

Introduction to Biomimicry

Concepts and Practice

Biomimicry Global Design Challenge Support Webinar
November 3, 2015



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Challenge.Biomimicry.org

WHAT IS BIOMIMICRY?

Definition, examples, difference from other bio-inspired approaches

CORE CONCEPTS

Functions and strategies, Earth's operating system, and nature's unifying patterns

PRACTICE

Introduction to the biomimicry design spiral

BIOMIMICRY:

The practice of adapting nature's best ideas to the invention of healthier, more sustainable technologies for people.



Sustainable innovation inspired by nature.



Marco Carrubba, CC-BY-NC-ND via Flickr



Hans Hillewaert CC-BY-SA via Wikimedia

Trains that move faster and more quietly on less energy



Vic DeLeon CC-BY-NC-ND

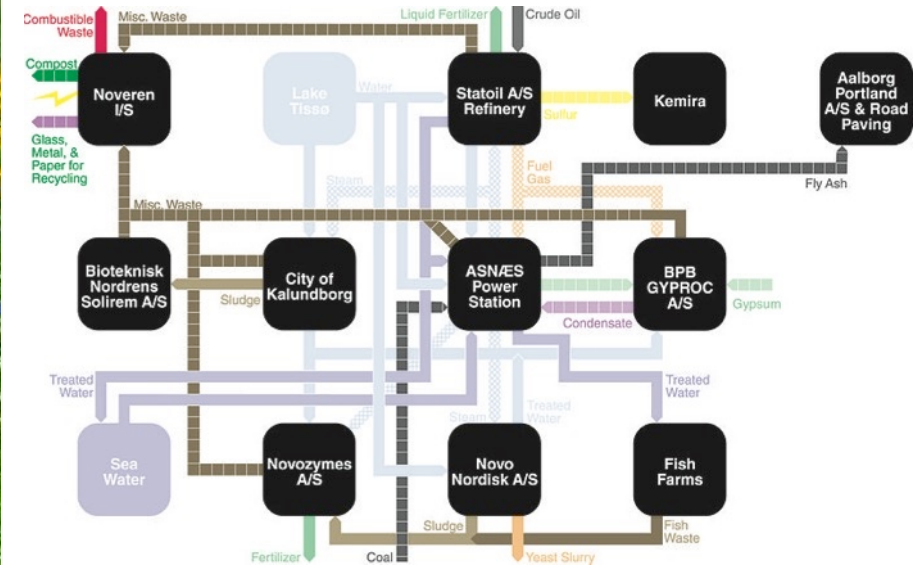
Antimicrobial surfaces that don't breed superbugs



Carbon-negative building materials



Chemical-free, on-site wastewater treatment



CC-BY-SA RosenfeldMedia via Wikimedia

Industry that works like an ecosystem

Biomimicry works in multiple ways.



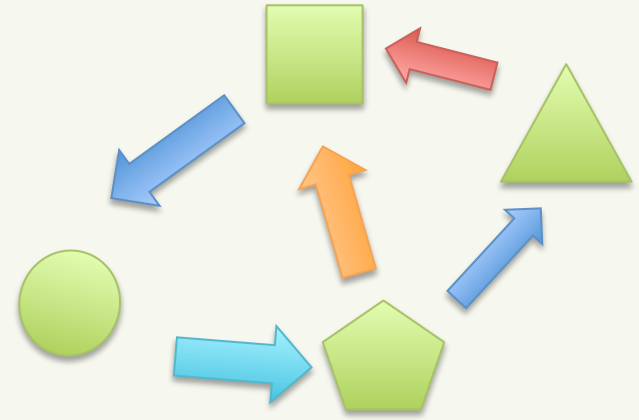
Form

Shape, surface,
texture
(Macro or micro)



Process

operations or behaviors



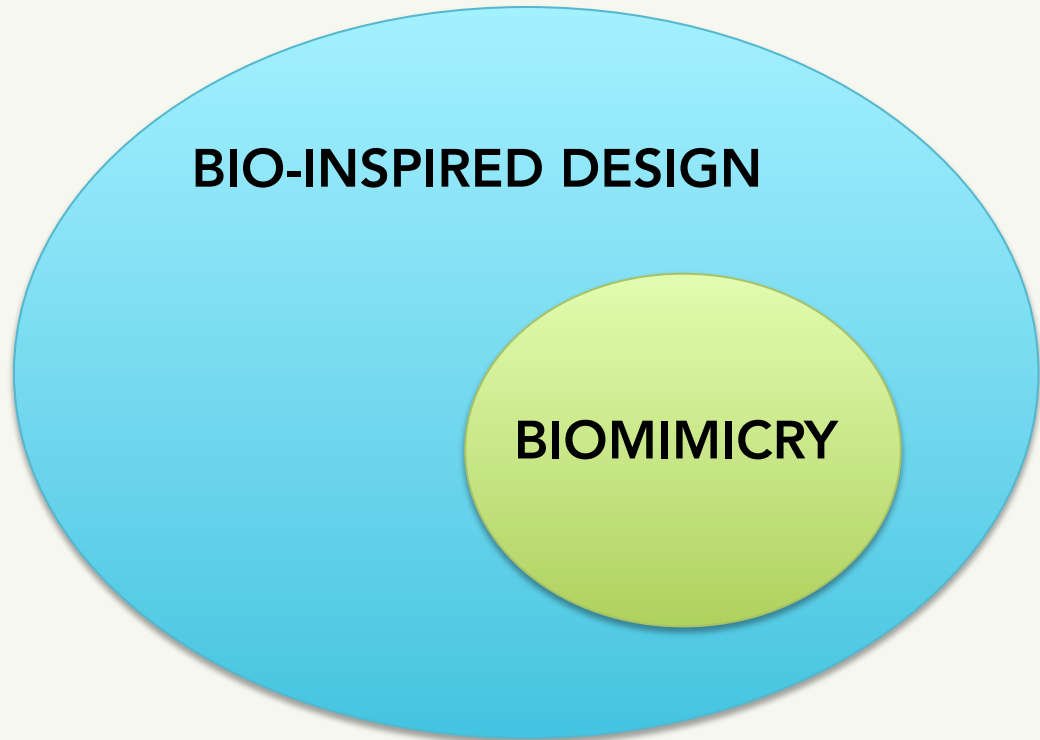
System

many forms and processes
interacting

Biomimicry is one of many “bio” approaches that use nature as a resource for solutions.

Bio-Inspired Design:

Biomimicry
Bio-engineering
Bionics
Biomimetics
Biomorphic design
Biophilia
and so on....



Bio-inspired design is not necessarily biomimicry.



