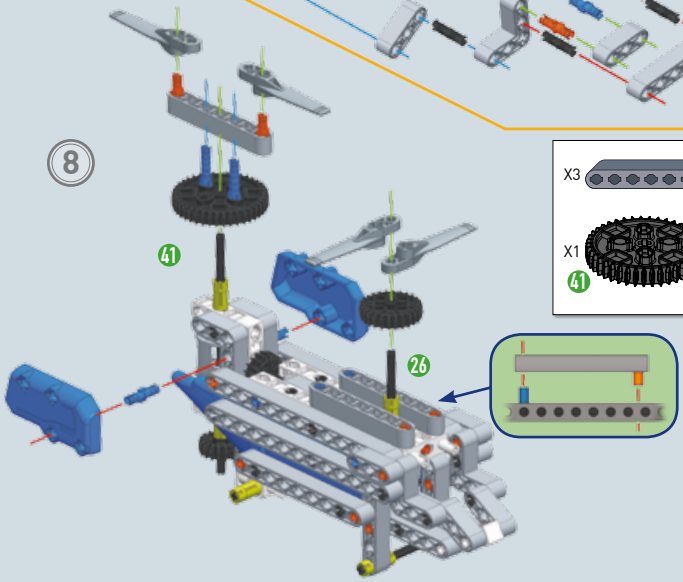
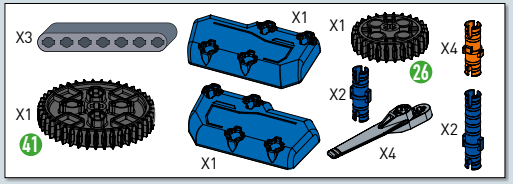
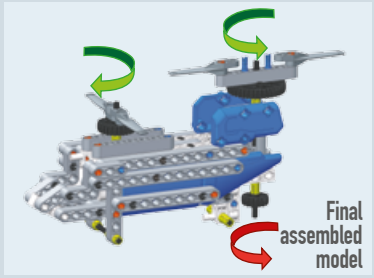
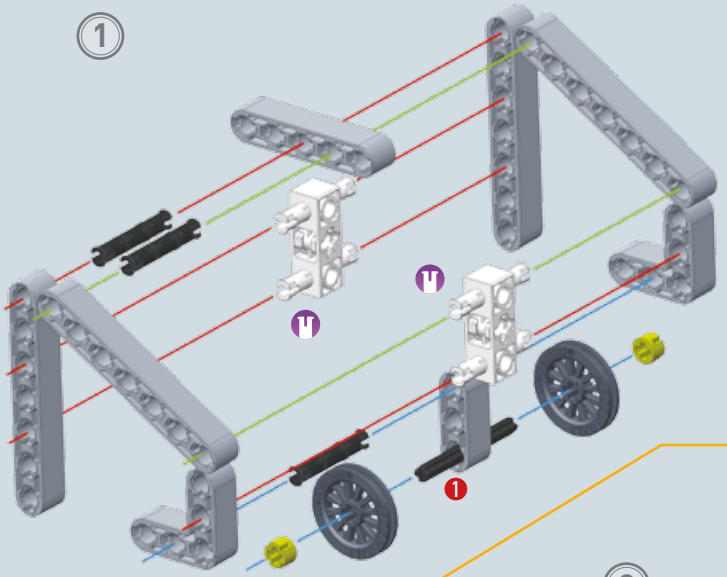
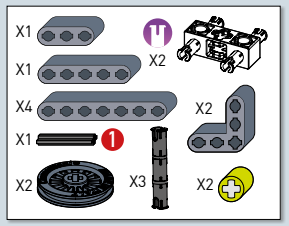






9 Working with a "flying crane" helicopter





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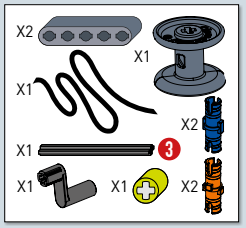
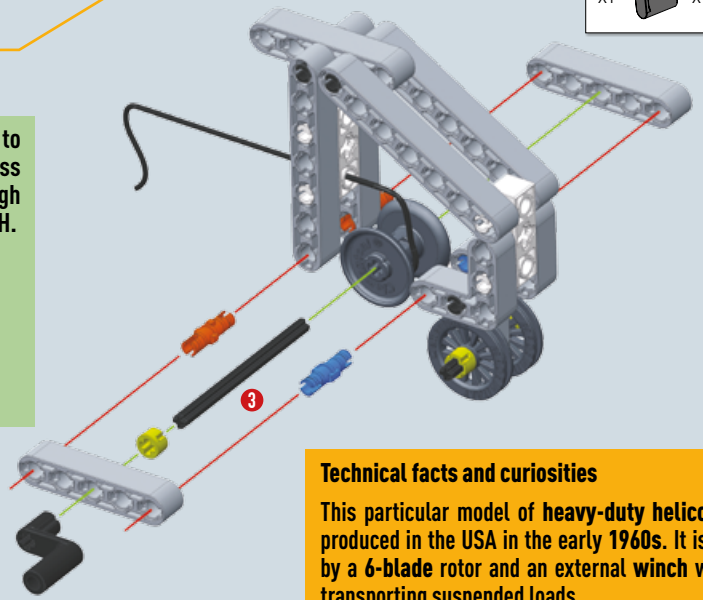
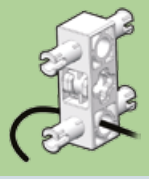




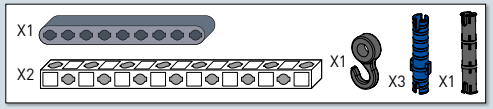
Tie the thread to the reel. Then pass the thread through the hole on part H.

