Quality First Education Trust

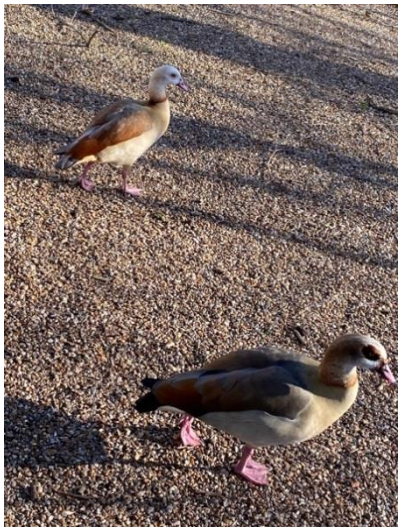
Wider Curriculum: Unit Plan for Home learning		
Subject: Science	Unit: Biomimicry and Design in Nature	**Year:** 5
This unit will be about what we can learn from the 3.8 billion years of design genius in in nature and how we can use this to be more sustainable and solve problems		

Session 1	**What can the natural world tell us about design? What is biomimicry?** • Make a list of things that you may see that spring has started. Have you seen any from this list? Or check those in the resources. • Think: How do these plants and animals know what to do and when? • Watch this *film as an introduction to Biomimicry What surprised you? What questions do you have? **Note: This is an adult level talk but will make you think in a good way! Do not worry if you do not understand everything. The scientist Janine Benyus is an amazing world expert.* • Tell someone at home something you have learned or thought about today. Challenge: Choose one of the questions from the video to research more about.
Session 2	**What is biomimicry? Why is it important?** • Watch this 2 minute summary on what is biomimicry? • Write your own definition of biomimicry in 'easy to understand' language. *Imagine you are explaining it to someone in your class who has missed the last 2 lessons* • Relisten to the video or research other definitions and improve yours. • Why is biomimicry important? Give 3 clear examples from what you have learned already. You can use diagrams or photos to explain. • **What questions do you have about biomimicry?** Create a list of things this has made you want to know more about. Challenge: Find out more about Janine Benyus or another scientist, engineer or designer working in biomimicry and what their main achievement is.
Session 3	**How has biomimicry helped improve transport?** • Look at the picture in the resource. What do you notice? • Look at shapes of different forms of transport. Are there any connections with the shape or form of any animals or plants? surf board - • Make connections with your understanding of forces, air resistance and water resistance. Draw pictures or use photos from internet and note anything you notice about shapes. • Watch up to 2.05 of this video (you can watch more if you like!) about how a birdwatcher changed Japanese train problem. • Watch this BBC video which shows it in a different way. • Use labelled diagrams to explain how the kingfisher solved the train problem. Challenge: Find out and explain how the boxfish inspired Mercedes through biomimicry. Start here. Would this design or 2005 appeal in 2021?
Session 4 	**What can we learn from studying how birds fly?** • Look at the pictures biomimicry in flight resource. What do you notice? • Human flight is all based on study of birds. Leonardo da Vinci was a genius in art, science and invention. His observations showed how much he understood. What do you notice here? • Look at these 3 biomimicry examples how birds are inspiring design and engineers now to answer: **What can we learn from studying how birds fly?** o OWLS – noise reduction: Watch this. Read resource. o Falcons –Watch this.(video scroll down page) Read resource. o Geese – flying together Watch this. • Answer the key question using pictures to help your explanation.