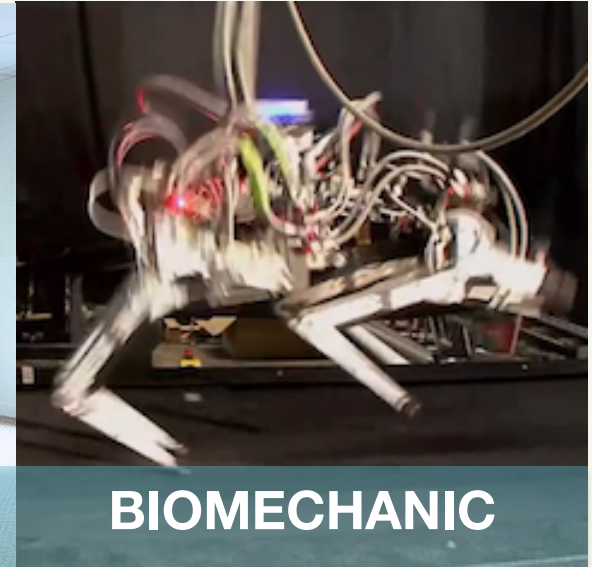
BIOMORPHIC

Saarinen Tulip chair, via Design Within Reach



BIOPHILIC

Green wall, CC-BY-SA Spaceo via Wikimedia



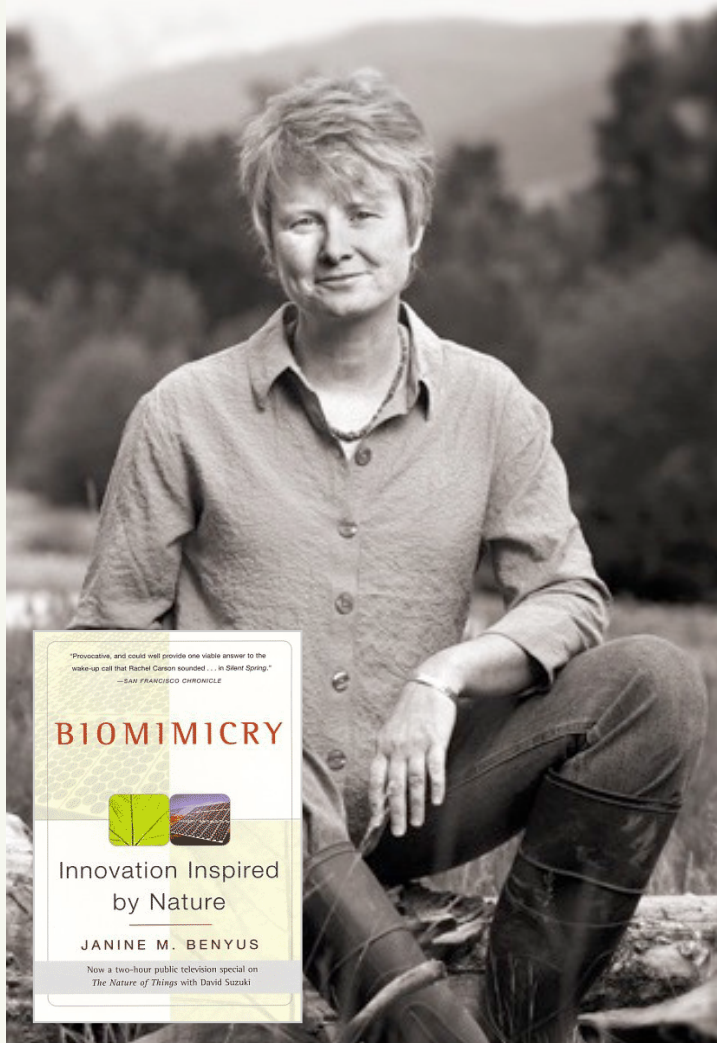
BIOMECHANIC

Cheetah robot, via Boston Dynamics for DARPA



CC-BY-NC Mark S. Elliot via Flickr

How can we “fit in” on Earth as elegantly
as the living systems around us?



“The core idea is that nature, imaginative by necessity, has already solved many of the problems we are grappling with. Animals, plants, and microbes are the consummate engineers. They have found what works, what is appropriate, and most important, what *lasts* here on Earth...

The conscious emulation of life’s genius is a survival strategy for the human race, a path to a sustainable future. **The more our world functions like the natural world, the more likely we are to endure on this home that is ours, but not ours alone.”**

- Janine Benyus

CORE CONCEPTS



Image: NASA, public domain

Earth's planetary context



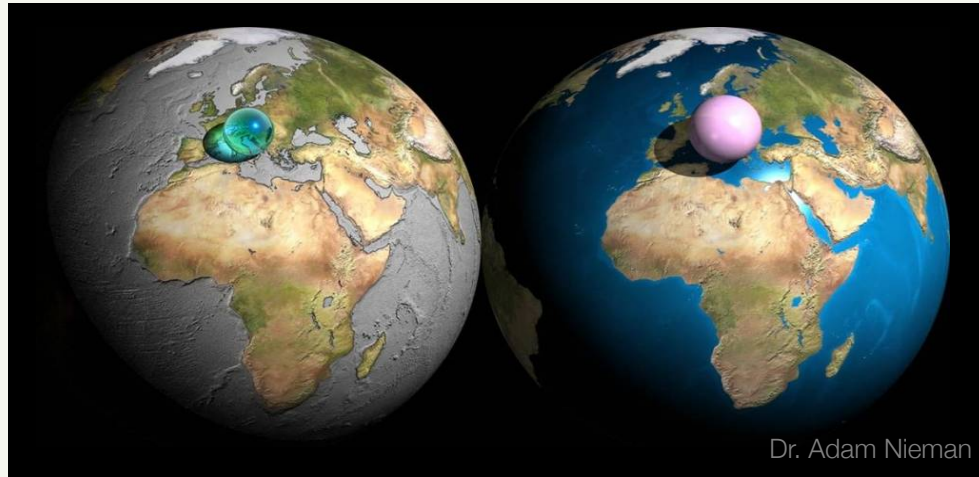
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Cheryl CC-BY



Jalal Hameed Bhatti CC-BY-ND



Dr. Adam Nieman





Nature exhibits overarching patterns

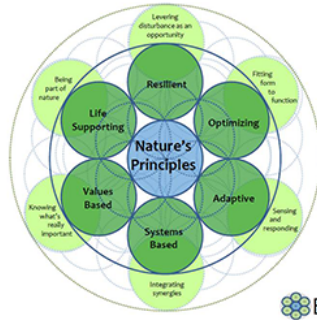
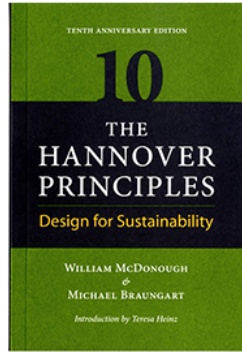
JANINE'S LIST

- Nature runs on sunlight.
- Nature uses only the energy it needs.
- Nature fits form to function.
- Nature recycles everything.
- Nature rewards cooperation.
- Nature banks on diversity.
- Nature demands local expertise.
- Nature curbs excesses from within.
- Nature taps the power of limits.

