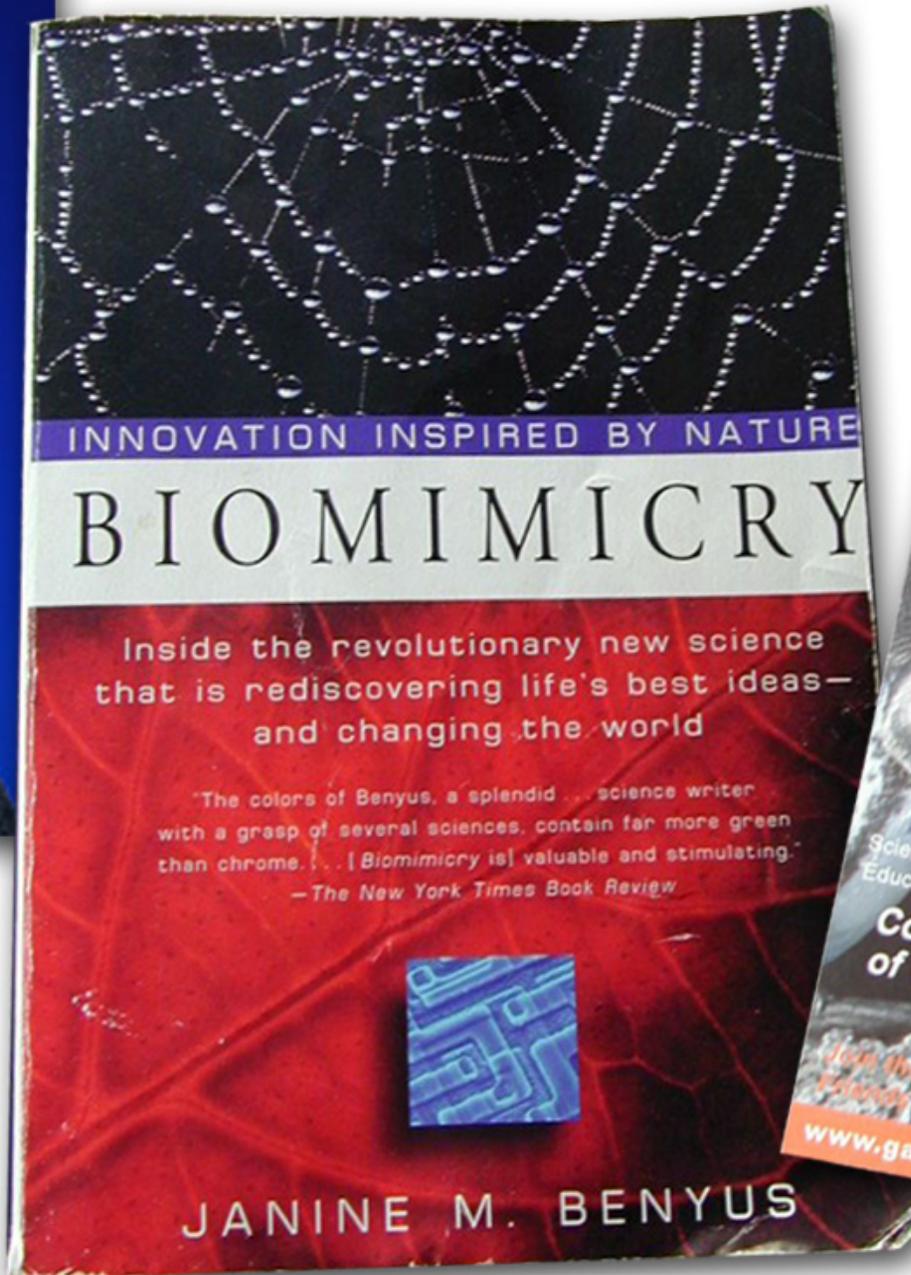


Biomimicry: Learning from Nature's Consummate Engineers

**A Presentation to
University of Arizona
Water Resources Research Center**

