

Engineering Education for the Next Generation

A Nature-Inspired Approach

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To teachers and children everywhere, and the human-built world your admiration of Nature will foster.

Introduction

How to Make Surfers Invisible

To be blunt, sharks sometimes eat surfers. It's considered an accident, which is sort of reassuring I guess, but sharks sometimes mistake the dark outline of surfboards for seals, a favorite snack, floating on the surface of the water.

Let's call that a "problem."

Some creatures in the ocean have a remarkable ability: they can generate light, which they direct below them. This ability to glow has the effect of blending the body in with the sky above. A form of camouflage, this neat trick obscures one's silhouette and makes it harder for predators lurking below to see you. Firefly squid (*Watasenia scintillans*) can do this, as well as Hawaiian bobtail squid (*Euprymna scolopes*). There are octopuses that do it, and fish, even crustaceans. There's also a shark that does it to sneak up on prey, the velvet belly lanternshark (a great name for an animal... though who was feeling this shark's belly?) as can the unnervingly-termed "cookiecutter shark" (*Isistius brasiliensis*).

Biologists call this ability to match the sky using light *counterillumination*—it sounds like a feature in your kitchen, but it can be a big help to ocean creatures: researchers found that midshipman fish using counterillumination are preyed upon half as much as midshipman fish who don't. Organisms with this ability not only can match the light intensity of the sky above but also can match the color wavelength of the water around them. Creatures achieve this astonishing feat through various means: some produce light themselves, like marine versions of fireflies; others maintain partnerships with bioluminescent bacteria that reside inside them (and presumably share the same motivation to get the camouflaging just right).

Let's call counterillumination one of Nature's many wonderful talents.

Now, what if I asked you to stop reading for a moment and think of a novel idea from Nature for how we might address the problem of surfers on surfboards getting attacked by sharks from below? . . .

What likely just happened in your mind is the subject of this book. Making a counterilluminating surfboard is terrific idea and an example of Nature-inspired engineering. It's also known as biologically inspired innovation, biomimicry, or biomimetics, and it's a fascinating and hopeful approach that professional engineers, designers, and architects today increasingly use to imagine and innovate for a better world. Nature-inspired engineering includes inventing shoes that grow along with the children that wear them, designing roads that fix their own potholes, unleashing the body's immune system to take out tumors, and addressing the sweeping perils of climate change (e.g., by learning how human lungs remove CO² from our bodies). The basic idea is how Nature, with its seeds journeying on the wind, singing whales, carnivorous plants, and flying snakes—what poet William Blake called "imagination itself"—

can spur our own creative species to invent technological breakthroughs to address the many challenges facing humankind, and to pursue untapped opportunities that abound in plain sight to make our lives better. This book is about teaching engineering and innovation to young people using this captivating and promising approach.

If you are an educator looking for ways to engage your students in STEM/STEAM (science, technology, engineering, art, and math), prepare students for college and career, or reconnect kids with Nature through education, this book was written for you.