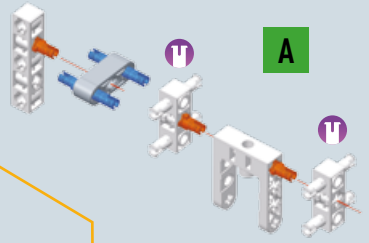


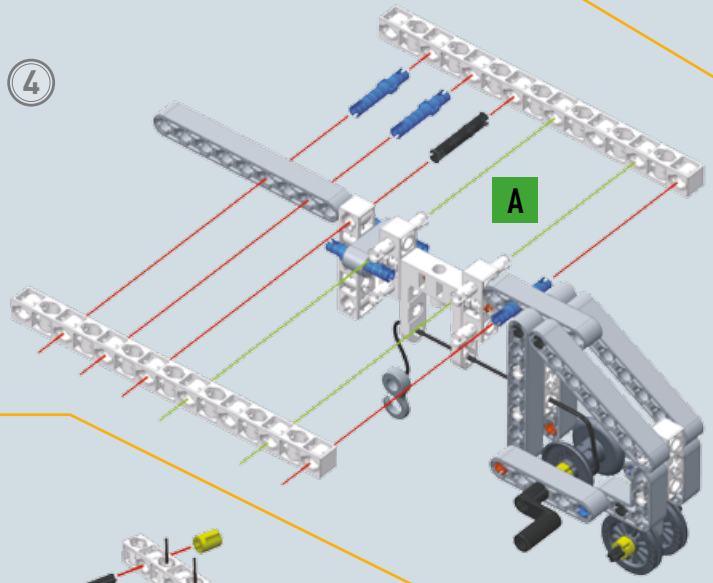
Technical facts and curiosities

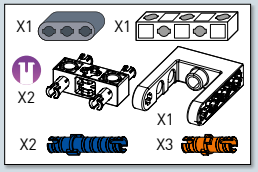
This particular model of **heavy-duty helicopter** was first produced in the USA in the early **1960s.** It is characterised by a **6-blade** rotor and an external **winch** with a **hook** for transporting suspended loads.

1:1

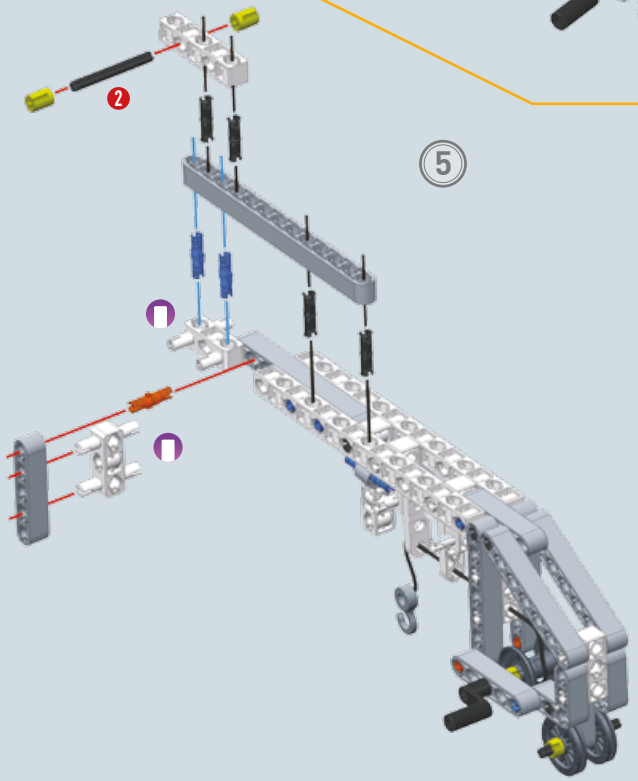






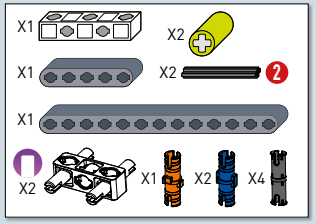


Pass the thread through the cross holes on the transmission module. Then tie the thread to the hook.



Technical facts and curiosities

A **"flying crane"** is used mainly for **moving large loads,** such as **containers** or **prefabricated** structures, and in **fire fighting.** Newer models have a lifting capacity of over **4 tonnes** up to altitudes of **3,000 metres.**



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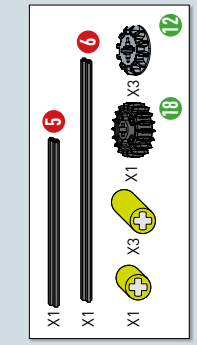
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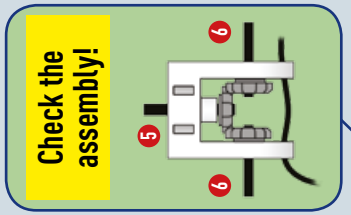
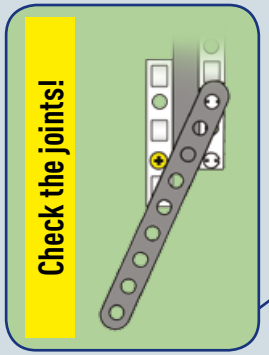
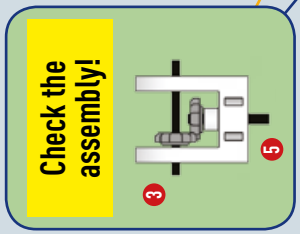

Check the assembly!