Mary Hansel
December 11, 2009

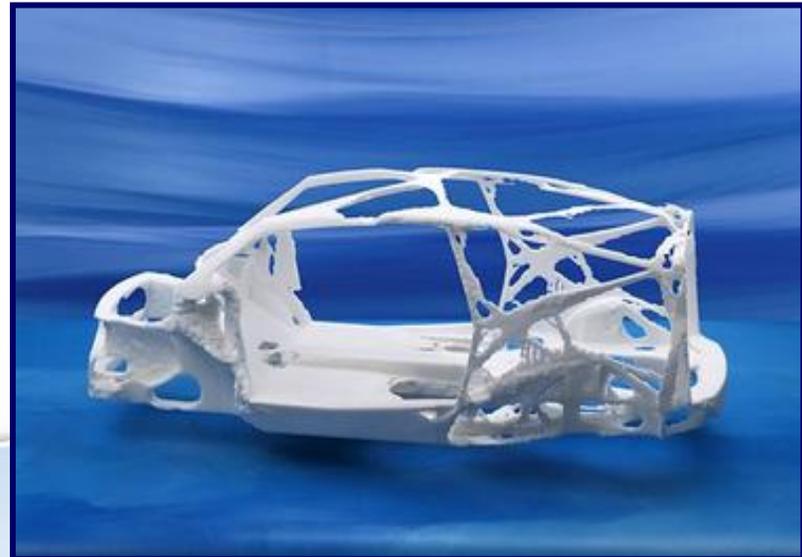
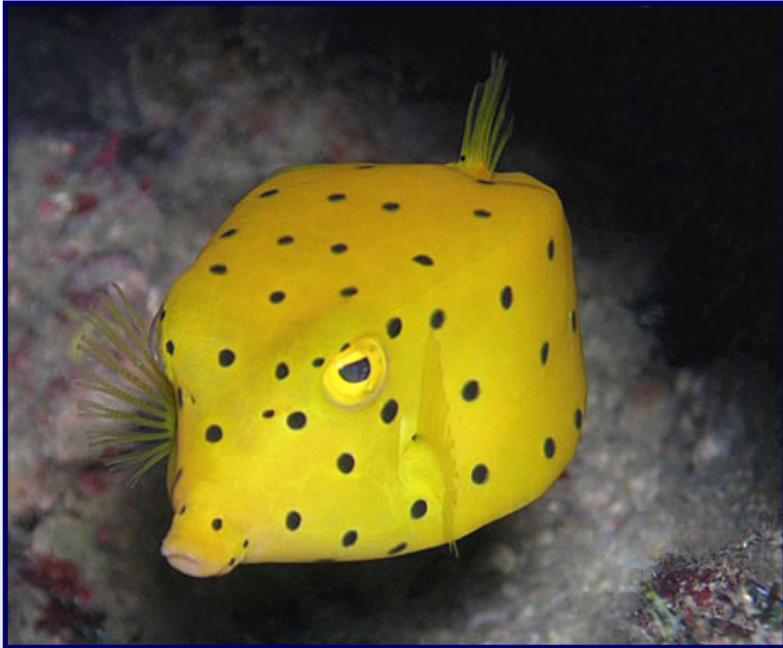




The Motley Crew!



Engineers fish for efficiency...



