Flight Investigations

Curlews vs the Airbus Air380-800

Key Stage 3 Design and Technology

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Specialist knowledge for teachers

Our scheme of work hinges on the comparison of the ***Eurasian Curlew***, Britain's highest conservation priority bird species, with ***the Airbus A380-800***, the world's largest commercial airliner. Our resource is written with a focus on biomimicry for Year 8 students, in schools around the Morecambe Bay area, comparing the Curlew with the A380-800, to explore learning primarily related to D&T.

That stated, there are multiple spin-out opportunities for other groups of learners, involving many related areas of the curriculum, and engaging with other groups of stakeholders inside and outside school settings.

People teaching our scheme of work will benefit from some fundamental knowledge about the Eurasian Curlew's habits around the Bay, and its red listed status. They should also develop some awareness of the Airbus A380-800, including industrial design, materials selection, and theories of flight. These facts and figures are provided in a fact sheet for teachers, parents and guardians, titled "Facts and Figures to Compare the Eurasian Curlew with the Airbus A380-800".

The fact sheet, along with the workbook which we have intended for learners, titled "Flight Investigations", ought to contain sufficient foundational new knowledge to confidently teach this resource.

Figure 1: Curlew

Figure 2: Airbus A380-800

We recommend that teachers engage with new knowledge in roughly the following order, with further details available in the teachers' fact sheet and in the learners'workbook:

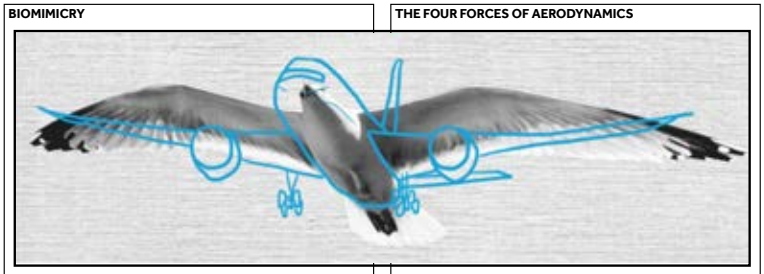
- Familiarity with how aircrafts use spoilers and ailerons to change wing profile, and how birds use morphing to change wing profile
- Confidence at explaining The Four Forces of flight (thrust, drag, lift, gravity), and Bernoulli's principle applied to lift (see Figure 3). This will facilitate comparative discussions of forces acting on the hoop glider which students build themselves (Figure 4), the body and wings of the Curlew (Figure 1), and the fuselage and wings of the A380-800 (Figure 2)
- Familiarity with the nesting, breeding and feeding patterns of the Curlew in the Morecambe Bay area, available from the **World Wildlife Trust**, and the migration patterns, available from the **Euro Bird Portal**
- Familiarity with the construction and characteristics of the A380-800 Airbus, available from the Airbus website, and the typical flight patterns, available from **FlightAware** for comparison with the Curlew
- Confidence at explaining how and why humanity has mimicked flight observed in nature, providing and explaining examples of the results of those attempts through history
- Capability at critically developing Year 8 D&T content from the above, using the provided resources to link place-based learning in the Morecambe Bay area. Examples include: materials selection and sustainability, the implications of force and efficiency for design processes, balancing natural and man-made built environments, locally, nationally, and globally

Examples in practice

FLIGHT INVESTIGATIONS

NAME

BIOMIMICRY



What is biomimicry

Name 2 products that use biomimicry

THE FOUR FORCES OF AERODYNAMICS

Although planes and birds fly in different ways, both use The Four Forces of Aerodynamics.

What are these four forces?

In the space below draw a diagram of either a bird or a plane that explains these four forces.

THE BERNOULLI PRINCIPLE

Birds and planes get off the gound because of the Bernouilli Principle. In the space below draw a diagram that explains this principle.

What about the A380-800 wings?

Planes can't flap their wings: they rely on forward thrust to achieve lift, which is why they need long runways. The A380-800 wing has a blend of materials to gain different advantages.

Q: What parts of the wing need to be strong, and what parts need to flexible, and what parts need to be light?