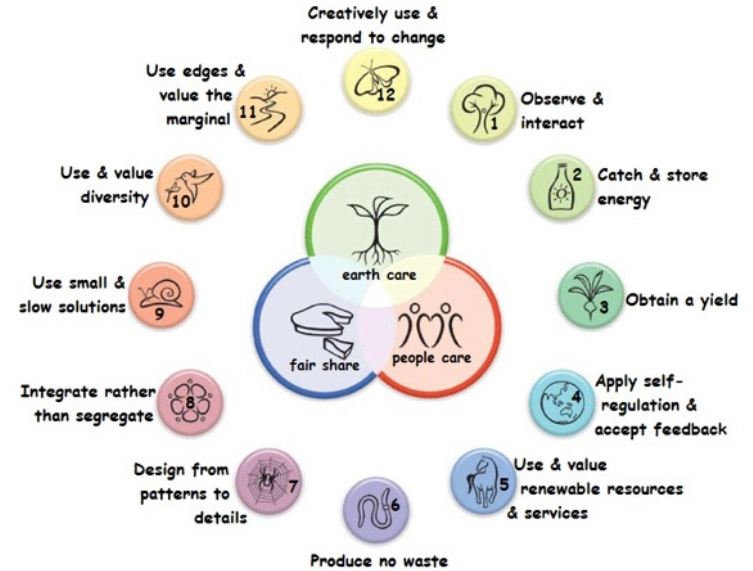
Biomimicry: Innovation Inspired by Nature
(Benyus, 1997, pg 8)



MANY OTHER LISTS



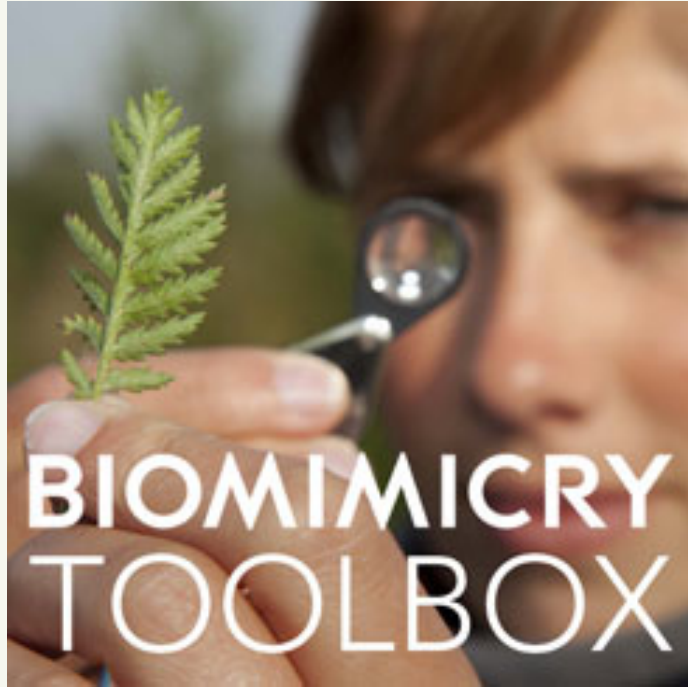
LIFE'S PRINCIPLES
Biomimicry DesignLens



10 of Nature's Unifying Patterns

1. Nature uses only the energy it needs and relies on freely available energy.
2. Nature recycles all materials
3. Nature is resilient to disturbances.
4. Nature optimizes rather than maximizes.
5. Nature rewards cooperation.
6. Nature runs on information.
7. Nature uses chemistry and materials that are safe for living beings.
8. Nature builds using abundant resources, incorporating rare resources only sparingly.
9. Nature is locally attuned and responsive.
10. Nature uses shape to determine functionality.

LEARN MORE



Toolbox.Biomimicry.org

CORE CONCEPTS
> NATURE'S UNIFYING PATTERNS



BIOMIMICRY
GLOBAL DESIGN
CHALLENGE



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Function links biology and design

FUNCTION :

the purpose or outcome of something.

The reason behind particular characteristics,
mechanisms, or processes.



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CC-BY-NC Ethan Staats



Public domain



Photo: edgeplot CC-NC-SA



Photo: Jill Clardy CC-BY-NC-SA via Flickr

Functions:

Capture water

Prevent loss of water

Stay warm

Communicate

Sense the environment

Protect from impact

STRATEGY:

characteristics, mechanisms or processes
that exist to meet a function

EXAMPLE: Spring Peeper



davehuth.com

CC-BY-NC

EXAMPLE: Spring Peeper

Function:

Protect from freezing
(ice crystals)

Strategy:

Produce a glucose (sugar)
solution to reduce formation
of ice crystals.

davehuth.com

CC-BY-NC

EXAMPLE: Platelets



Photo: ZEISS Microscopy CC-BY-NC-ND

EXAMPLE: Platelets

A scanning electron micrograph showing several large, smooth, red blood cells (erythrocytes) and smaller, green, bumpy platelets (thrombocytes). The platelets are shown in various orientations, some appearing to be clumped together. The background is dark, highlighting the cellular structures.

Function:

Prevent loss of a liquid (blood).

Strategy:

Lens-shaped structures that flow into and plug the wound.

Photo: ZEISS Microscopy CC-BY-NC-ND

IMPORTANCE OF FUNCTION

Function (and strategies) are what biology and design have in common.

	FUNCTION	STRATEGY
NATURE	Something an organism or living system must do in order to survive/persist.	Something that meets the functional needs of an organism or living system.
DESIGN	What you want your design to do.	A designed element that meets a function.

Understanding function is key to looking for nature’s models.
Focusing first on function opens up possibilities.

Applying the concepts of function/strategy:

Think about what you want your design to **do**,
not what you want your design to be.

Look for organisms and systems that need to meet
the same functions you want your design to meet.

METHODS OF PRACTICE

Biomimicry Design Spiral

- **Identify** *function*
- **Define** *context*
- **Biologize** *the challenge*
- **Discover** *biological models*
- **Abstract** *strategies*
- **Emulate** *strategies*
- **Evaluate** *fitness*
- **Iterate** *again...*