Mercedes Benz 70
mpg Bionic
Concept Car

... and develop light-weighting software



IMF
Institute for Materials Research

<http://www.fzk.de/fzk/idcplg?IdcService=FZK&node=0040&lang=en>

Today's agenda

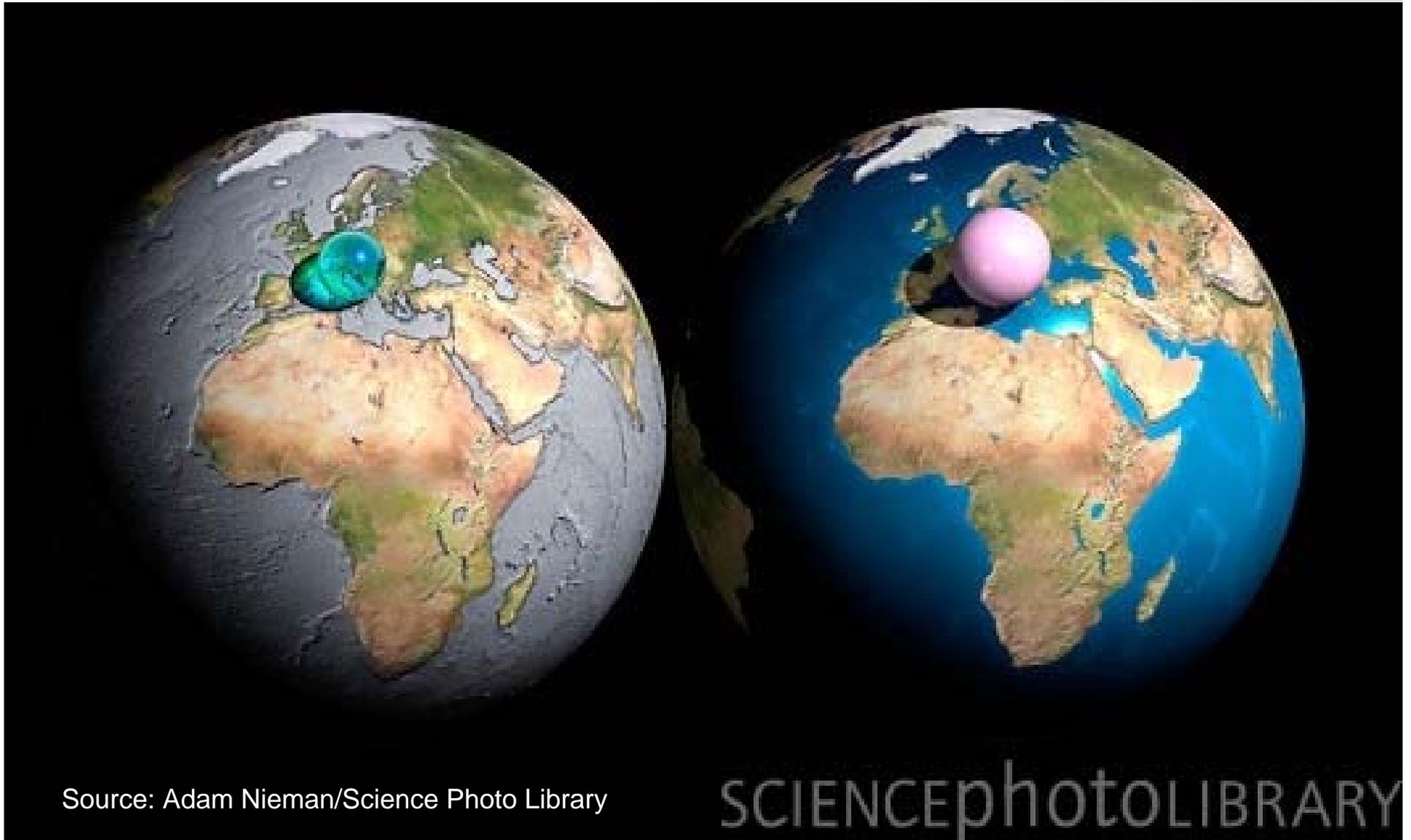
- What is biomimicry?
- Case studies
- How do we *do* biomimicry?
- Resources





Water-Based

Limits and boundaries



Source: Adam Nieman/Science Photo Library

SCIENCEPHOTOLIBRARY



adjusting to meet current
environmental conditions



ignoring changes of
environmental conditions

Dynamic non-equilibrium

Slide adapted from Jamie Dwyer

The survivors know what works



"... After 3.8 billion years of research and development, failures are fossils, and what surrounds us is the secret to survival."

- Janine Benyus

A photograph of Earth from space, showing the curvature of the planet and the bright sun in the upper right corner. The Earth's surface is visible, showing land and oceans. The sun is a bright, multi-pointed star in the upper right, casting a glow over the scene. The background is the dark void of space.