CURLEW and A380-800

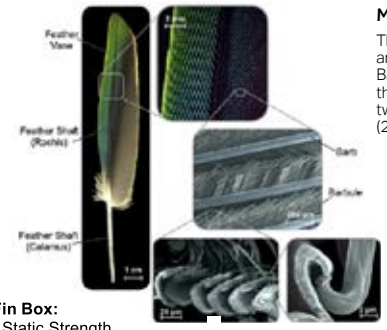
What about those Curlew wings?

A Curlew generates lift by flapping its wings, then changing the cross-section, direction, and shape to make the most of the Bernoulli principle (called wing morphing). The feathers have curved barbs to interlock and adjust, and the wing bones are hollow.

Q: What can aeronautical engineers learn from a Curlew's wings?

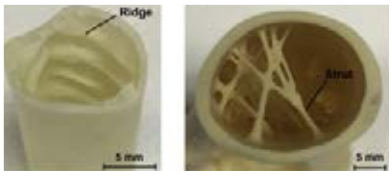
Biomimicry for designers and technologists: human flight and birds in flight.

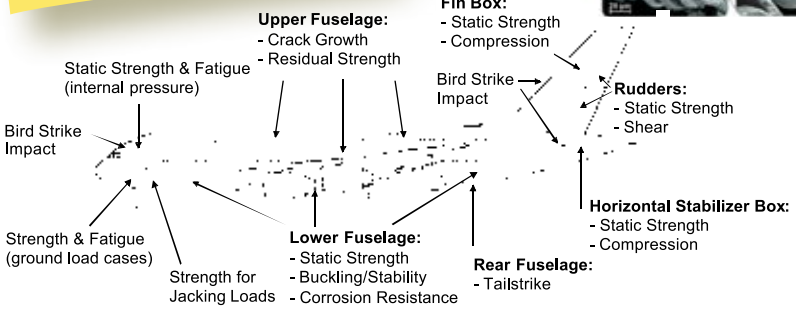
A case study of the A380-800 and the Eurasian Curlew.



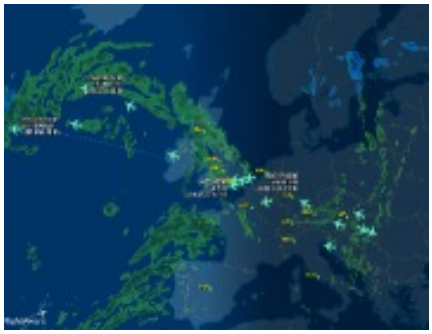
Materials and characteristics

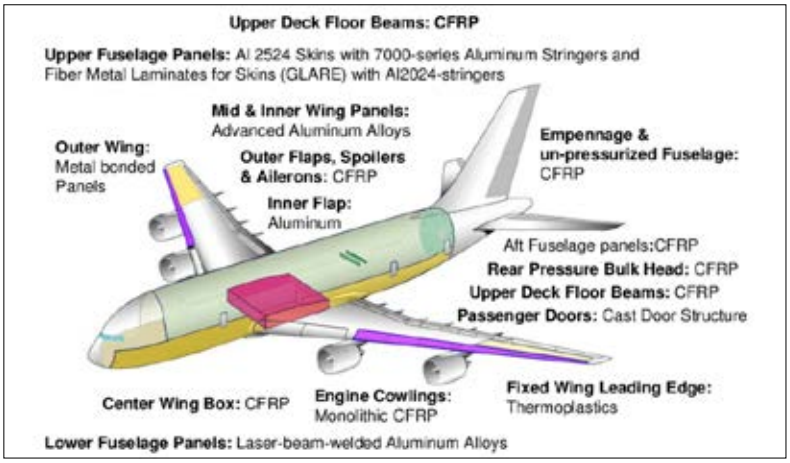
The flight feather is composed of the feather shaft (rachis and calamus) and the feather vane (barbs and barbules). Barbs are foam filled asymmetrical beams and grooves that branch from barbs to interlock with each other. The two bottom SEM images are taken from T.N. Sullivan et al. (2016) [108].





Distribution of the Curlew and the A380-800





Curriculum aims and objectives

Lesson structure

4 lesson sequence (one-hour lessons) but each lesson can also be used as a 'stand-alone' for flexibility.