Biomimicry Design Spiral

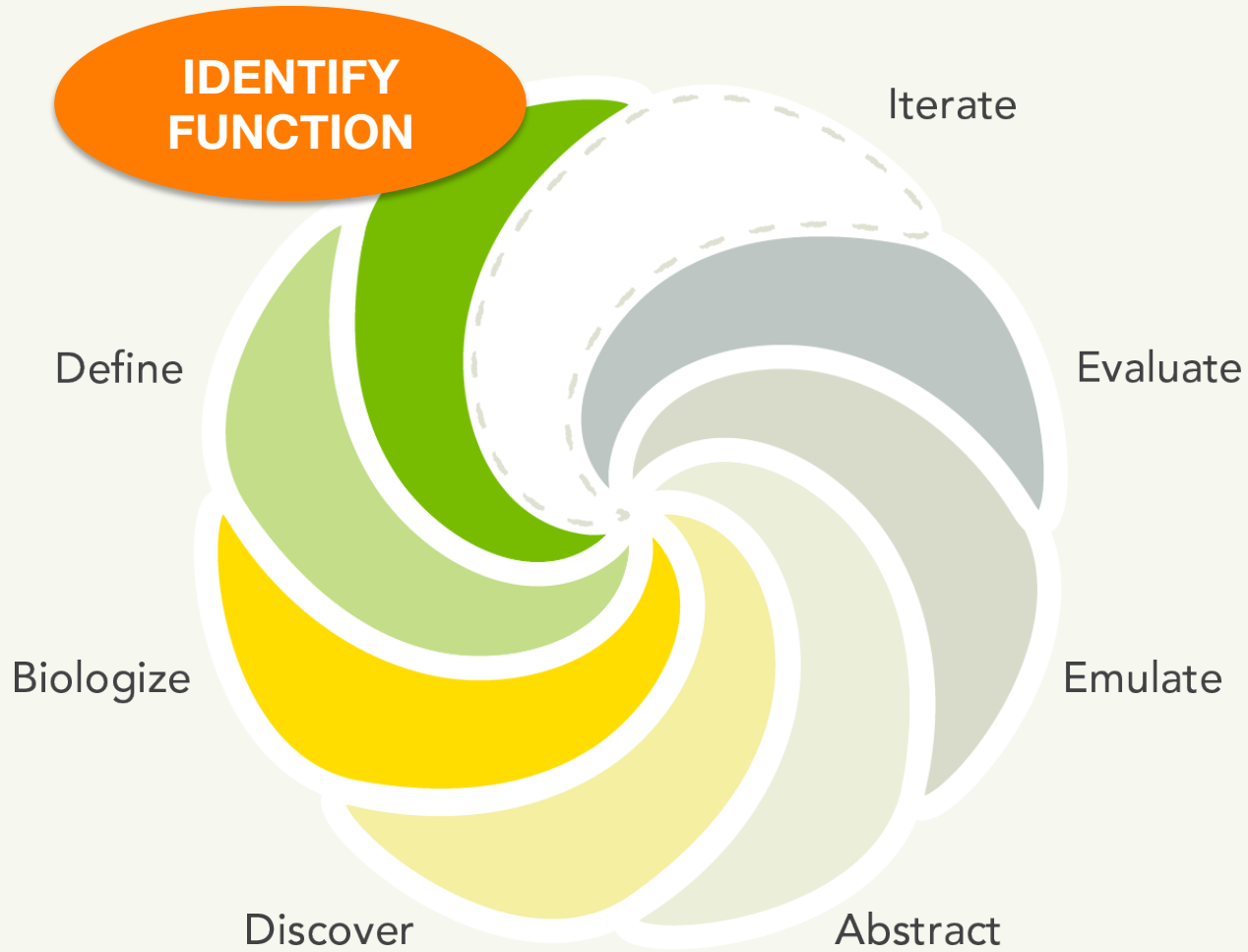
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Biomimicry Design Spiral

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IDENTIFY FUNCTION

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CC-BY-NC "TQT" via Flickr

Keep greens from wilting

manage temperature | provide humidity





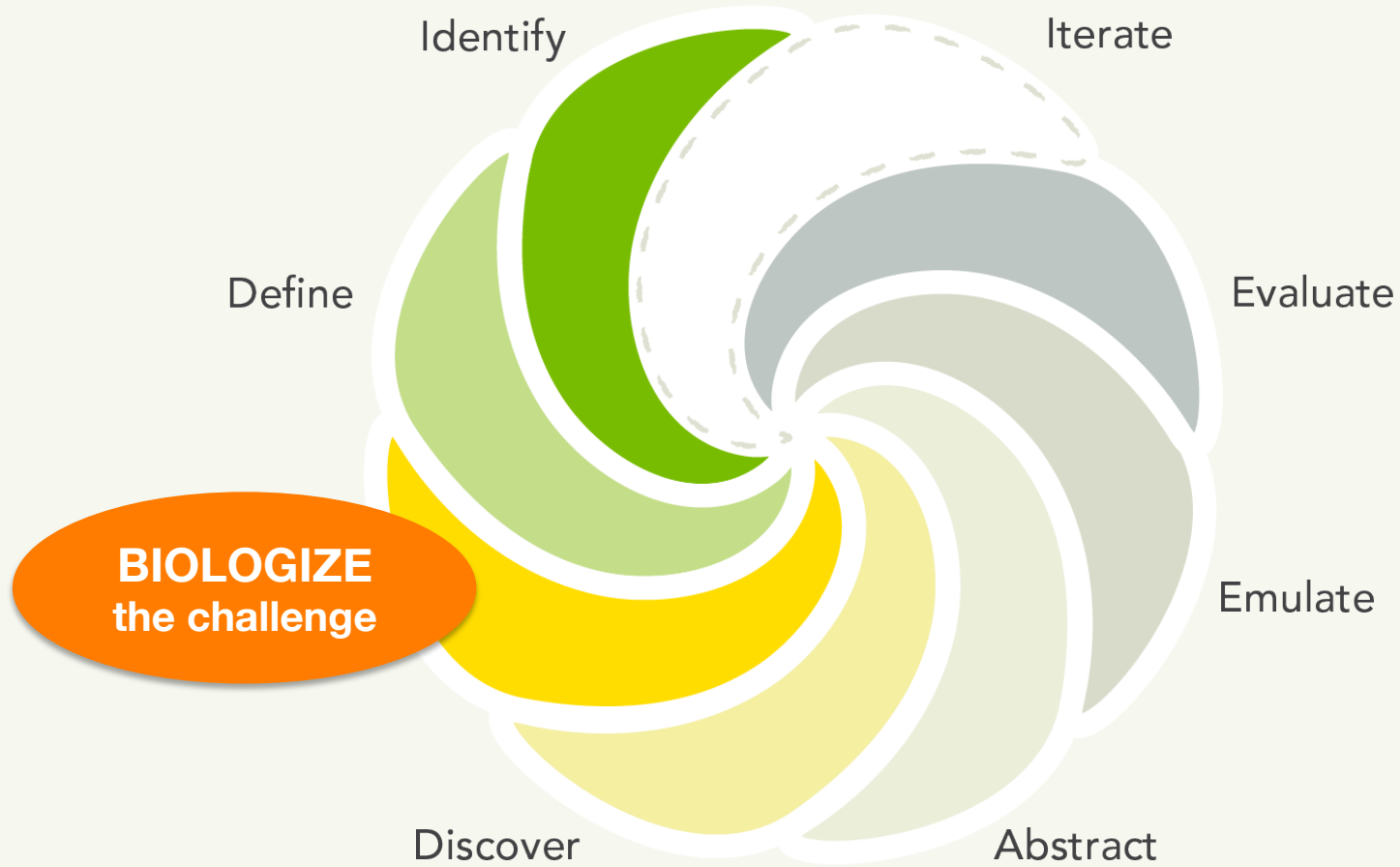
Colorado River aqueduct, ,California (Reuters)



Planetary Context

Together, function and context articulate
the challenge:

*what the design must do; and
under what conditions/constraints*



“Biologize”

*to take a human challenge and rephrase it
so that an answer may be found in biology.*

“How does nature....?”

