STEM Project

## Chapter 7: Forces

Pages 119–142

# What a drag!


A helicopter is a type of 'rotorcraft' that can take off and land vertically, making it useful to get to dangerous and remote places where there is no runway. The rotors of a helicopter rotate and tilt to create the forces it requires to travel in all directions. When a helicopter is coming down to land, the rotors produce an upwards force that slows the helicopter down and ensures a gentle landing. This upward force, pulling against gravity, is called **drag**.

Drag can act in any direction, depending on how an object is moving. Drag is a force that *opposes* the motion of a moving object. It is always pulling in the opposite direction from the direction of travel.

### Meeting a specification

When engineers have a precise engineering objective they call it a 'specification'. In this task, you have the following engineering specification to meet:

**Specification: A helicopter that will descend 4 metres in exactly 4 seconds.**

In a small group, your task is to investigate different helicopter designs to meet this specification as closely as possible.

First, you will conduct a preliminary experiment to determine the average time a standard helicopter will take to descend 4 metres. Then you will modify the drag created by your standard helicopter to meet the specification.

### Preliminary experiment

Aim: To determine the descent speed of a standard helicopter for comparison.

Materials: helicopter template attachment, paper clip, staircase/balcony, stopwatch, measuring tape

Method:

1 Assemble the helicopter template in the attachment as instructed.

2 Find a safe location with a drop of at least 4 metres (e.g. from a staircase or balcony). Use the measuring tape to measure 4 metres from the ground and mark this as your 'launching point'.

3 Drop the helicopter from the 4 metre launching point and measure the time taken for it to fall to the ground with the stopwatch.

4 Repeat this process three times.



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5 Record the results in the table below and find the average descent time of the standard helicopter.

Results:

| Trial | Time |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| Average | |

## Modifying the standard design

Using the standard helicopter design as a starting point, your group will now attempt to meet the specification of 4 metres in 4 seconds. You will be asked to think of ways to modify the standard design in order to change how much drag is generated during the helicopter's descent, making it faster or slower.

Before you begin, think about the different tasks that are involved in this problem. You will need people to brainstorm ideas, design and create the helicopter, launch it, time its descent and record the data. Take a few minutes to discuss with your group how you will share these tasks and note this down.

The five steps of the engineering design process below will guide you through this investigation.

### Step 1: Think

What could you modify on the standard helicopter to increase/decrease the drag forces in order to speed it up or slow it down to meet the specification? Blade dimensions? Type of material? Extra/less weight? What else? Discuss your ideas as a group and write down as many ideas as possible.

### Step 2: Design

From your list, decide on three modifications you would like to attempt first and write them down.



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How will you create these modifications? What materials will you need? Write a short description of each modification and how you will create it.

**Step 3: Create**

Collect the required materials and make your three modified helicopters.

**Step 4: Test**

Repeat the preliminary experiment with your three modified helicopters, recording their descent time from 4 metres. Enter your results in the tables in the Results and data section. Did they meet the specification?

**Step 5: Improve**

What worked well? What didn't work? Using the results you have obtained, how could you modify your design again to get closer to the specification?

Do another round of three modifications by repeating steps 2 to 4 to refine your design. Use a new Data and results page and name it 'Modification round 2'.

If you have time, continue to carry out modification rounds until the specification is precisely met.

## Data and results

Use a separate sheet for each round of modifications and number them.

Modification 1 description:

Modification 1 results:

| Trial | Time |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| Average | |

Modification 2 description:



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Modification 2 results:

| Trial | Time |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| Average | |

Modification 3 description:

Modification 3 results:

| Trial | Time |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| Average | |

**Discussion and reflection**

Did you meet the specification? Which modification came closest? How many rounds of modifications did this take?

Were you able to use the knowledge you learnt in one round of modifications for the next round? How?

Were there any other uncontrolled forces (such as wind) at play in your investigation? What effect did they have on the investigation process?



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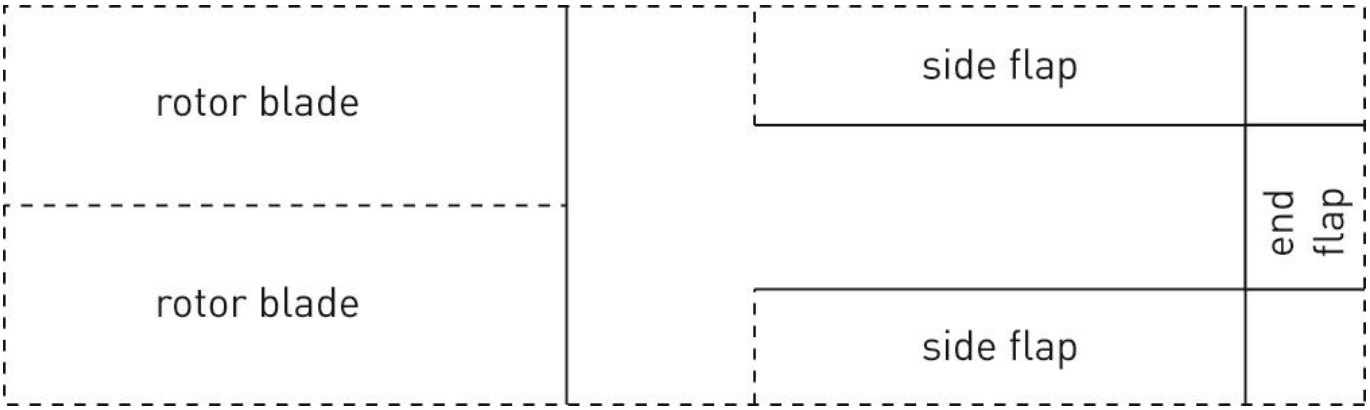
Can you think of other situations where the idea of repeated (or iterative) attempts at something is used to work towards a goal?

**Attachment: Standard helicopter cut out**




Assembly instructions:

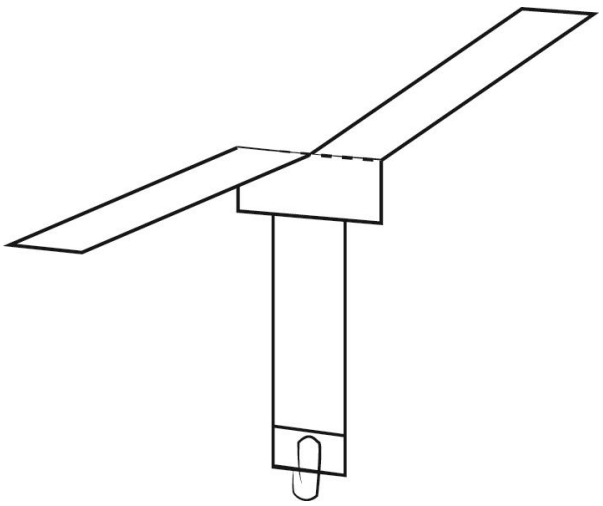
1 Cut along the dotted lines. Fold along the solid lines.

2 Fold one rotor blade towards you and one rotor blade away from you.

3 Fold both side flaps into the centre so they overlap each other.

4 Fold up the end flap to secure the side flaps in place.

5 Place a paper clip over the folded-up end flap to lock it in place as shown below.

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