*We are just 1 of 30 million
species on earth.*

Slide courtesy of Karen Allen

Bios = Life
Mimicry = Imitate
**“the conscious emulation of
nature’s genius”**



Slide adapted from Karen Allen

Nature as Model

How would nature...?

Nature as Measure

What *wouldn't* nature do?



Slide adapted from Karen Allen slide

Nature as Mentor

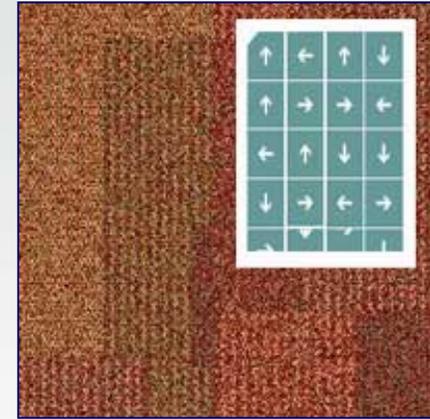
How can I give thanks?



Photo courtesy of Stefan Groenveld via www.biomimicryinstitute.org

We foresee a world where biomimicry not only can change the way we design our planet, but also the way we value it.

Nature as Model: Form Entropy carpet tiles mimic forest floor



Nature as Model: Process

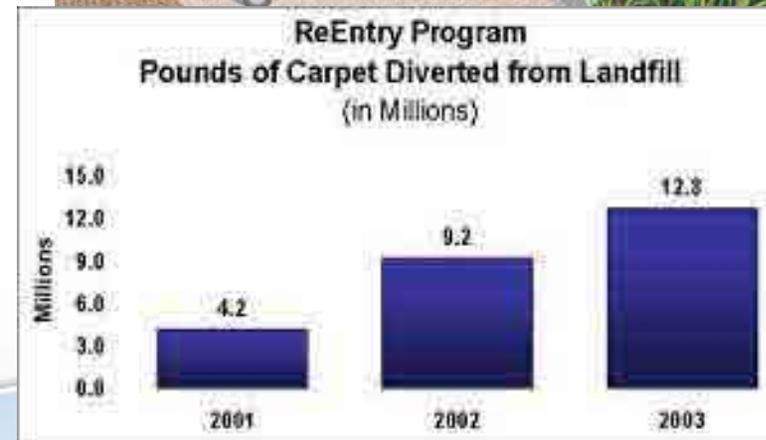
Solar powered factories; Zero emissions; Renewable /reusable materials



TacTiles

Nature as Model: Ecosystem InterfaceFLOR

- Shift from products to service
- Recover used products
- Sustainability Reporting & Consulting



Interface CEO Ray Anderson

"...40% of sales are based on products derived from the biomimicry thought process..."
– Ray Anderson, CEO



Biomimicry expands the conversation



Function is the bridge between biology and design





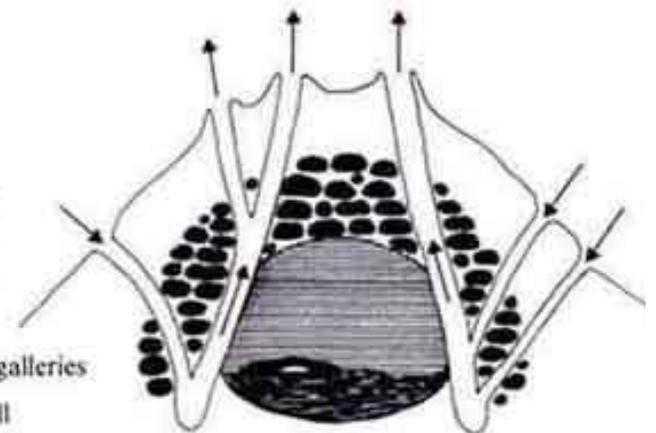
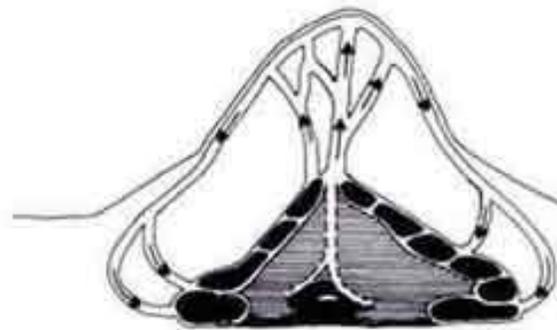
Biomimicry Case Studies