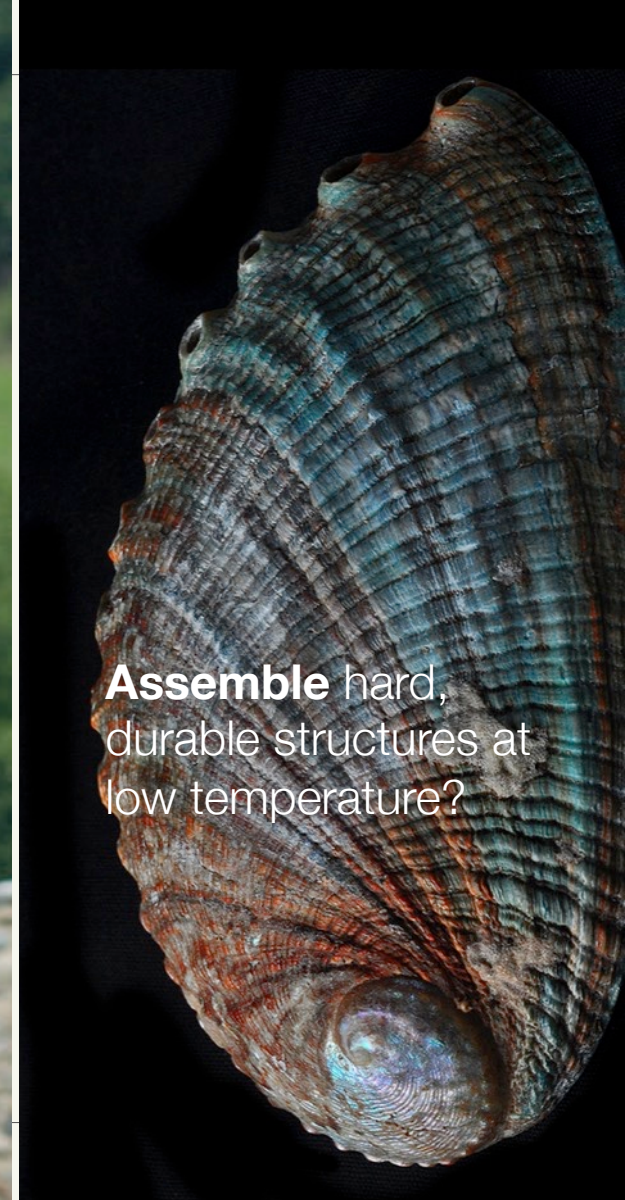


Manage temperature

In cold, wet
environments?



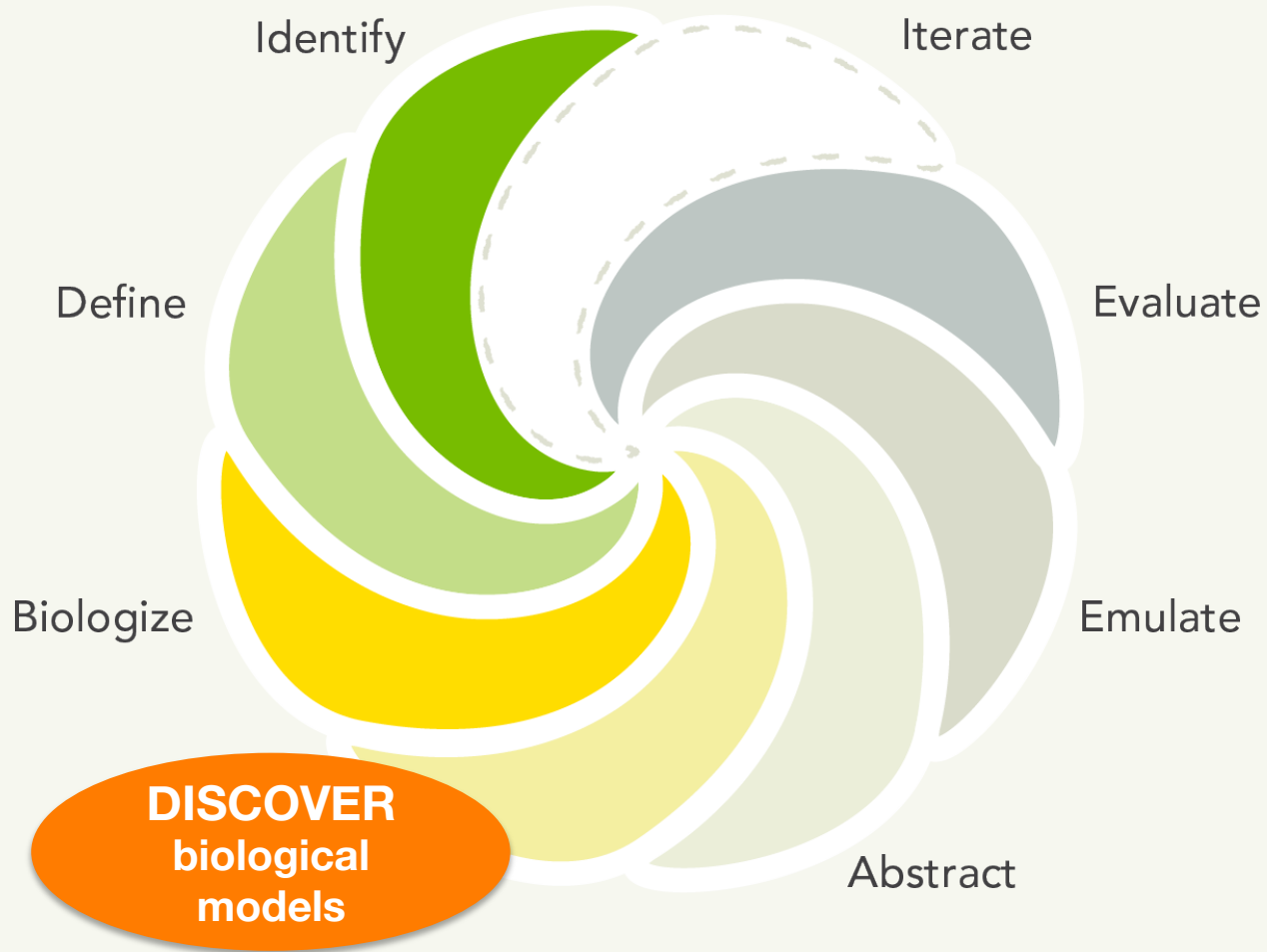
Move silently
through air?



Assemble hard,
durable structures at
low temperature?

Although these first three steps seem simple it's worth spending a lot of time here.