	You can choose one example in detail or give a short example from different birds. Challenge: Find out how this research into studying birds is going to mean the flight of drones can improved.
Session 5	**What materials are there in nature to explore?** • Start to think like a designer, scientist and engineer with biomimicry ideas. Go outside (if you can) to look closely at different animals and plants and what they do and especially what they produce. You can use knowledge of other animals/plants if you cannot go out. • Think/observe: What is produced by plants or animals or done by them that could be useful? *eg a way of joining things, attracting attention, defending, use of colour, shape of body* • **Record at least 5 ideas**. You can complete a table (see resource) or present clearly in a different form if you prefer. You are thinking about the potential or possibilities of materials/substances in nature. • Every invention has come from close study and observation. Choose an animal or plant and create a set of observations, questions, notes about what you see (like Leonardo da Vinci). Challenge: Investigate the biomimicry potential in spider webs.
Session 6	**What are the best sticking solutions in natural world?** • You are to compare 2 biomimicry sticking solutions: Velcro and Slug Slime. **1. Velcro**: o Look at the pictures in the resource. What do you notice? o Have you got Velcro on a bag or shoes? Have you thought about how it works, if you have some go and have a closer look! o Check here find out how this plant led to Velcro being invented. Scroll down to watch the video at the bottom of the page. **2. Slug slime** is sticky even on wet surfaces, how could this be useful? o Read more in the resource or listen to it being read here. • Answer: **Which is the most useful sticking solution: Velcro or Slug Slime?** Why? Write or record your explanation using scientific language and evidence. Challenge: Why hasn't the slug slime solution be used straight away in surgery?
Session 7 and 8	**What are the best sticking solutions in natural world?** **How are geckos such good climbers? How is this useful for design?** • Read the pages 'Geckos Stick anywhere' below from the book Beastly Bionics • Watch this video Beyond Bionic - Geckos. Could humans ever climb like a gecko? What other reasons are there for knowing about how they do climb? • Look at the partly finished page in resources. It has some but not all of the information to answer the key question. Think: What more could you add? Go back and find information that explains more about why geckos are such good climbers and how this helps designers solve other problems. • Answer the key question: **How do geckos such good climbers? How is this useful for design?** • **You can either** o finish the resource by writing/drawing in the blank spaces o create your own infographic poster or page for a Biomimicry book for children on paper or a digital presentation using Book Creator, Powerpoint or other application o do a voice over or video talking about chosen images (like Janine Benyus) o If you prefer the content from last lesson, you could choose to answer the Session 6 question: **What are the best sticking solutions in natural world?** **Challenge:** Watch David Attenborough's short video BBC The Wonder of Science. Which source, explanation or image has been the best to learn from and why?
Session 9	**What is the impact of biomimicry?** Choose one of the questions in resources to present on. You can of course

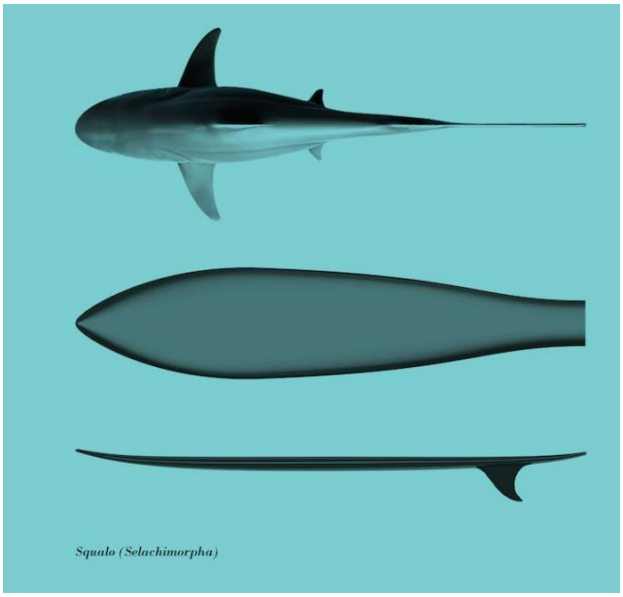
	choose a question about biomimicry that is not mentioned. If you want to find other examples look here. eg How can shark skin help create swimwear to help athletes? • Research your question using the internet. If not possible you can answer the question using the examples you have from previous lessons. • Make notes, find the key pictures to help you explain the impact of design. • Present your learning in less than 2 minutes as a spoken presentation. • Try it on someone at home and share with your teacher. Challenge: Is the impact of biomimicry always positive?
Session 10	**Are the secrets to a sustainable world really all around us?** • Look around your home or school area and create some questions that have solutions in nature. You can refer to your work in lesson 5 and collect a range of ideas in the table in resources. *eg How can such a small animal like an ant carry such a large object?* • Think of **one** animal or plant which has a particular skill that makes it successful and think how that might help designers or scientists answer other problems. • Develop one of your ideas as a how can help designers think of a new way. Remember to use drawings like Leonardo da Vinci or the diagrams for the Japanese train. • **Present your ideas and thoughts in your own way, this could be:** ○ a video of the animal/plant explaining what you see and your questions and design ideas ○ a page from our 'Beastly Bionics' book (like Geckos) about your idea ○ a proposal to a company about your animal and how it might help their business
Session 11	**What technologies will change our world?** • What discoveries or problems do you think scientists and designers should be working on to change our world for the better? • Scan the titles 22 technology ideas in BBC Science Focus on this website (just look quickly through the range of ideas first) • Choose 2 to read more closely and watch video linked to the idea if there is one. Which was the better idea and why? • **You are going to review ONE idea from this site.** You can do this in writing, as an audio or video presentation. • What is the main idea? (Summarise) ○ How well do you think it will work? (Evaluate) ○ How successful do you think it will be? ○ What might stop it being a success? **Challenge:** Which of the 22 ideas will make the biggest difference to the biggest number of people? Does that mean it would be the most successful?
Session 12	**How could nature shape our future?** • What discoveries or problems do you think scientists and designers should be working on to change our world for the better? You could consider: *environment, buildings, food and farming, medicine, transport, disabilities, disease, robotics* or ….. you decide! • Set a problem or question you would like the scientific community to answer. What is there in nature than might be worth investigating to help with the answer? Has anything already begun on this? • If you are not sure or cannot come up with anything there are lots more amazing examples to explore here. • Answer: What are your hopes for the future of biomimicry? **Challenge:** If nature is 3.8 billion years old, why is biomimicry relatively new area?