Cooling without air conditioning



A. *Macrotermes michaelseni*

B. *Macrotermes subhyalinus*

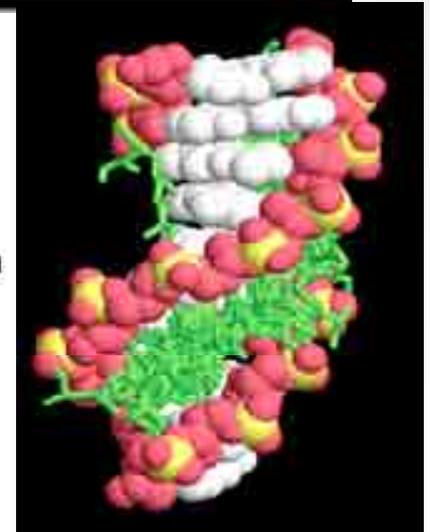
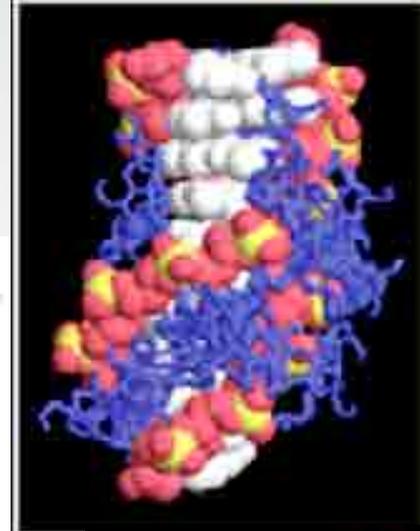
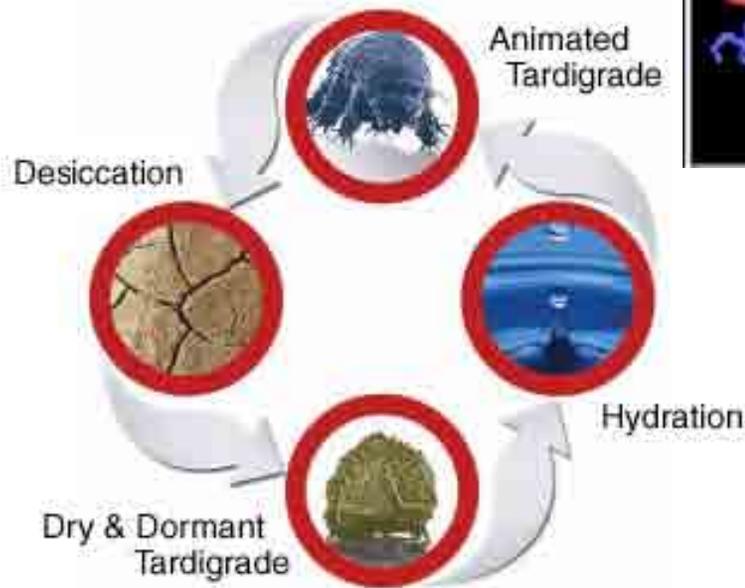