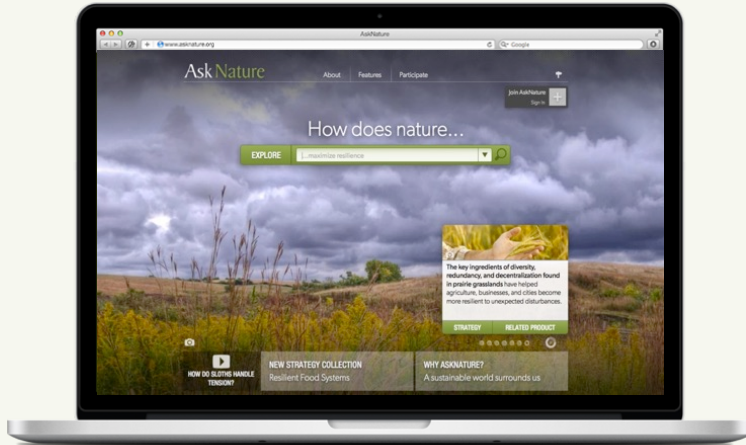




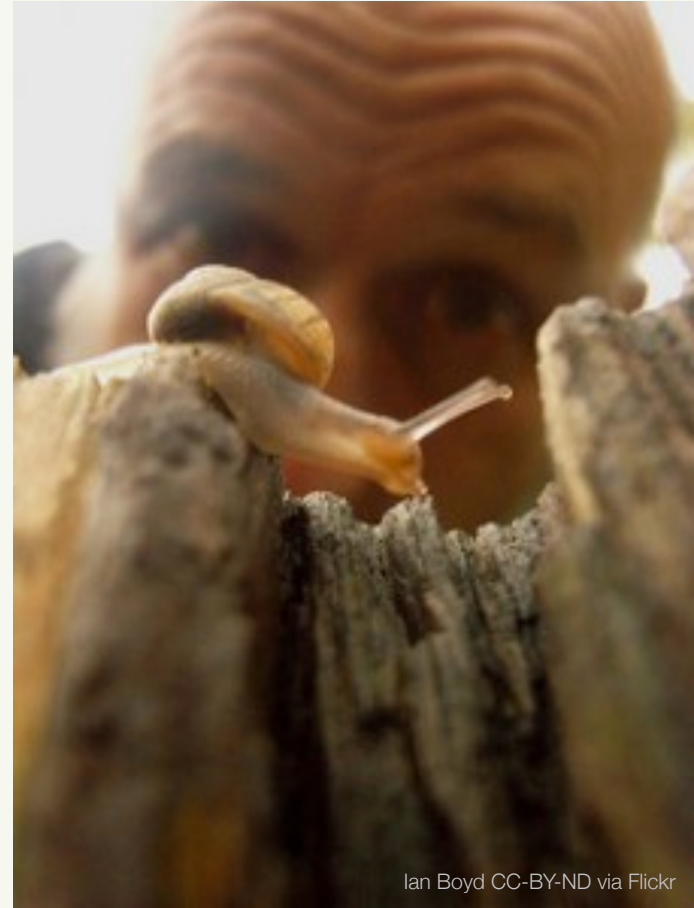
Biological model:

*an inspiring organism or living system which exhibits
a strategy that is relevant to your challenge
(function + context)*

strategy: *a characteristic, mechanism, or process that performs a function.*



AskNature.org



Ian Boyd CC-BY-ND via Flickr



Abstract:

*Capture the essence of the biological strategy
such that it can be applied to a design*

- *focus on **how** the strategy does what it does*
 - *remove biological terms*

Biological Strategy

“Owl Wing Feathers Enable Near-silent Flight

Owls are capable of flying just inches from their prey without being detected. The quietness of their flight is owed to their specialized wing feathers. When air rushes over an ordinary wing, it typically creates a “gushing” noise as large areas of air turbulence build up. But the owl has a few ways to alter this turbulence and reduce its noise. First, the leading edge of the owl’s wing has feathers covered in small structures (hooks and bows) that break up the flowing air into smaller, micro-turbulences...

(excerpt from AskNature)