Session 1



Session 3

Shark – surfboard biomimicry

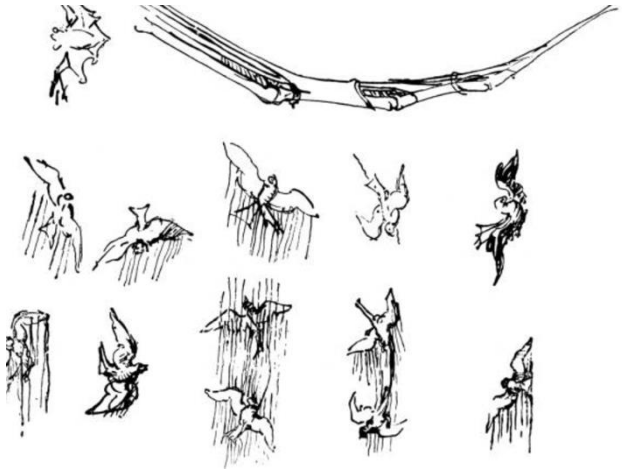


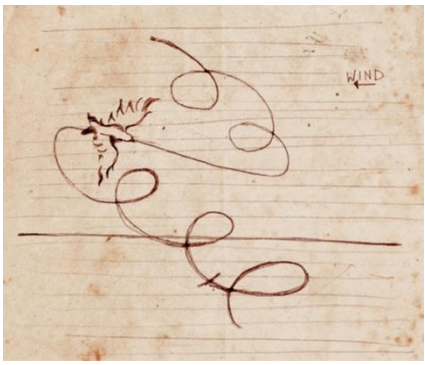
Session 4 Biomimicry and flight

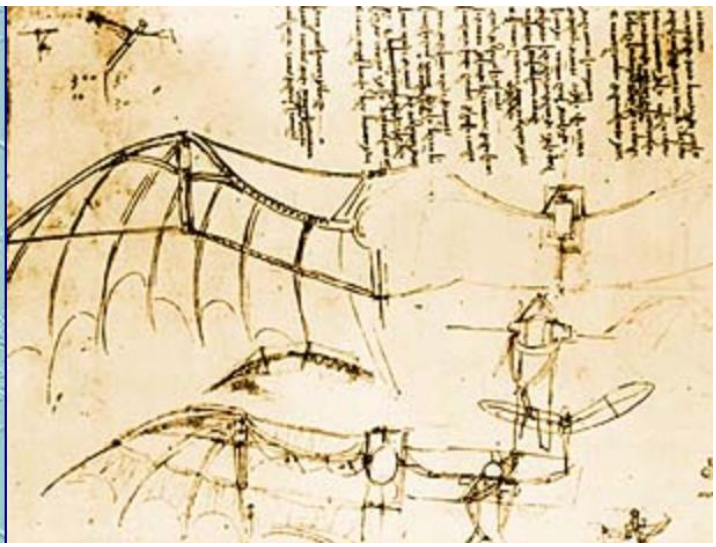
Resource 1