Check the joints!


Check the assembly!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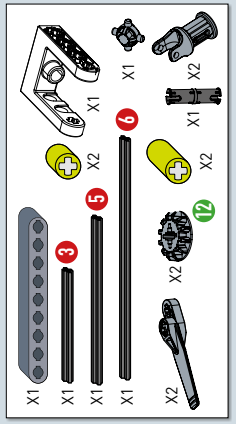
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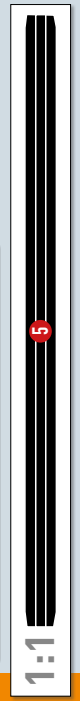
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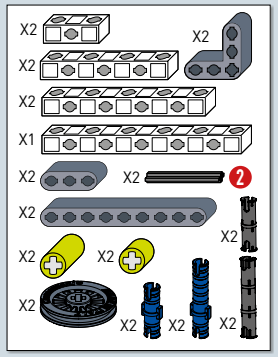
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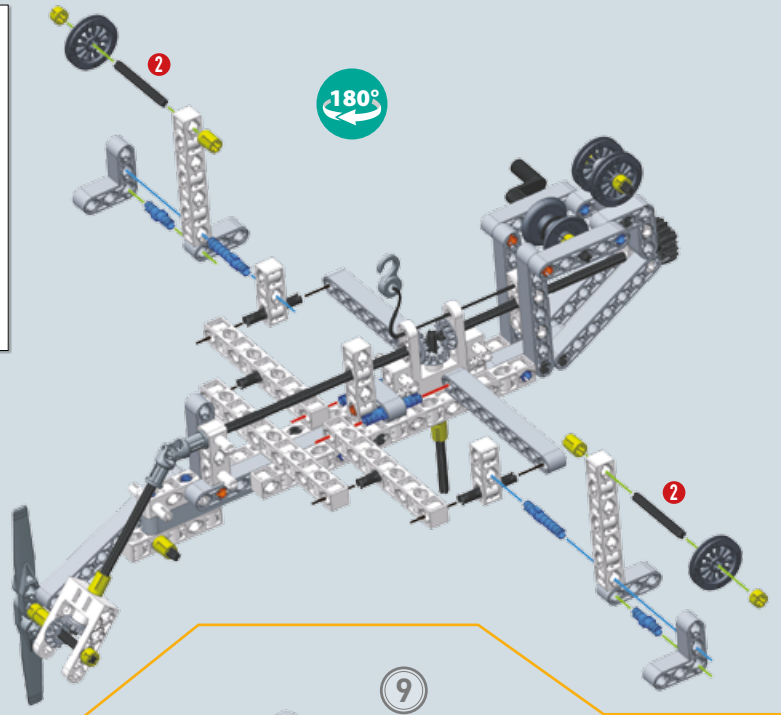
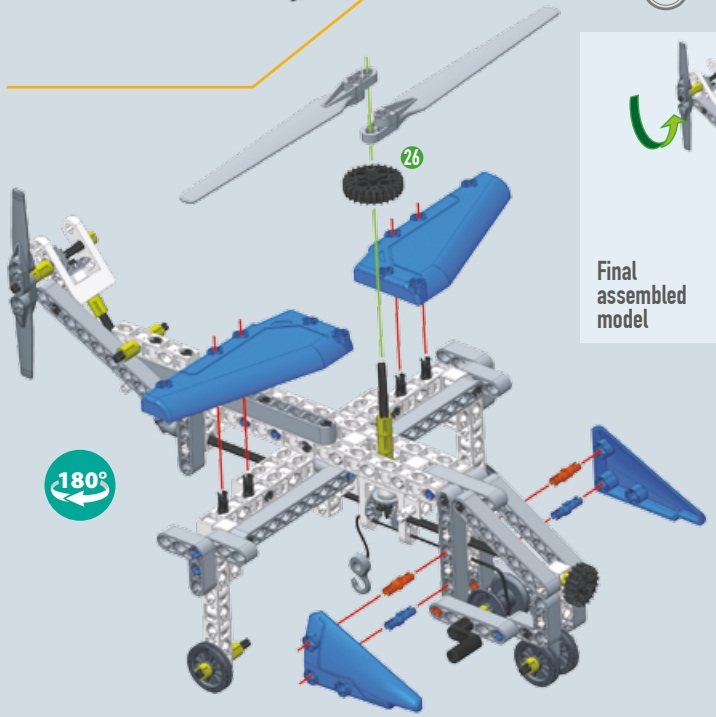
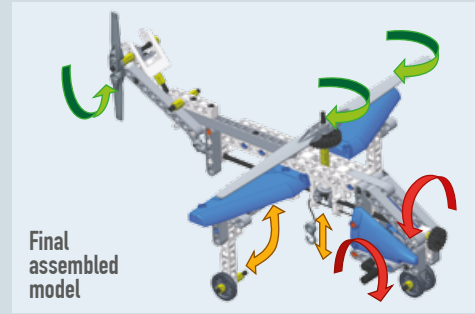
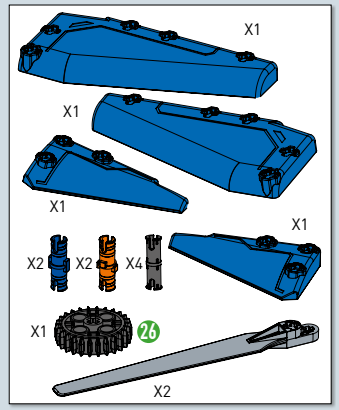