Owl: Luc Viatour CC-BY

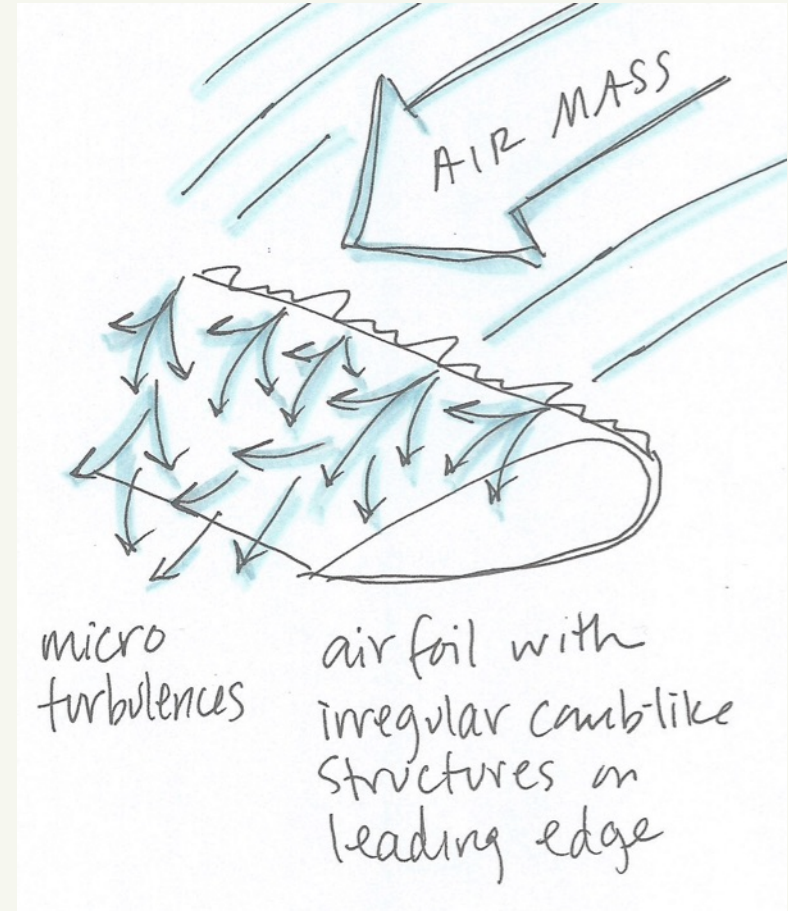
Feather: Kersti Nebelsiek, CC-BY-SA

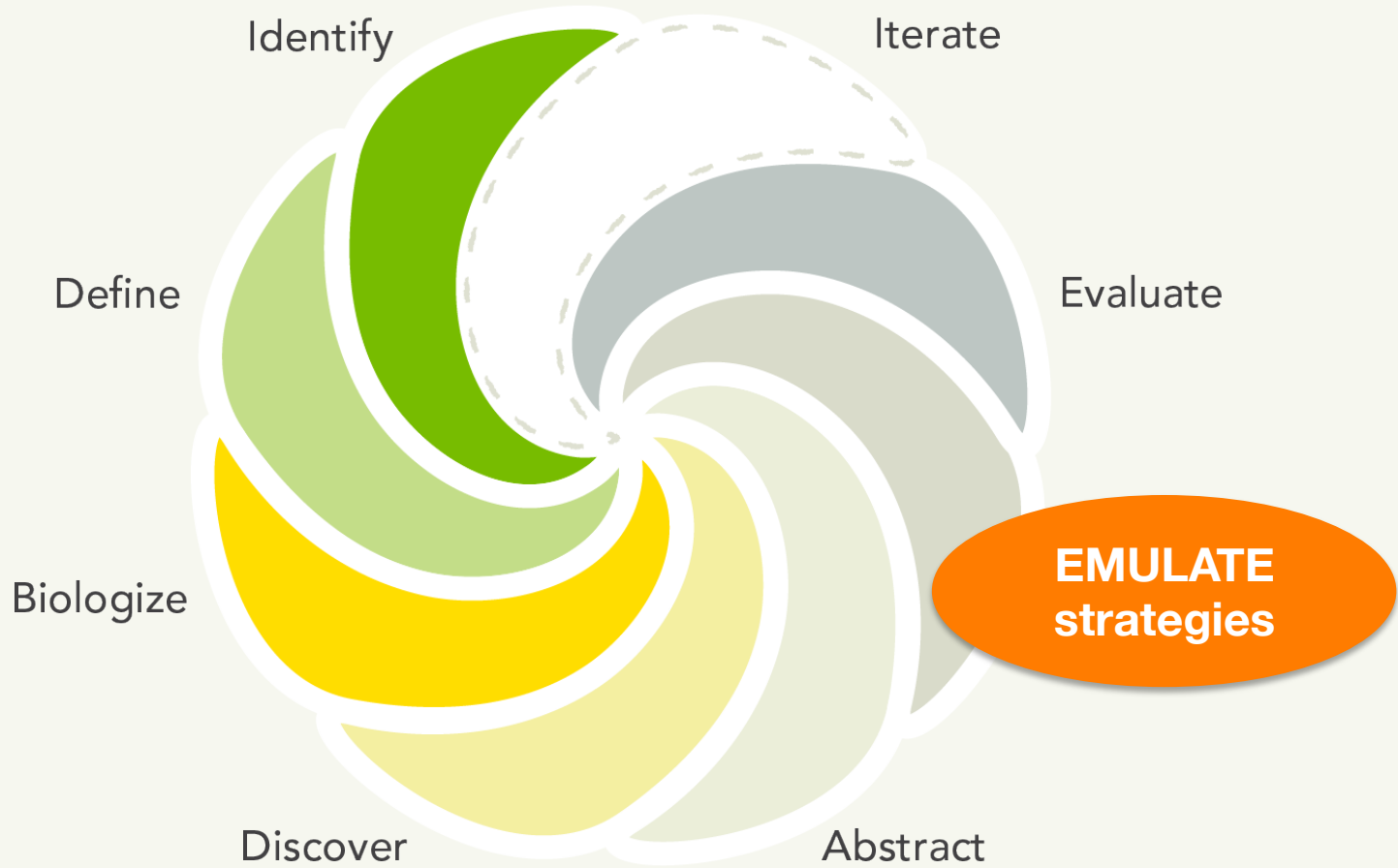


Design Strategy

Comb-like structures reduce noise when located on leading edge of an airfoil.

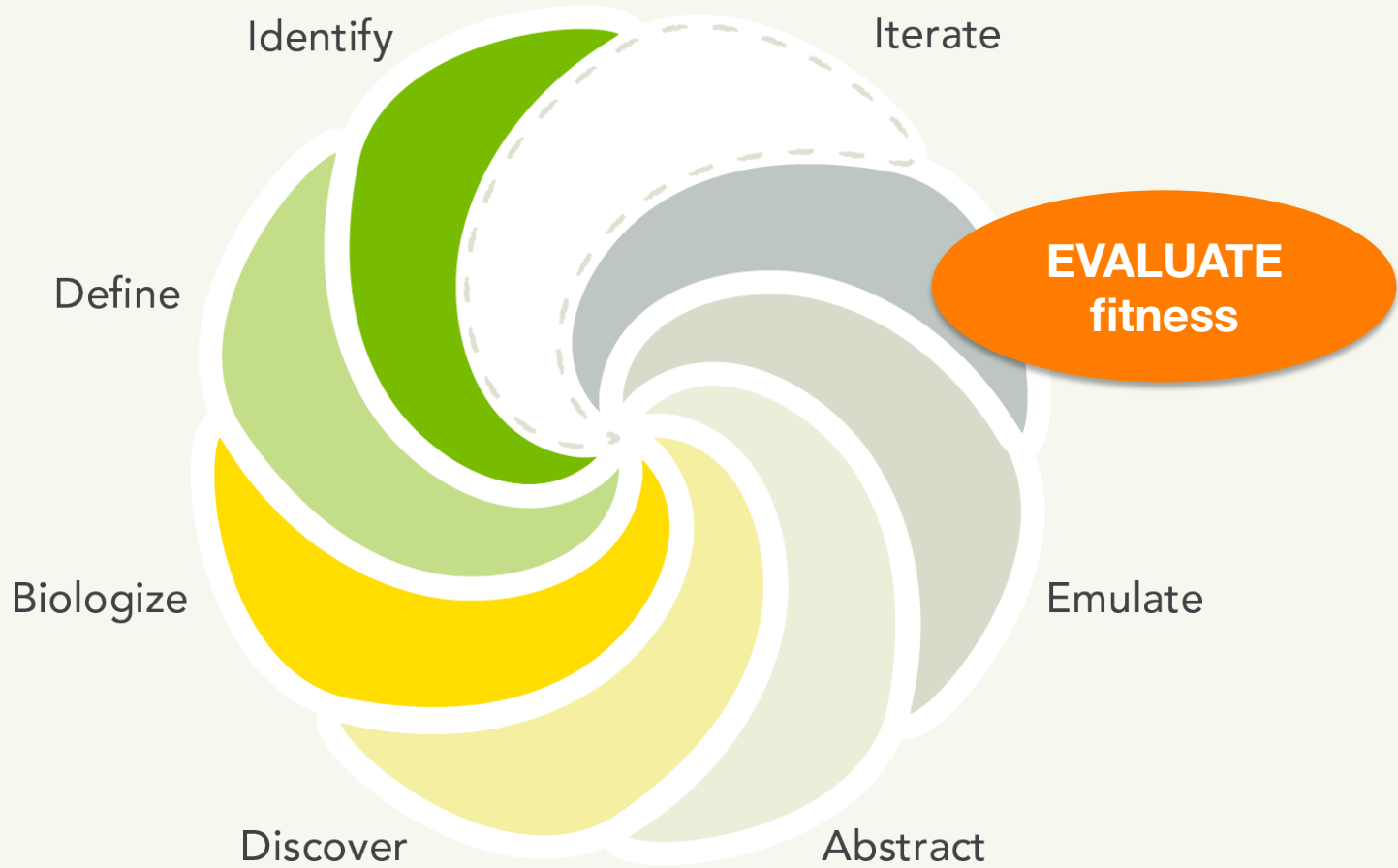
An airfoil reduces noise when passing through air by altering air turbulence. It does this by first breaking up air flowing over the leading edge of the airfoil into small micro-turbulences, which roll over the surface of the airfoil toward its trailing edge. The trailing edge is flexible, further breaking up the flowing air and reducing noise.





