Engineered for Flight: Birds and Planes

Activity Description

Spring is a great time to be outside and observe nature. Through observation of birds in flight, planes have been designed to have similar capabilities. This activity introduces learners to how wing size and shape affects how airplanes and birds fly. Learners are also introduced to the concept of aspect ratio which is the relationship between the length and width of a wing. A high wing aspect ratio indicates long, narrow wings, while a low aspect ratio indicates short, wide wings. Flyers with a high wing aspect ratio tend to be more stable and more efficient, while flyers with a low wing aspect ratio are more maneuverable.

Learning Objectives

This activity explores the following ideas:

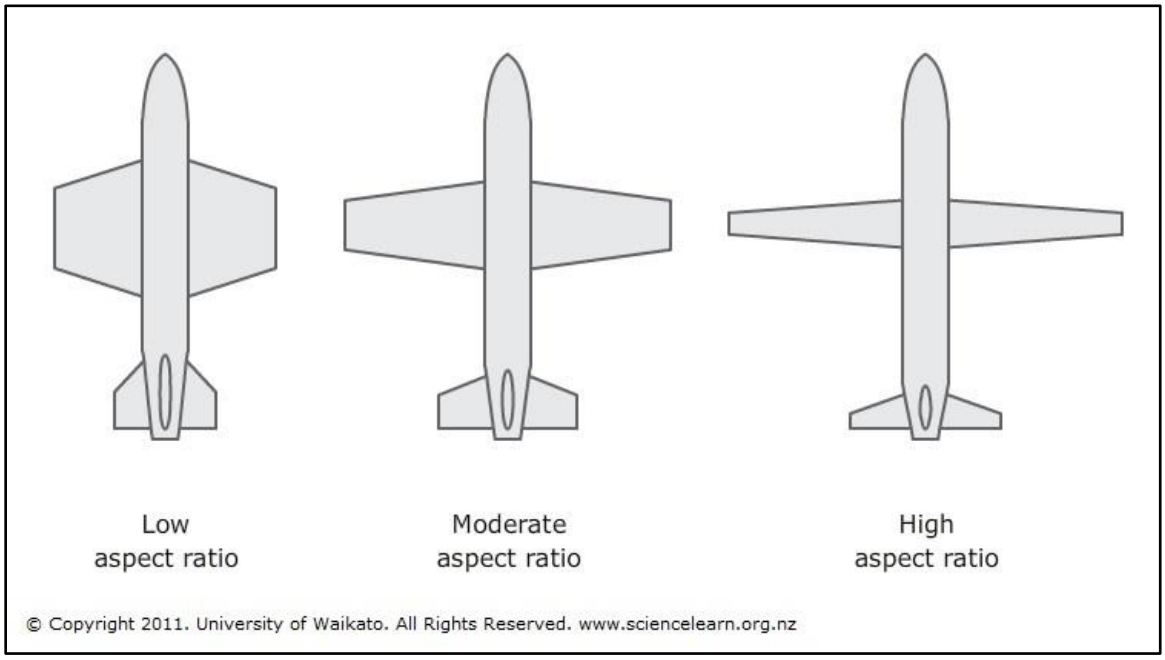
- Explain how differences in wing size and shape affect the capabilities (such as speed, soaring, gliding, and maneuverability) of a bird or plane
- Compare wings of different flyers to determine how they might perform
- Recognize low and high wing aspect ratios of birds and planes

Materials

- Worksheet showing photos of birds and planes
- Scissors
- Binoculars (optional)
- Ruler
- Pencil
- Blank sheet of paper
- Printer (optional)

Activity #1 Introduction to Aspect Ratio (time – 30 minutes)

1) One way in which the shape of the wing can be described is through the wing aspect ratio. Generally, high aspect ratio wings give slightly more lift and enable sustained, endurance flight, while low aspect ratio wings are best for swift maneuverability. The images below show the difference between a low, moderate, and high aspect ratio.



2) Take a blank sheet of paper and using your pencil and ruler draw a rectangle. The rectangle can be any size but use whole numbers for the length and width. The length will be the longest side of your rectangle and the width will be the shortest side. NOTE: Avoid drawing a square since the length and width will be equal.
3) Calculate the aspect ratio of your rectangle. A ratio is a way to compare two numbers. You can write a ratio in several ways: 1. Use a ":" between the two numbers (for example 2:1) , 2. Instead of the ":" you can use the word "to" (for example 2 to 1) , or 3. Write it like a fraction (for example 2/1)
4) Let's use the second option (2 to 1) to determine our aspect ratio. Measure the length of the longest and shortest side of your rectangle. Write these numbers as a ratio (for example length to width).
5) Now, let's write this as a fraction (for example length/width).
6) Draw another rectangle and determine the aspect ratio.
7) Compare the two aspect ratios of the rectangles. Is one a low aspect ratio? Is one a high aspect ratio?
8) If your rectangles were a wing of an airplane or bird, which would be a slow flyer? Which would be more maneuverable?