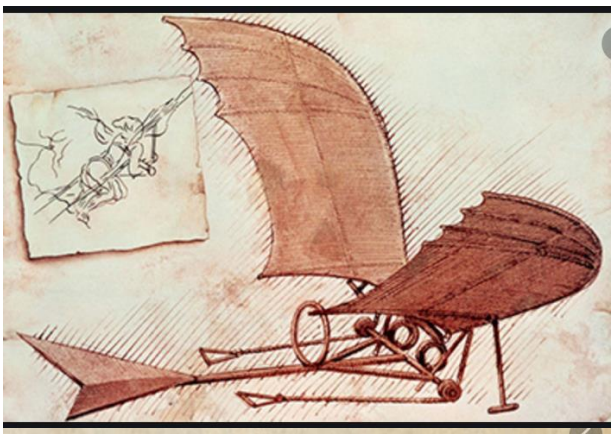
Session 4 resource 2

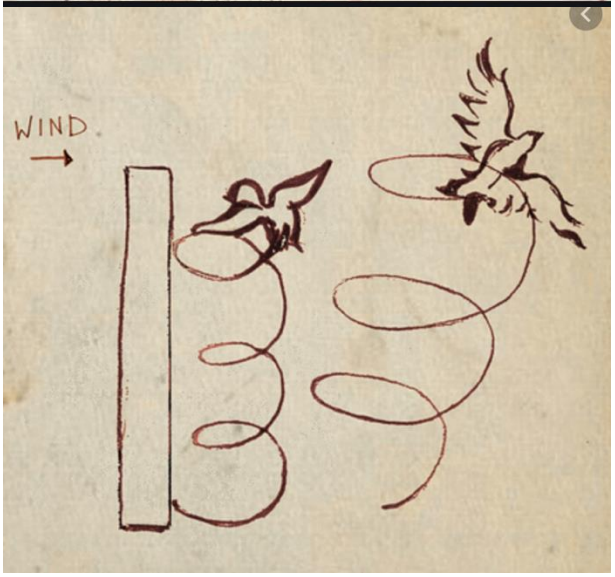
Leonardo da Vinci 1452- 1519





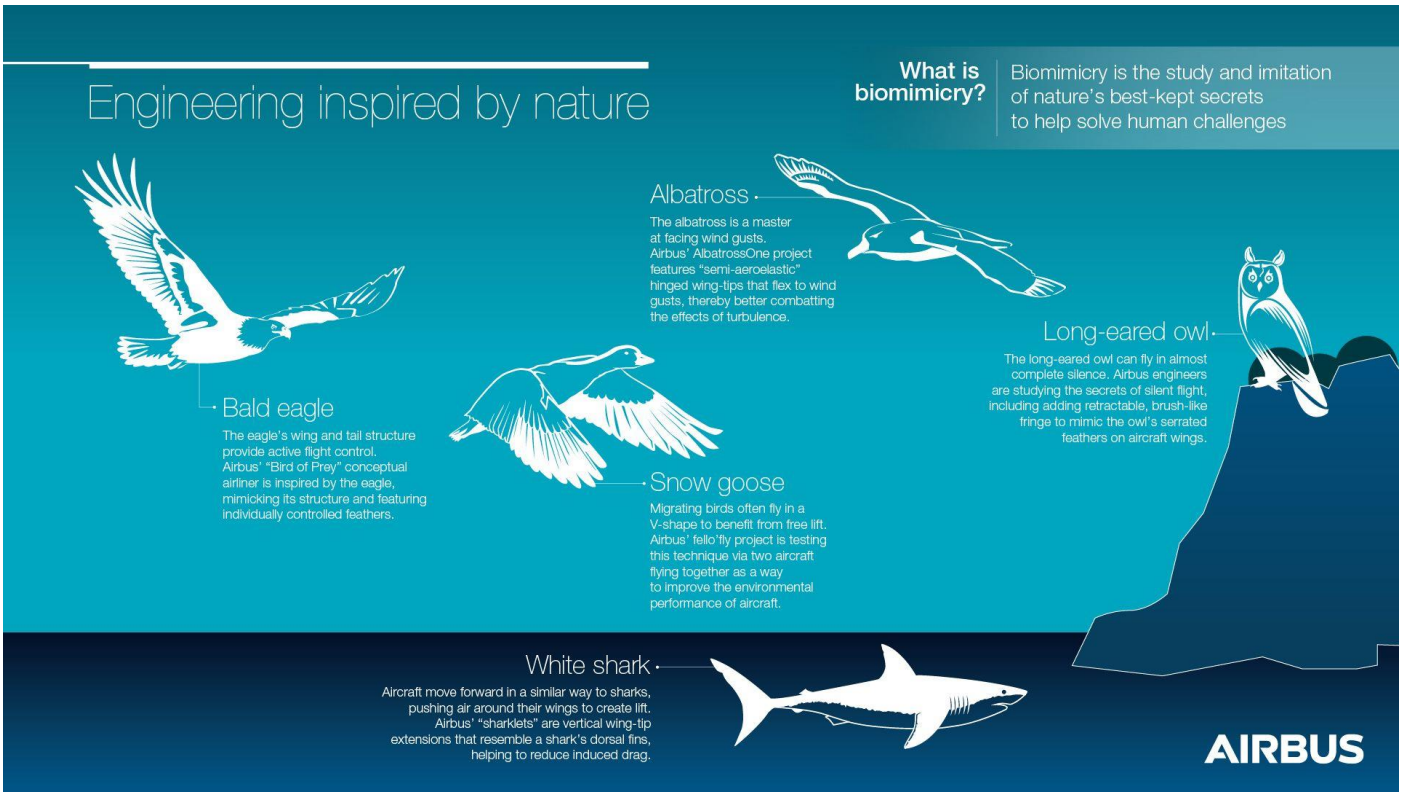






Session 4

Resource 3



Resource 4

How can owls fly silently?