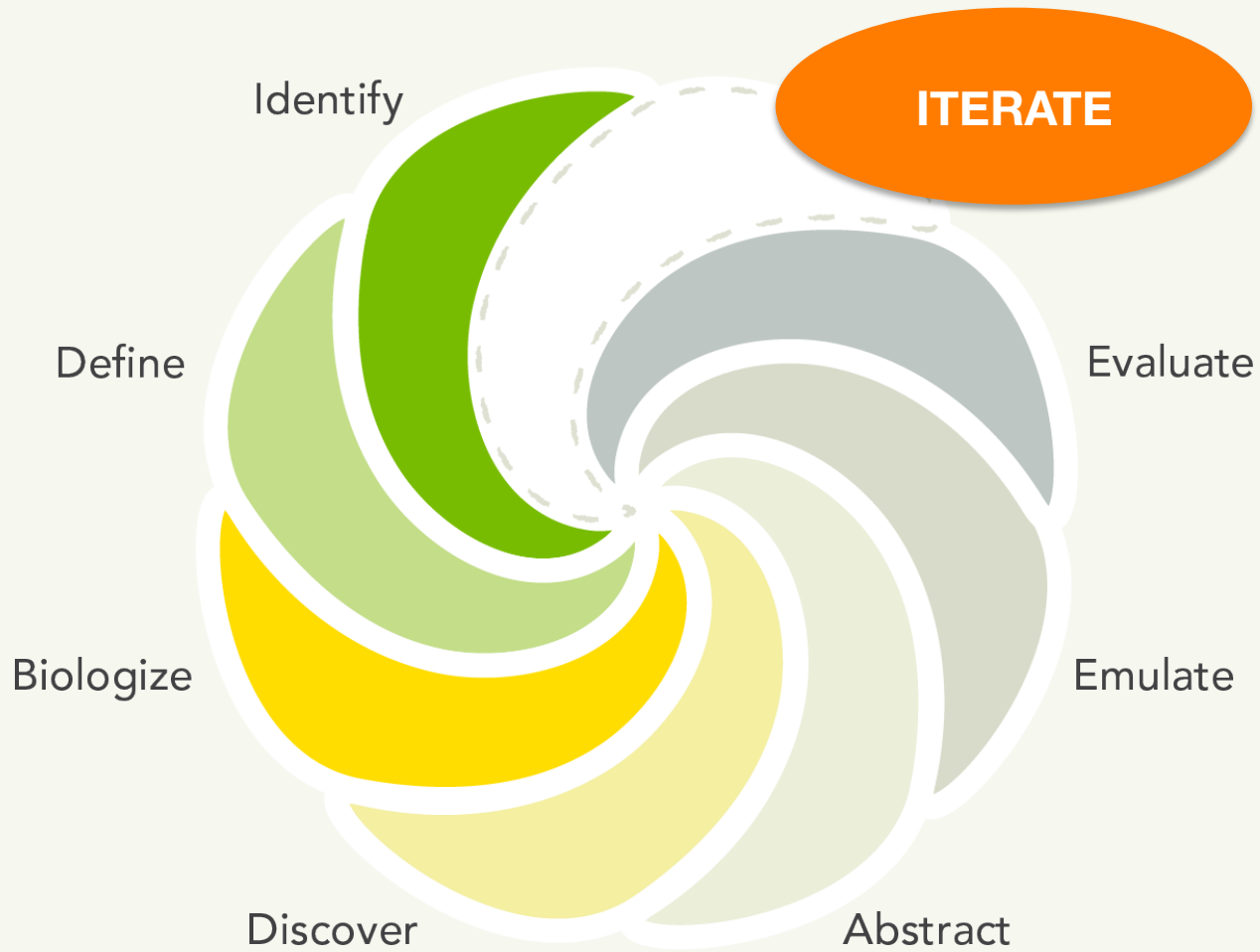
Emulate:

To apply essential patterns or principles within [a strategy], rather than directly copy it.



Does the design 'fit' the challenge?

- *Does it meet the functional need(s)?*
- *Will it function within context/constraints?*
- *Is it compatible with Earth's living systems?*



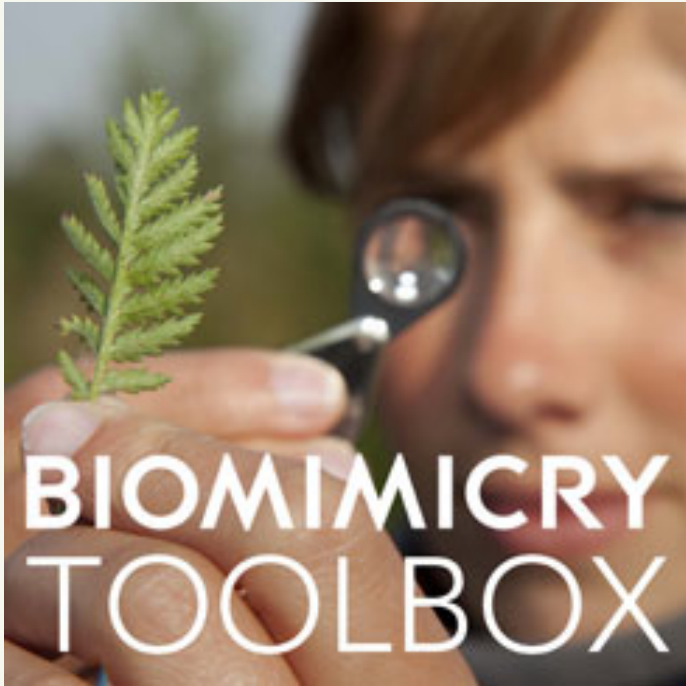
Feels kind of like this...



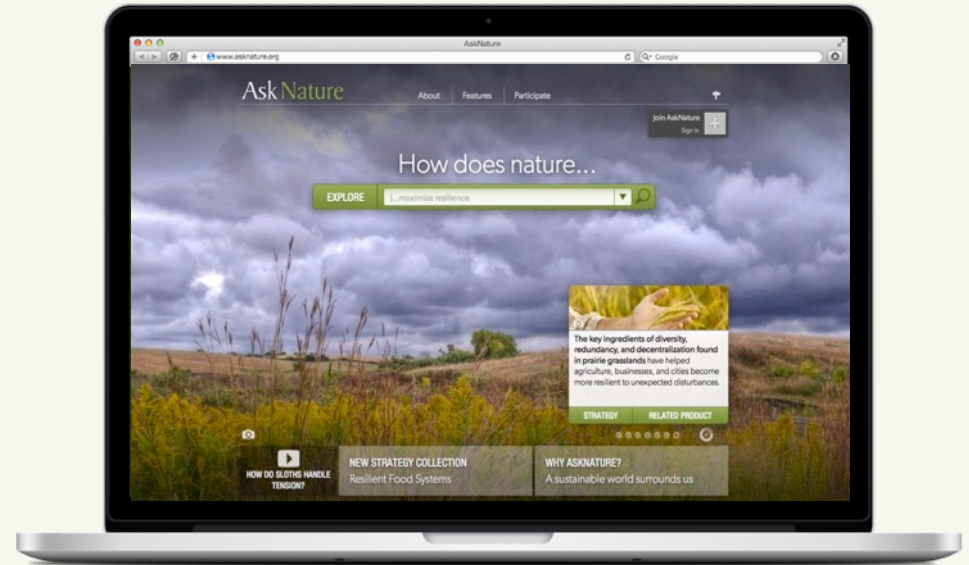
CC-BY-ND Damien Newman

Questions?

RESOURCES FOR LEARNING MORE



Toolbox.Biomimicry.org



AskNature.org

UPCOMING EVENTS

Join us at the Disruptive Innovation Festival this month. Register at **thinkdif.co**



Designing a Food System Revolution

November 10, 7pm GMT & November 17, 2pm GMT

Panel conversations with teams in the inaugural Biomimicry Design Challenge Accelerator

Using AskNature to Guide Sustainable Solutions

November 19, 5pm GMT



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