180°
2
2
8

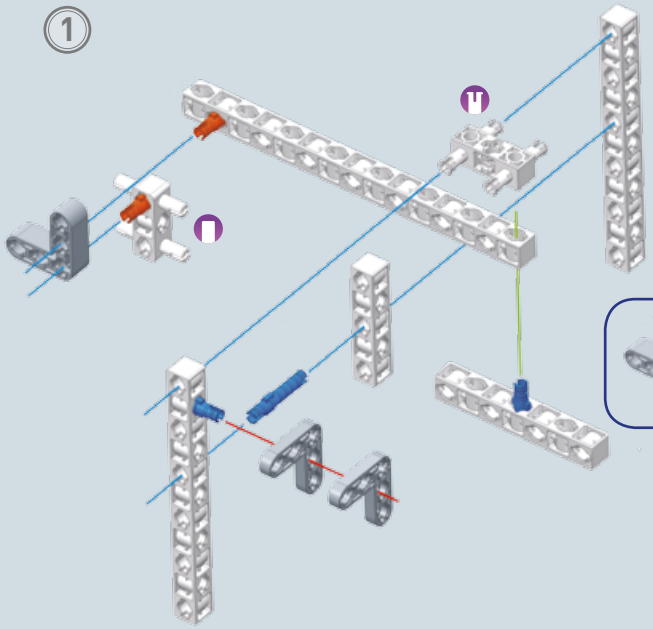

26
180°

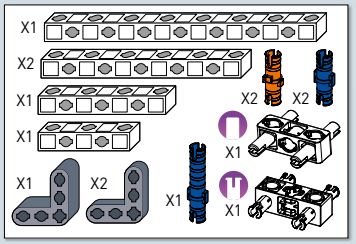

1:1
2

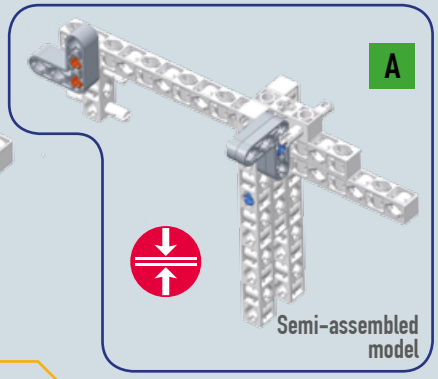

9
Final assembled model


X1
X1
X1
X1
X2
X2
X4
X1
26
X2

1







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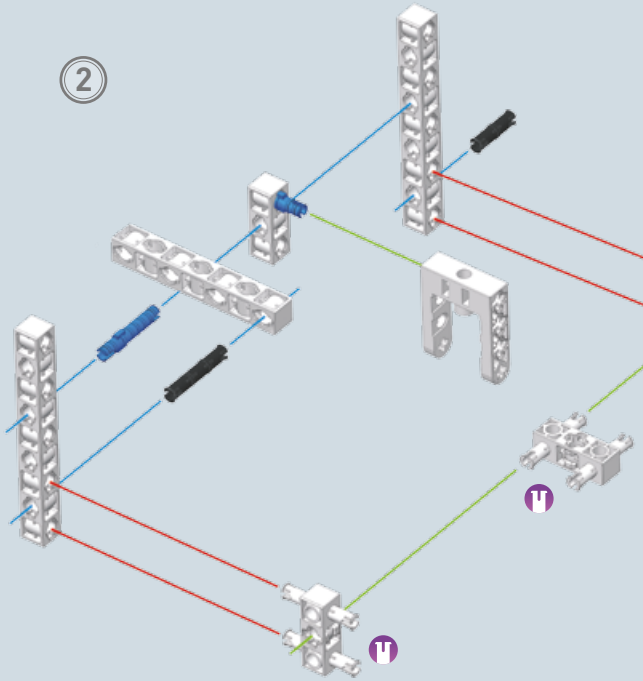