Year group

Suitable for any KS3 group, ideal for Year 8.

Pupils' outcomes

Head

Pupil knowledge of the topics will develop through a combination of theoretical delivery and hands-on practical experience. In the process of answering the key questions pupils will build an understanding of the principles of flight (thrust, lift, gravity and drag) and how a bird and a plane exploit these forces. Ultimately, they will be able to make comparisons between planes and birds and evaluate which is the 'better flier'.

Heart

Using the two contexts of the Curlew and the Airbus 380-800 pupils will be able to develop their understanding of locality. They will learn how human behaviours can have negative consequences and how human solutions can bring benefits.

Hands

Pupils will investigate lift and construct a 'hoop flier' to put their theoretical knowledge into practice. They will use fact sheets and their own research to identify solutions in response to the questions. Their creative thinking and problem-solving skills will be developed as they address problems on a local and global level.

Overview

The project is based around a series of questions that learners will seek to solve:

- What is biomimicry?
- How do planes and birds fly?
- Which is the 'best flier', the Curlew or A380-800?
- What is sustainability?
- How as designers can we improve situations using local and global contexts?

Adaptations to extend impact

Interaction with MBC colleagues and other stakeholders illustrates a number of opportunities for extending, stretching, and adapting to other contexts:

- Comparing natural and man-made flight through biomimicry could be extended to land-based and water-based equivalents, linking the project to the 'blue space' and 'green space' concepts being examined by other MBC resources in the booklet
- The notion of biomimicry in D&T and engineering, through applied examples of materials selection and structural characteristics, can be extended to the MBC FE Construction project which is examining biomimicry for the built environment
- The principles of flight and materials selection can be adapted to other KS3 curriculum areas, including forces (science), flight inspiring the arts (music, art and design), population and urbanisation (geography) and to other levels at KS2 and FE
- Adaptation could also extend to climate change themes and how the intertidal zone ecology will be affected by changes in marine and weather rhythms through rising sea levels, more extreme storms and increased marine temperatures
- In different coastal environments investigating the intertidal zone could focus on rockpools and the organisms they contain rather than on mudflats

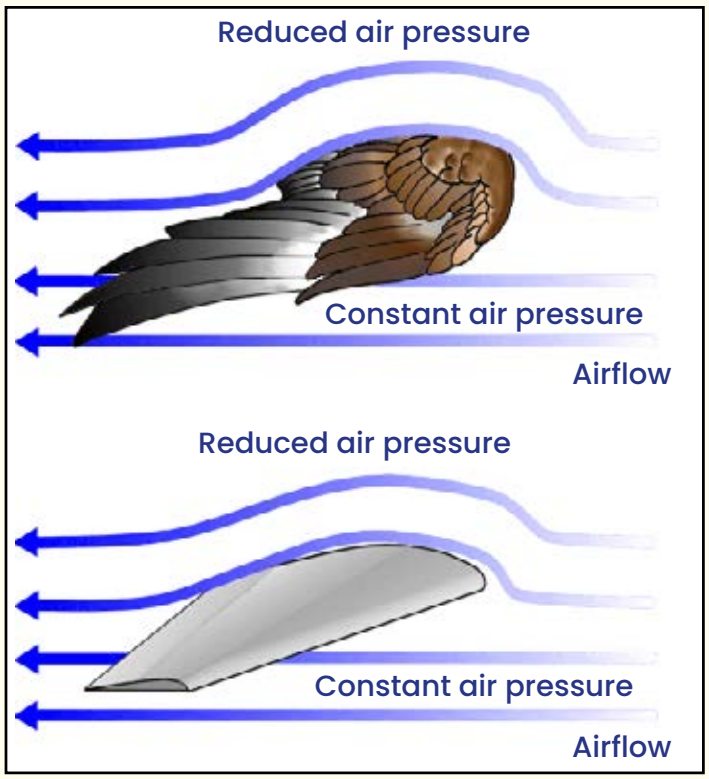


Figure 3: Bernoulli's principle from Slonsar, N. (2021). Avians to Airplanes: Biomimicry in Flight and Wing Design. Berkeley Scientific Journal, Spring.

Figure 4: Hoop glider kit.