BY SARAH WINKLER

Owls' Feathers and Wing Structure

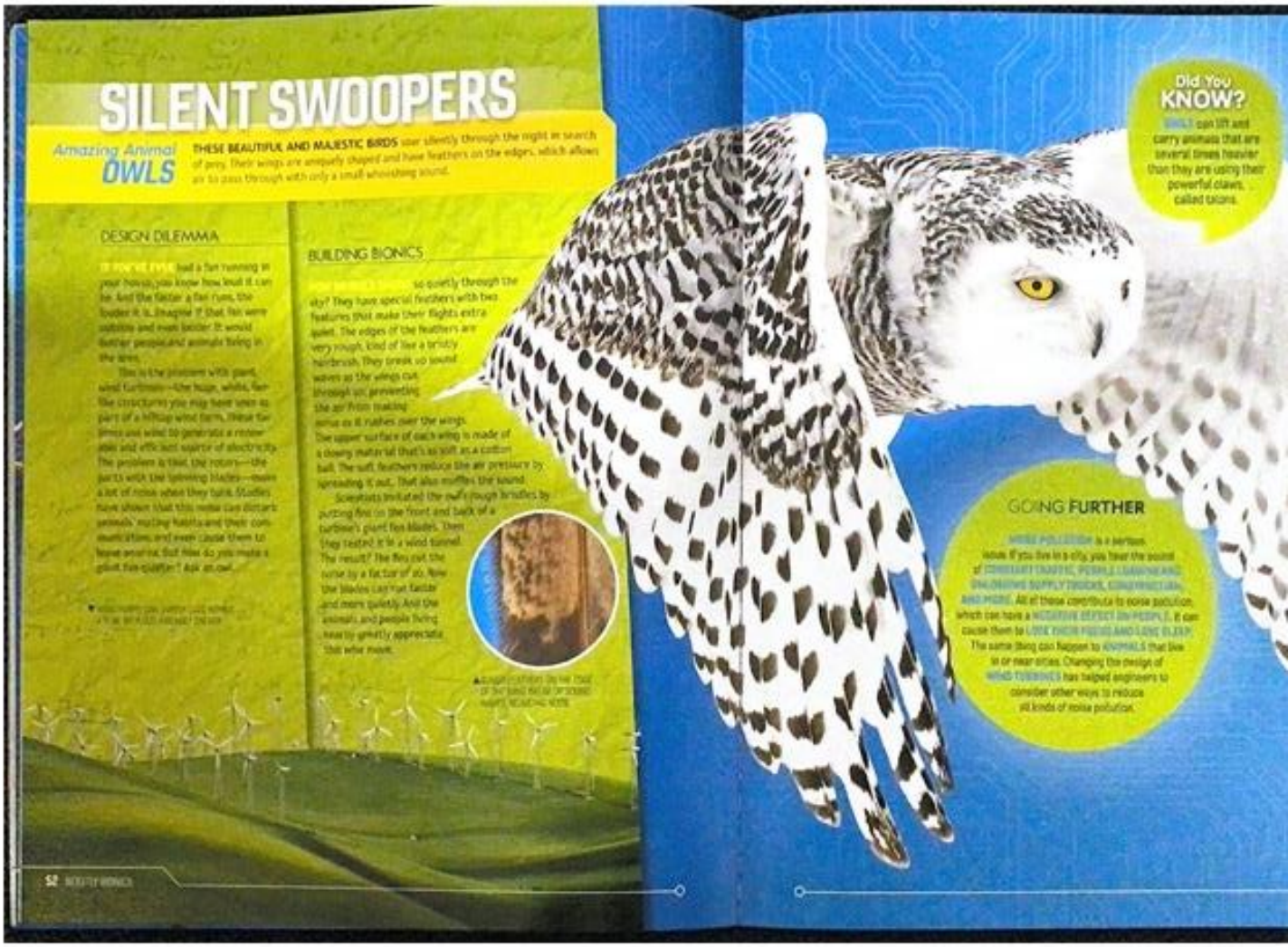
« PREV NEXT »

HOWSTUFFWORKS

While it adds to the owl's mystique, silent flight serves a very practical purpose. It helps this nocturnal creature sneak up on its prey. But how do owls fly silently in the first place?