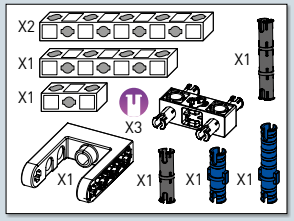

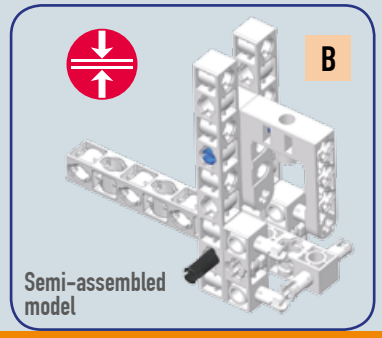

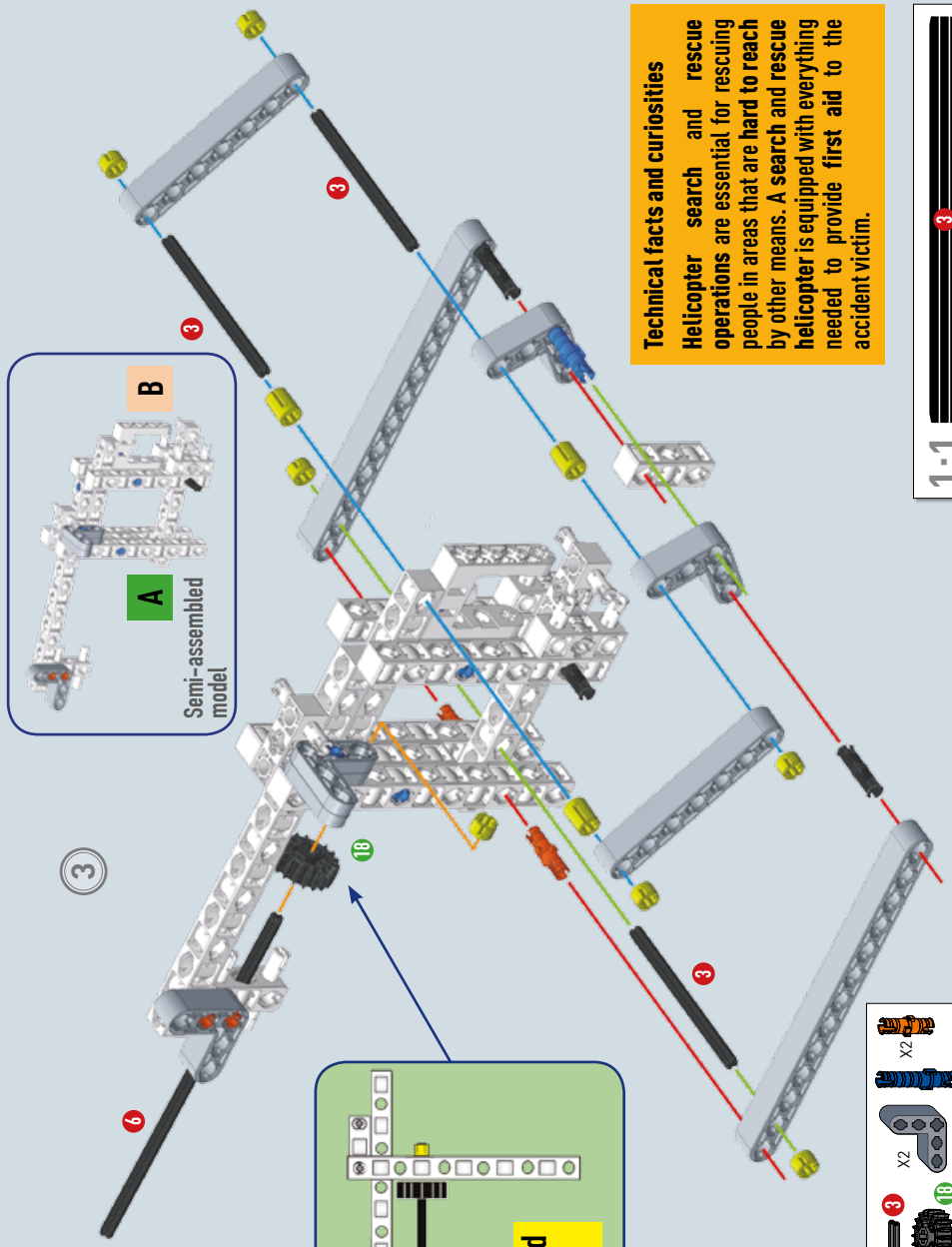

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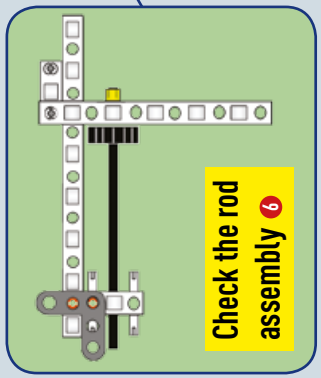
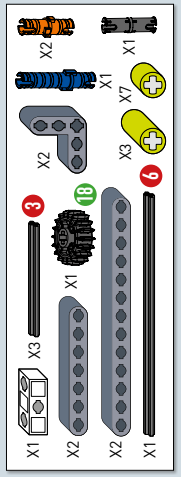
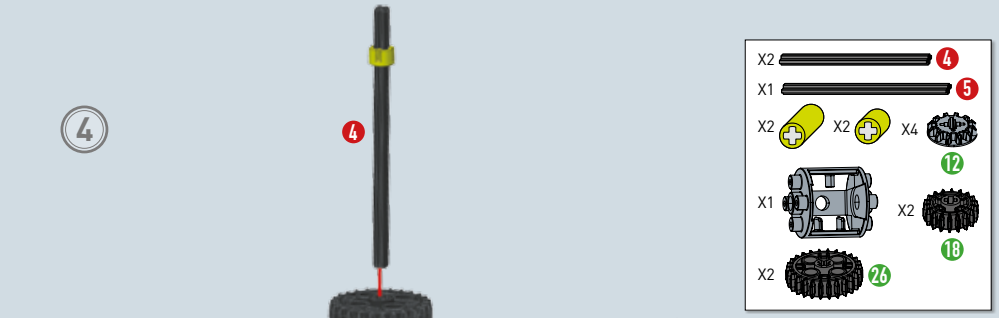
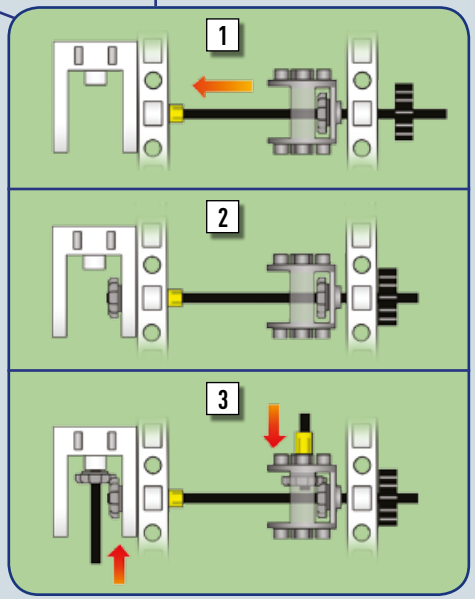


