BIOMIMICRY: LEARNING FROM NATURE

15-20 min introductory slideshow | Presenter Notes

Lets begin with a simple question: **What is nature?**

Most of the time, people use the word "nature" mainly to refer to things that are not human.

We talk of …enjoying nature…using natural materials…visiting nature reserves…studying natural history…and so forth.

In this way we cast ourselves and the things we make in a category apart from nature -- much the way this subdivision draws a sharp boundary between itself and the remaining forest around it: People over here… nature over there.

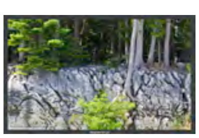
But no matter how much we separate ourselves in habit or in language, we must acknowledge that <u>we are part of nature</u>. We are animals, too, and we have many of the same needs as other creatures on this planet.

Take for instance these corals.
The beautiful structures you see here are built by tiny coral polyps, living together inside a calcium-carbonate exoskeleton that they have grown for themselves.

With a little bit of imagination, it's not hard to see how what the corals do relates to our own need to find reliable shelter. Like corals, we build our own type of "exoskeleton".

So, the difference between people and the rest of nature is not really <u>what</u> we're trying to achieve, but <u>how</u> we do it.

Most of these skyscrapers are made from concrete, a mixture of gravel and cement.



Cement comes mainly from limestone, a sedimentary rock formed from ancient sea beds and rich in <u>calcium carbonate.</u>

To create cement we find limestone deposits in the earth's crust and remove them with heavy equipment and explosives. Over 39 billion tons are mined each year.

Then we cook the limestone at extremely high temperatures order to make the calcium carbonate reactive with water. 6% of humanity's annual greenhouse gas emissions can be attributed to this process.

The cement must then be packaged and shipped to the building site.

Meanwhile corals acquire the same building materials—calcium and carbon-dioxide--from the sea water around them, and assemble those building blocks using a low energy, waste-free process that has lasted for 450 million years.

In fact, the limestone that we mine to make cement is actually formed from the remains of corals and other animals that turn CO_2 into calcium carbonate.

So, one might ask… instead of mining this material, wouldn't it make sense to learn how the coral makes it in the first place, and copy nature's recipe to make more sustainable cement?

Well, *that's* biomimicry.

There is actually a company called Calera that is working on doing exactly that. We'll talk more about them later in this presentation.

The term "biomimicry" comes from the Greek: "bios" = life , and "mimicry" = to copy. It was popularized by Janine Benyus in her 1997 book "Biomimicry: Innovation Inspired by Nature."

In Janine's words, biomimicry is the **"conscious emulation of life's genius."** Her words are carefully chosen.

"**Conscious**" refers to intent. Biomimicry implies active forethought, seeking nature's advice *before* something is designed.

"**Emulation**" does not mean direct copying, but learning from the biological principles -- for example how the coral uses CO_2 as a feedstock, or how the ocean recycles nutrients. It means taking those biological principles and translating them into design principles that we can apply to the challenges humans want to solve.

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"**Life's genius**" is a recognition that we need to quiet our own thinking, forget what we *think* we know, and open our minds so we can learn and mimic nature's lessons.

The basic idea is that, in 3.8 billion years on earth, life has arrived at well-adapted solutions for many of the challenges we face – and they are embodied in the plants, animals and microbes that have stood the test of time, within the constraints of a finite planet.

Compared to the rest of life on earth, **we are a young species.**

In the scale of evolutionary time, we're newcomers, and the industrial revolution is just a blip in the history of life on earth. If we compressed the history of the earth into a calendar year, it would have happened just 2 seconds ago.

Yet in that time we've made an indelible mark on the planet.
And have taken up maladapted strategies we call 'heat, beat, and treat' – that is, using high temperatures, high pressures, and toxic chemical processes to get the results we want.

If we want to stick around for the next 3.8 billion years, we need to ditch the brute force approach and study how nature's well-adapted strategies work and emulate those in our own technologies.

Clearly this is not a brand-new idea. Leonardo Da Vinci was famously inspired by nature and it's a recurring theme among the world's most celebrated inventors. (The Wright brothers, Alexander Graham Bell, and more). And long before them, indigenous cultures around the world revered and learned from nature's ways.

What's new is the development of a more rigorous and interdisciplinary approach to translating nature's design lessons into solutions for humankind.

You can think of biomimicry as **"an emerging discipline of an ancient practice"**

At it's most basic, the practice of biomimicry encompasses three aspects we call the Essential Elements. It is **the combination of these elements that distinguishes biomimicry from other bio-inspired approaches.**

The **ethos** element represents the essence of <u>why</u> we practice biomimicry: to <u>support a sustainable world</u>. Ethos is our respect for, and responsibility to our fellow species and our planet.