The design of owls' wings allows them to fly in almost absolute silence. Different parts of their wings and the characteristics of their feathers contribute to their silent flight. Owls have broad wings with large surface areas that help them to float through the air without flapping too much. Less flapping makes less noise.

Session 4 Resource 5



SILENT SWOOPERS

Amazing Animal **OWLS**

THESE BEAUTIFUL AND MAJESTIC BIRDS soar silently through the night in search of prey. Their wings are uniquely shaped and have feathers on the edges, which allows air to pass through with only a small whooshing sound.

DESIGN DILEMMA

IF YOU'VE EVER had a fan running in your house, you know how loud it can be. And the faster a fan runs, the louder it is. Imagine if that fan were outdoors and even bigger. It would bother people and animals living in the area.

This is the problem with giant, wind turbines—the huge, white, fan-like structures you may have seen as part of a hilltop wind farm. These fan blades use wind to generate a renewable and efficient source of electricity. The problem is that the rotors—the parts with the spinning blades—make a lot of noise when they turn. Studies have shown that this noise can disturb animals' nesting habits and their communications, and even cause them to leave an area. But how do you make a giant fan quieter? Ask an owl.

BUILDING BIONICS

[illegible] so quietly through the sky? They have special feathers with two features that make their flights extra quiet. The edges of the feathers are very rough, kind of like a bristly hairbrush. They break up sound waves as the wings cut through air, preventing the air from making noise as it rushes over the wings. The upper surface of each wing is made of a downy material that's as soft as a cotton ball. The soft feathers reduce the air pressure by spreading it out. That also muffles the sound.

Scientists imitated the owl's rough bristles by putting flexible combs on the front and back of a turbine's giant fan blades. Then they tested it in a wind tunnel. The result? The fan cut the noise by a factor of 10. Now the blades can spin faster and more quietly. And the animals and people living near by greatly appreciate that what move.

▲ [illegible]

Did You KNOW?

OWLS can lift and carry animals that are several times heavier than they are using their powerful claws, called talons.

GOING FURTHER

NOISE POLLUTION is a serious issue. If you live in a city, you hear the sound of CONSTANT TRAFFIC, PEOPLE TALKING AND SHOUTING, DELIVERY TRUCKS, CONSTRUCTION, AND MORE. All of these contribute to noise pollution, which can have a NEGATIVE EFFECT ON PEOPLE. It can cause them to LOSE THEIR FOCUS AND LOSE SLEEP. The same thing can happen to ANIMALS that live in or near cities. Changing the design of WIND TURBINES has helped engineers to consider other ways to reduce all kinds of noise pollution.

Falcon's Flight

Nature inspired future aircraft technologies.

BAE Systems and City, University of London are using research on falcons' flight to consider new technologies for aircraft.

Peregrine Falcon Facts

- The peregrine falcon is the fastest bird in the sky. When diving for prey, the bird can fly at speeds over 200mph
- The fastest speed in a dive of a falcon recorded was 242mph in 2005
- The falcon's wingspan is 74 to 120 cm
- The falcon can withstand diving at high speeds due to its one-way breathing system.

Sensory Feathers:

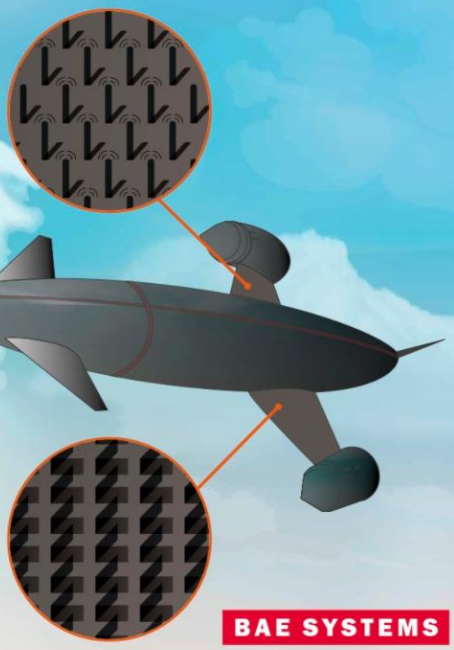
In Nature: A peregrine falcon's feathers alert the bird that it has lost airflow and is in danger of stalling.

On Aircraft: Directly 3D printing polymer hair filaments onto the wing of an aircraft could give the plane real-time data on its aerodynamics, allowing it to take early evasive action if needed. More densely packed filaments could also help reduce the aerodynamic drag on wings as this is what slows aircraft in flight.