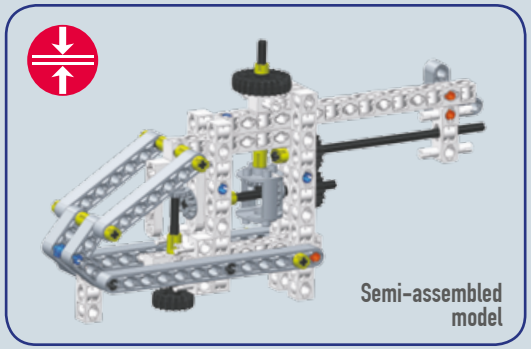
Technical facts and curiosities

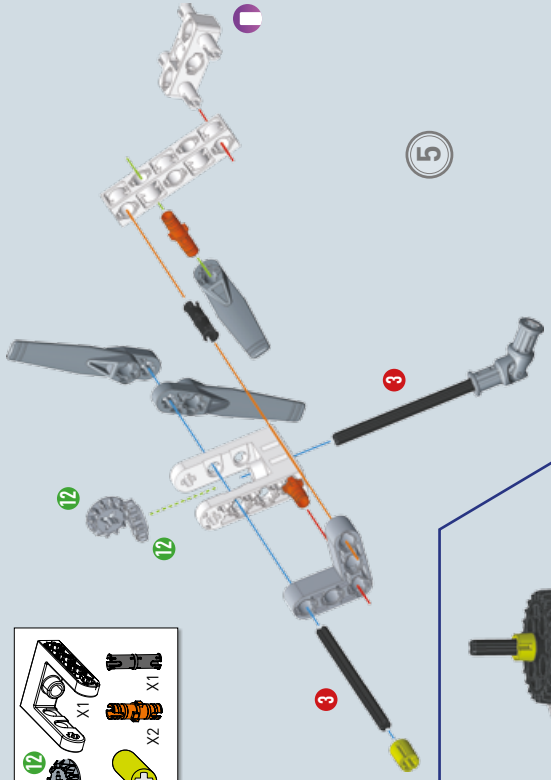
Helicopter search and rescue operations are essential for rescuing people in areas that are **hard to reach** by other means. A **search and rescue helicopter** is equipped with everything needed to provide **first aid** to the accident victim.

