Biomimicry in Engineering

Student Worksheet:
What is Biomimicry?

People have always been inspired by nature -- and engineers are no exception! Throughout history, structures, systems, and materials developed by engineers have had roots in natural structures, systems, and materials. For example, the echolocation used by bats in the dark have helped lead to improvements in cane technology for blind people. Others have looked to the methods beetles use to draw water from fog, or how the structure of a lotus leaf can help keep moisture away from the surface -- this has led to changing the surface of fabrics at the nanoscale so they too repel water. And, gecko tape mimics the feed of a gecko lizard by including nanoscopic hairs. Other engineers have looked to the way tower building termites have structures designed to maintain a constant temperature in climates with wide temperature swings. The Eastgate building in Harare, Zimbabwe has passive, self-cooling systems modeled on termite mounds. The building, a mixture of offices, shops and car parking, uses an average of 90 per cent less energy than a comparable structure saving more than $3.5 million since opening in the 1990s.

How butterflies' wings could cut bank fraud

University of Cambridge scientists and engineers recently discovered a way of mimicking the stunningly bright and beautiful colours found on the wings of tropical butterflies. The findings could have important applications in the security printing industry, helping to make bank notes and credit cards harder to forge. Mimicking nature's most colourful, eye-catching surfaces has proved elusive. This is partly because rather than relying on pigments, these colours are produced by light bouncing off microscopic structures on the insects' wings. Mathias Kolle, working with Professor Ullrich Steiner and Professor Jeremy Baumberg of the University of Cambridge, studied the Indonesian Peacock or Swallowtail butterfly (Papilio blumei) (Image at right is courtesy: University of Cambridge), whose wing scales are composed of intricate, microscopic structures that resemble the inside of an egg carton. Because of their shape and the fact that they are made up of alternate layers of cuticle and air, these structures produce intense colours. Using a combination of nanofabrication procedures - including self-assembly and atomic layer deposition - Kolle and his colleagues made structurally identical copies of the butterfly scales, and these copies produced the same vivid colours as the butterflies' wings. As well as helping scientists gain a deeper understanding of the physics behind these butterflies' colours, being able to mimic them has promising applications in security printing.

China Winter Olympics

The National Aquatic Center in Beijing, China structure stands on enormous twisted beams around the exterior similar to a nest. The designing team studied some countless natural nests for understanding the weaving pattern of the threads. Some hundreds of models were created for the design.

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Student Worksheet:

Engineering Teamwork and Planning
You are part of a team of engineers given the challenge of developing a system or building that would be based on the moon that is based on a product or system found in nature. You'll research ideas online, then work as a team to develop a drawn diagram. You'll also consider patenting your idea, and present your designs to your class.

Research Phase
Read the materials provided to you by your teacher. If you have access to the internet, also visit Asknature.org, and take some time to explore the various challenges and solutions nature has to offer. For example, you might search for "store oxygen" or "termites" or anything related to what you are considering working on. Gain ideas by seeing what others are working on.

Planning and Design Phase

Leonardo da Vinci both studied how birds fly and also drew intricate illustrations of his designs in preparation for construction. In the same way, George de Mestral, a Swiss engineer hiking in the Alps found that many burs from a burdock tree were sticking to his clothing….he later invented what is now known as Velcro. But he also had to draw his ideas in order to gain a patent for his invention. You can see one page of his patent to the right. Mechanizing the process of weaving the hooks took eight years, and it took another year to create the loom that trimmed the loops after weaving them. It took him about a decade to create a mechanized process that worked. He submitted his idea for patent in Switzerland in 1951 and the patent was granted in 1955.

Now it is your turn! On a separate piece of paper draw a detailed diagram showing several views of your system, similar to what might be required for a patent. Present this plan to your class. Be sure to list the materials you might need and include a paragraph or more describing how your invention works and how it relates to nature….what makes it an example of Biomimicry?

Presentation Phase
Present your ideas, drawings, and connection to Biomimicry to the class, the complete the reflection sheet.

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Student Worksheet:

Reflection
Complete the reflection questions below:

1. What was the most interesting proposed used of biomimicry that was developed in your class presentations? Why?

2. Do you think that your design is patentable? Is it unique enough to be approved?

3. Do you think your product, building, or system would work if manufactured?

4. Do you think that you could raise funds to pay for manufacturing? How would you go about raising funds?

5. Do you think that many engineers explore solutions from nature into their inventions?

6. Did you think that working as a team made this project easier or harder? Why?