Safe Swoop:

In Nature: When a peregrine falcon swoops to catch prey, its feathers bristle upwards to help it stay airborne.

On Aircraft: Hinged flaps on an aircraft's wing could allow the wing to manoeuvre quickly and land at lower speeds more safely, allowing for more compact design or it to carry more fuel.

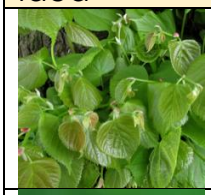
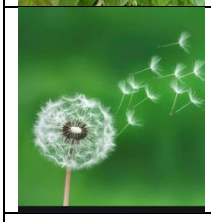


BAE SYSTEMS

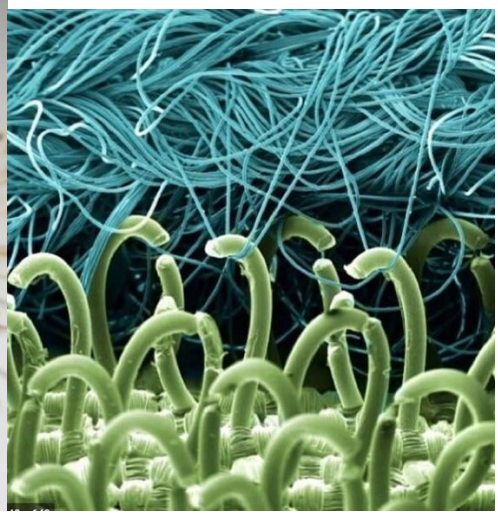
INSPIRED WORK

Session 5

Exploring ideas

Idea		Produces	Could be useful in…
	*Leaves* *Bark of trees*	*Sap – a sticky liquid*	*Medicines* *making glue*
	*Dandelion seeds*	*Light seeds that fly well*	*Transport design, carrying weights*

Session 6
Velcro vs Slug Slime



Session 6
Resource 2 Slug Slime

SLUG SURGICAL GLUE

Amazing Animal SLUG

THIS SLOW-MOVING CREEPY CRAWLER leaves a trail of slime (actually, mucus!) wherever it goes. When startled or threatened, the slug attaches itself to an object and is extremely tough to remove.

DESIGN DILEMMA

FINDING A WAY TO HEAL WOUNDS is a huge problem in medicine. It's even more difficult to do inside the body—like after surgery—than on the skin. The human body is a moist place. You can't just put a bandage on the wound. In a wet environment, it would come off. Plus, how would the bandage be removed? It would have to be able to dissolve on its own so that another surgery isn't needed to remove it.

Now, think of a tough place to fix inside the body—the human heart. The heart beats continuously, which means the heart muscle expands and contracts nonstop. Closing a wound on a beating heart is not easy. Any type of cut you make into the heart must be closed with stitches, which don't expand and contract as the heart beats. Stitches sometimes don't hold well and can interfere with the heart's movement. Doctors have been searching for years for something to help. Believe it or not, slug slime may be the answer.

Did You KNOW?

SLUGS are basically snails without a shell. They have green blood (called hemocyanin) and spend most of their lives underground.

BUILDING BIONICS

A SLUG MOVES BY SECRETING SLIME FROM ITS FOOT. (A slug has one foot, and it looks nothing like a human's.) The thick goo oozes out and allows the slug to glide across surfaces. Without it, the slug couldn't move. The slime is made of tiny crystals called "liquid crystals" because they are between a liquid and a solid. The crystals help slugs stick to objects if they want to crawl up or down. When a slug feels threatened, it secretes an extrastrong type of slime that allows the slug to stick to any surface. This comes in handy if a bird spots it and swoops in for a snack. The bird can try to pluck the slug off its perch, but the bird can't grab it and pull it away. The slug survives another day.

Scientists began studying slug slime for its special gripping abilities. They then discovered something even more interesting. Not only does the slime grip tightly, it's also flexible—another very useful quality! Scientists got to work creating an adhesive, tape-like substance based on the makeup of slug slime. They used a lot of water, which is a component of slug slime, and a mucus-like substance produced by algae whose properties are similar to slug slime. When the scientists put these materials together, they had made a bandage that was flexible and strong enough to stick to a pig's beating heart!

The bandage is still being tested, but it could possibly be used to help patients heal more quickly after open-heart surgery. Although it may seem like a strange idea, open-heart surgery patients may one day owe their lives to a tiny slimy slug.

▶ SURGICAL ADHESIVE INSPIRED BY SLUG SLIME (IN BLUE) HOLDS WOUNDS TOGETHER AND HELPS THEM HEAL.