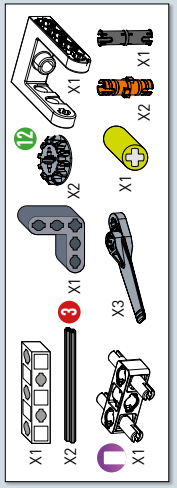


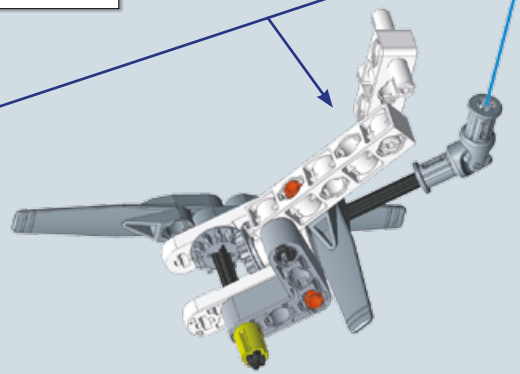






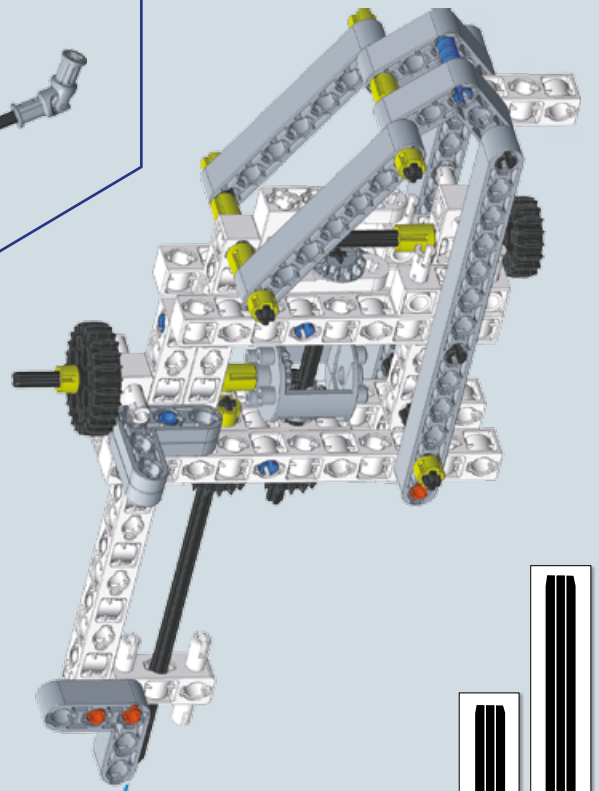


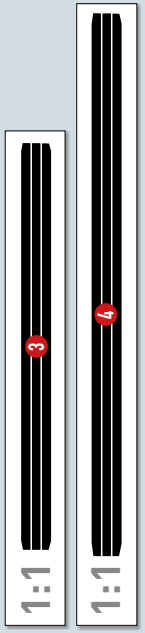


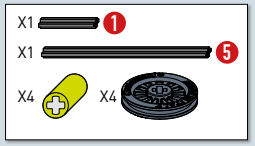


Technical facts and curiosities

The crew consists of a team of highly trained personnel: the **pilot** of the helicopter; the co-pilot, also called the **helicopter pilot engineer**; **search** and **rescue engineers**, who are entrusted with the task of rescuing the accident victim; and **medical personnel**, who are responsible for providing first aid.







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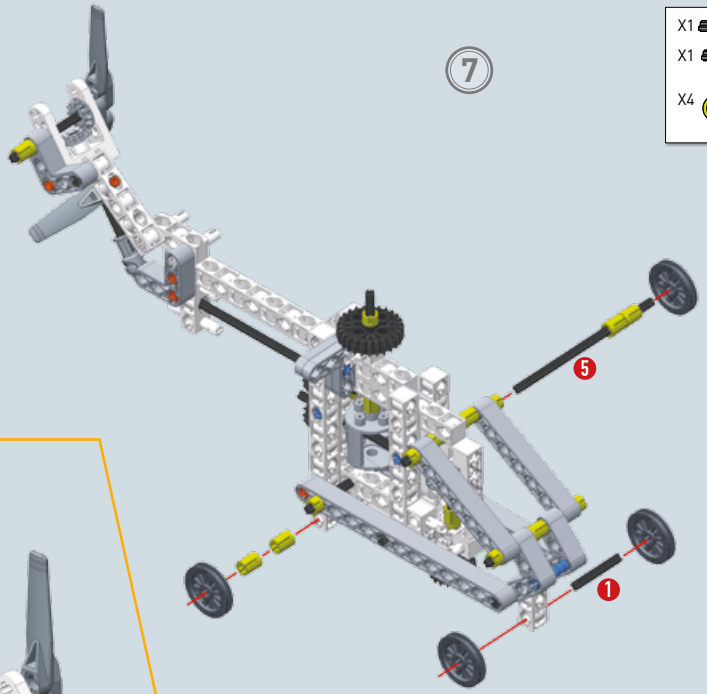
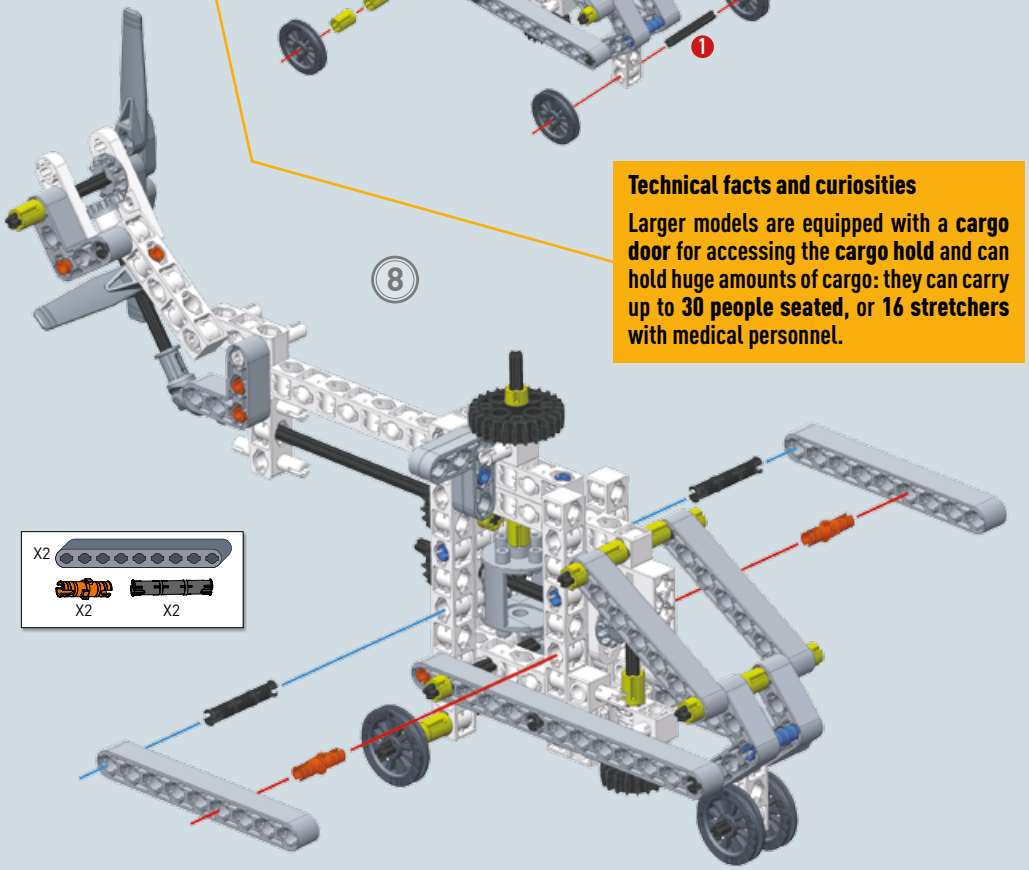
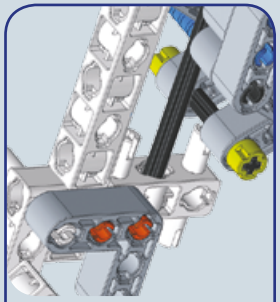