Activity #2 Matching Game (time – 30 minutes)

NOTE: The matching game can also be done online at https://www.sciencelearn.org.nz/embeds/15-wings-for-flight

1. Print out the sheets containing the images of the birds and airplanes. If you do not have a printer, write down the names of each in two columns (one column for birds/one for planes) on a sheet of paper.
2. Cut out each of the images.
3. Cut a blank sheet of paper into six squares.
4. Create descriptor cards. Write the following words (one word per square) on the squares made in step 3. (soaring, speed, gliding, hovering, maneuvering, endurance)
5. Place the descriptor cards on a large work space (such as the floor).
6. Read the descriptions for each of the birds and planes.
7. Compare the size and shape of the wings for each of the birds and planes.
8. Match one bird and one plane to one descriptor card.
9. Do they all match? Check your answers against the solution provided.

Activity #3 Observing Birds in Nature (time – varies)

1. Take your binoculars (optional), pencil, and paper outside.
2. Observe birds in their natural habitat.
3. Draw the shape of the birds wings you observe.
4. Does the wing have a high or low aspect ratio?
5. Based on what you have learned, is the bird a good at soaring, speed, gliding, hovering, maneuvering, or endurance?
6. Once back inside visit the Frontiers of Flight Museum's website.
7. Cut and paste the following link into your browser. http://www.flightmuseum.com/aircraft-3/
8. Match the birds you observed to an aircraft in the Museum's collection. ***(Hint: The E-Systems XQM-93A, Chance Vought RF-8G "Crusader", and Culver "Dart GC" are good choices)***.

References

https://www.sciencelearn.org.nz/images/704-wing-aspect-ratios

https://www.sciencelearn.org.nz/embeds/15-wings-for-flight

Images for Matching Game

Falcon - Falcons are the fastest animals on earth (with the peregrine falcon reaching speeds of over 320 kph). They can tuck their wings in to reduce drag.

Albatross - Wandering albatrosses have the longest wingspan of any bird. The long, narrow, pointed wings coupled with low wing loading enable the birds to glide effortlessly on up draughts – sometimes for months at a time.

Hummingbird - Hummingbirds have the ability to hover in one place by rotating their wings.

Godwit - Migratory birds like godwits have high aspect ratio wings equipped for long ranges and endurance at a relatively fast speed.

King Vulture - The high aspect ratio wings allow king vultures to spend hours in flight, soaring slowly without flapping their wings. They search for carcasses while riding thermals.

Hawk - Hawks' wings are wide and rounded at the ends. This low aspect ratio, elliptical shape with separated or slotted feathers at the end allows them precise maneuverability.

Spitfire (WWII fighter plane) - The elliptical shape of the wings (short and rounded low aspect ratio) give the Spitfire excellent maneuverability. They allow the plane to turn sharply while still flying at speed.

Glider - A glider's long, slim wings and low wing loading maximises lift, enabling the gliding action.

U2 (spy plane) - The high aspect ratio wings of a spy plane allow it to move slowly, not using much energy. This means it can stay airborne for some time while spying out the land.

B-1B (bomber) - This B-1B swing-wing bomber has adjustable wings that can be swept back for high speed. The tight angle of the wings helps to reduce drag, giving it supersonic speed capability.

Helicopter - The helicopter has the ability to rotate its wings, enabling it to hover in one place.

Boeing 787 (passenger jet) - Airplanes such as the Boeing 787 with high aspect ratio wings have long ranges and endurance times at fast speeds.

Solutions for Matching Game

- ***Speed*** **- Falcon and B-1B – ability to tuck in their wings to reduce drag and increase speed**
- ***Gliding*** **- Albatross and glider – long narrow wings and light bodies enabling gliding action**
- ***Soaring*** **- King vulture and U2 spy plane – high aspect ratio wings enabling slow, soaring flight (similar to the glider and albatross, but their wings are slightly wider)**
- ***Maneuvering*** **- Hawk and Spitfire – elliptical-shaped low aspect ratio wings allow for maneuverability**
- ***Endurance*** **- Godwit and Boeing 787 – capable of long-distance endurance flight at high speed**
- ***Hovering*** **- Hummingbird and helicopter – ability to rotate their wings and hover.**

NOTES: There could be a discussion concerning what is different between the helicopter and hummingbird. Rather than wing size and shape, their relationship is based on their ability to rotate their wings, enabling them to hover in one place. The example of the Airbus and the godwit may not be so obvious either. They both have high aspect ratio wings (long compared to width) and are designed for long-distance endurance flight at speed.