Session 7 and 8

▶ONE CREATURE, **MANY CREATIONS**

GECKOS STICK ANYWHERE

GECKOS ARE PRETTY INTERESTING CREATURES. They are lizards that vary greatly in size. Some are a little over a half inch (1.3 cm) long. Others can grow to be more than a foot (30.5 cm) in length. Regardless of their size, all geckos have an awesome ability to stick to practically anything. Although it might seem that geckos have glue on their toes, they actually don't. They do have millions of tiny, nano-size hairs. To give you an idea of how tiny that is, a single strand of human hair is between 60,000 and 100,000 nanometers!

These microscopic hairs grip objects extremely well. About the only surface that a gecko cannot stick to is Teflon because it's too slick. The only way for a gecko to stick to a Teflon pan, such as a cookie sheet, would be to get it wet. The water on the pan provides the tiny bit of friction needed to allow a gecko's feet to stick. With its amazing "stick-to-it-tiveness," the gecko is likely to inspire many biomimetic creations.

GECKO ADHESIVES

The **GECKO'S STICKY FEET** are inspiring new bandages for humans. These **SUPER-GRIPPY BANDAGES** can be used on both the **INSIDE AND OUTSIDE OF THE BODY.** They stick to wet and dry surfaces and even **FLEX AND BEND WITH YOU.** The bandages are coated with a **SPECIAL TYPE OF GLUE** that contains **THOUSANDS OF MICROSCOPIC GRIPPERS** that stick to the skin. They can also be coated with a substance that will **DELIVER MEDICINES** to the wound.

UP THE WALL

Wish you could **SCALE BUILDINGS LIKE SPIDER-MAN?** Maybe you can. Scientists are working on making **WALL-CLIMBING PADS** that **ATTACH TO YOUR HANDS AND FEET.** They are designed with **NANO-SIZE FIBERS** and work like the **HAIRS ON A GECKO'S FEET.** The pads attach and pull off the wall easily to allow a climber to keep going using **LESS ENERGY.** It would be great fun to **CLIMB UP TO YOUR CEILING** and **SURVEY THE WORLD** from there, wouldn't it?

STICKY SPACE TRAVEL

NASA has sent **GECKO GRIPPERS,** small flat objects with the gecko-like **ADHESIVE** attached, to the **INTERNATIONAL SPACE STATION** to see if they can hold things in **MICROGRAVITY**—meaning environments with **LITTLE GRAVITY.** If the adhesive works, astronauts would hope to use the grippers to **ATTACH SENSORS** to satellites both inside the station and outside in **SPACE.**

▲ STICKY PADS ON THE GECKO'S FEET ALLOW IT TO STICK ANYWHERE.

Session 8 Geckos

How do geckos stick to walls?

Our toe pads!

Though the hairs are tiny and the forces are weak, the millions of hairs working together allow these critters to crawl up and around!

Geckos have toe-pads consisting of thin-hairs called setae. These setae, which are little bristles on organisms' bodies, can serve a wide range of purposes from being sensory organs for spiders to helping adhesion for geckos. The setae on the feet of these creatures are made of keratin, a structural protein, and end in smaller structures—spatulae.

So why can't we all be Spider-Man?

Because of mass and surface area proportions! The more someone weighs, the more surface area of spatulae they need to allow them to "stick" onto surfaces. Geckos are small so only 2–4% of their surface area, their feet and hands, need to be padded. For humans, the number is around 40%, which would force us to have disproportionately large hands and feet, throwing our balance off.

Session 9

What is the impact of biomimicry?

Possible Presentation Questions:

- How can shark skin help create swimwear to help athletes?
- How can butterflies help with solar power?
- How can leaves show us how to make waterproof materials?
- How did geckos and burrs help astronauts?
- How can ants/termites teach us how to design better buildings?
- How can elephant trunks teach us about lifting heavy objects?
- What can bees/ants teach us about teamwork and organisation?
- How can deer antlers teach us about the strength of materials?
- **OR choose your own question to present on.**
- **If you want to find other examples you could look here.**

Session 10

Name	Questions	Skill or design feature	How might it help?
 Earthworm	How can such a soft bodied animal push through heavy soil?	Strength Flexibility	Farming Building
Tree 	How can roots must be to hold such a heavy structure steady? What transport of water to get water from roots to leaves? (bottom to top – moving vertically)	Trees balance and are very strong structures Water moves from low to high	Buildings foundations
Ant	How can it carry an object so much bigger than itself?	Strength Communicating with other ants and teamwork	

Session 12