Technical facts and curiosities

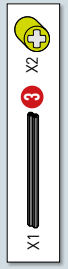
Larger models are equipped with a **cargo door** for accessing the **cargo hold** and can hold huge amounts of cargo: they can carry up to **30 people seated**, or **16 stretchers** with medical personnel.

8





Once you have attached the cargo door to the fuselage, use the blue double peg to raise and lower it. You can lock it in position by clamping it to the bar with pins.



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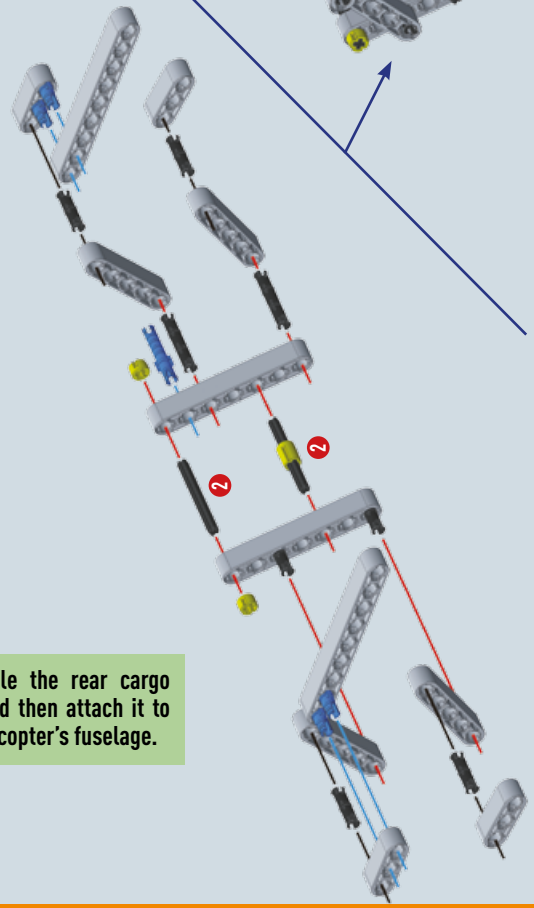

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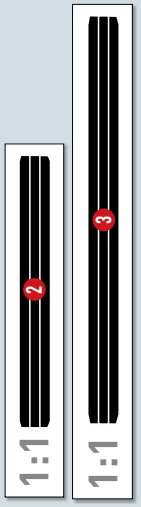
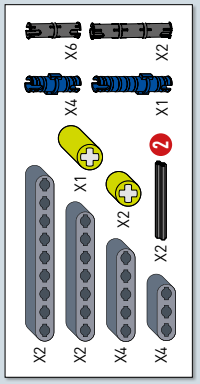
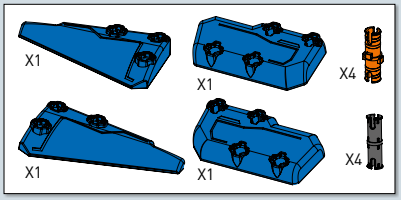




Assemble the rear cargo door and then attach it to the helicopter's fuselage.

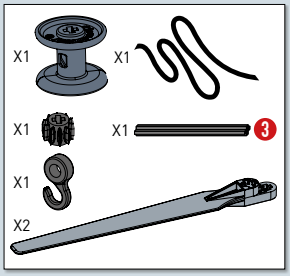
11

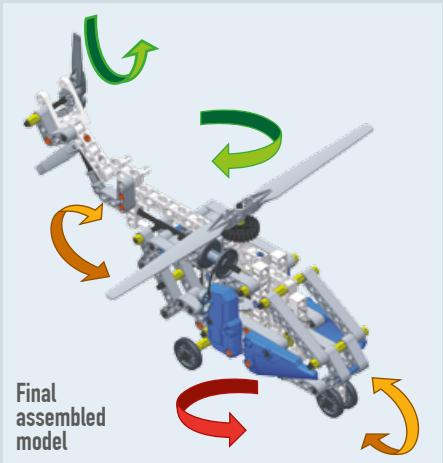


Technical facts and curiosities

Its rotors are generally arranged in a classic configuration, with a **four-blade main rotor** and a **tail rotor.** It can reach high very speeds while still ensuring a **comfortable journey** for its passengers, which is extremely useful in cases of severe trauma patients.

12





Final assembled model

1:1 3