The **(re)connect** element reinforces the understanding that, while seemingly "separate," people and nature are actually deeply <u>intertwined</u>. It also represents a practice and <u>commitment to seek out connection</u> with the rest of nature as a source of creativity and wisdom.

And finally… The **emulate** element is perhaps the most familiar.

It is <u>learning from</u> the patterns, strategies, and functions found in nature and <u>applying</u> those lessons to inform human design.

For educators, thinking about the Essential Elements as ***entry points*** into biomimicry can be a **helpful framework for understanding how one might reach different student groups** based on their interests, developmental stages, or discipline.

For example, young children often have an innate affinity for nature and outdoor play that aligns with the ReConnect element and that can be a gateway for introducing other content and ideas.

Other students may be less innately interested in nature, but really interested in mechanisms and how things work – biomimicry can be a way to introduce new material about biology in a way that speaks to how they think and process information.

Scale is another important framework for understanding and sharing biomimicry. When you look across the various biomimicry examples, they generally fall into these three categories: FORMS, PROCESSES, and SYSTEMS.

The ideal biomimetic design would work at all three scales, but those examples are still hard to come by.

Examples Pictured

- FORM: Kingfisher – Shape of beak reduces turbulence when moving between low to high density fluids (air or water); emulated in the Japanese Shinkansen bullet train to reduce noise when train exists tunnels. **http://www.asknature.org/product/6273d963ef015b98f641fc2b67992a5e**
- PROCESS: Blue Mussel – Process of creating non-toxic adhesive that works in dirty wet conditions; emulated in Purebond wood glue. **http://www.asknature.org/product/22aa5601fcdb68b5d2dc9e3d3a22f7f1**
- SYSTEM: Wetland ecosystem – integrated community of organisms removes excess nutrients and particulates from waterways; emulated in a variety of ecological water treatment systems including Eco-Machines. **http://www.asknature.org/product/d0a39e225aea22ee036e9602369c6ee0**

Biomimicry of **form** is emulation of shape. It could be the micro structure of a surface, or a larger physical trait that can be observed with the naked eye. Such as the kingfisher's beak on the previous slide.

In the example here, it is the microstructure of shark skin that is being emulated. Sharks are naturally resistant to bacteria because the texture of their skin inhibits bacterial growth.

Sharklet is a synthetic surface which deters colonization by certain disease-causing microbes by mimicking that texture. Because the artificial surface works without killing microbes, there is no selection for resistance.

Biomimicry of **process** is the emulation of a series of operations that create a material or produce an effect.

Here we return to Calera, which is mimicking the process by which corals use CO_2 as a resource. Calera is developing a process that takes the CO_2 in smoke stack emissions and uses it to create cement – actually sequestering greenhouse gases in the process, instead of creating them.

System level biomimicry involves creating an integrated system that efficiently manages material and/or energy in an ongoing cycle.

Systems, are perhaps the most challenging form of biomimicry to implement.

Some examples include –

- **Eco Machines**, which mimic wetland ecosystems, to treat waste water without chemicals.
- An industrial park in **Kalundborg**, Denmark, which practices **Industrial Symbiosis**. The city's power station and a number of processing companies have partnered to use each other's waste material and by-products as resources.
- And similarly, the **Zero Emissions Research Institute's** (ZERI) systems design for nearly waste free production of coffee and beer, by capitalizing on waste as feedstock for secondary products.

Biomimicry offers educators a new and exciting lens through which to **teach the subjects students need to learn anyway**… like STEM… and to connect those studies with creativity and design.

Biomimicry is also uniquely poised to support 21st century teaching models that aim to prepare students to be creative, collaborative, critical thinkers. Such as…

- Project Based and Experiential Learning
- Interdisciplinary Teamwork
- Next Gen Science Standards –
    - "Crosscutting" concepts dimension
    - Emphasize links between disciplines.

And… Research has demonstrated that nature makes people more creative!

A recent study found that "four days of immersion in nature, and the corresponding disconnection from multi-media and technology, increases performance on a creative problem-solving task by a full 50%." [***Creativity in the Wild: Improving Creative Reasoning through Immersion in Natural Settings,*** by Ruth Ann Atchley, David L. Strayer, and Paul Atchley]

And biomimicry taps into **things students care deeply about**

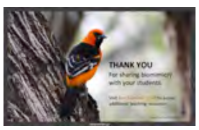
- Sustainability
- Solving real and meaningful problems.
- Contributing to a hopeful future…

But perhaps most of all… **biomimicry introduces a fundamentally different way of seeing the natural world.**

Instead of presenting nature in reductive terms, as a list of facts like these about the ponderosa pine….

… biomimicry speaks to the great possibilities and opportunities when we learn *from* nature.

When a student's eyes are opened to the wonder and abundance of innovation that surrounds us in the natural world, they're given a lesson that lasts a life time, sparks curiosity and will serve to move our species toward a brighter future.



Thank you!

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