Direction of air movement
Fungus combs
Nursery galleries
Royal cell

Life without water



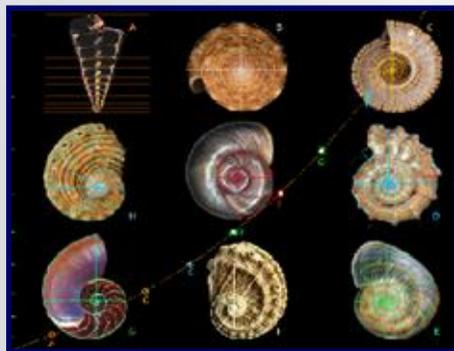
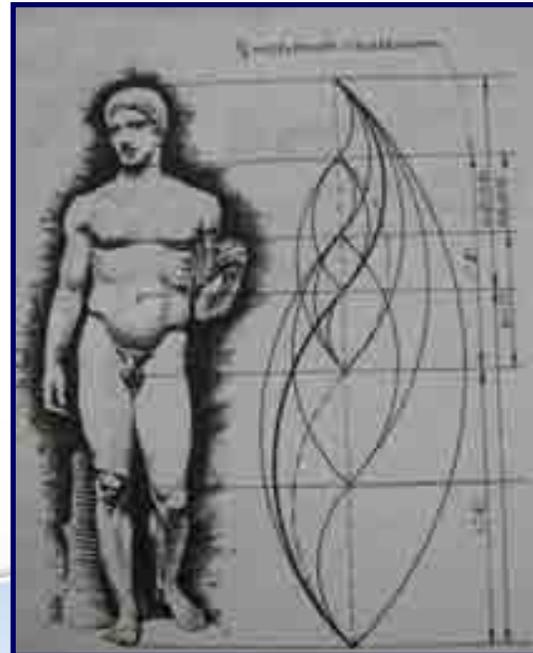
Anhydrobiosis in a Tardigrade



www.biomatrica.com

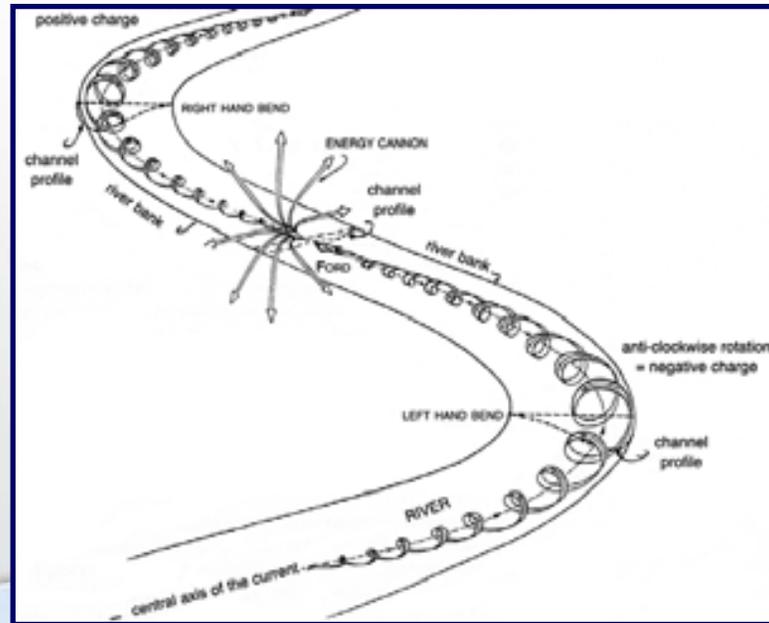
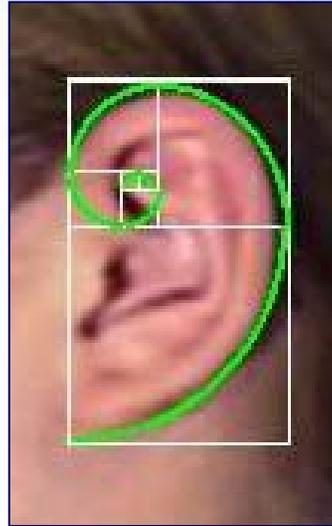
Bob Goldstein, UNC Chapel Hill

Flow without friction



L. Shyamal

How does nature move fluids?



Flow without friction

PAX Scientific



PAX Water Mixer (the "Lily")



- Biomimicry-inspired impeller
- 50% reduction in energy; 70% reduction in noise; little or no cavitation



Flow without friction



- 32% reduce drag
- 8% increase lift

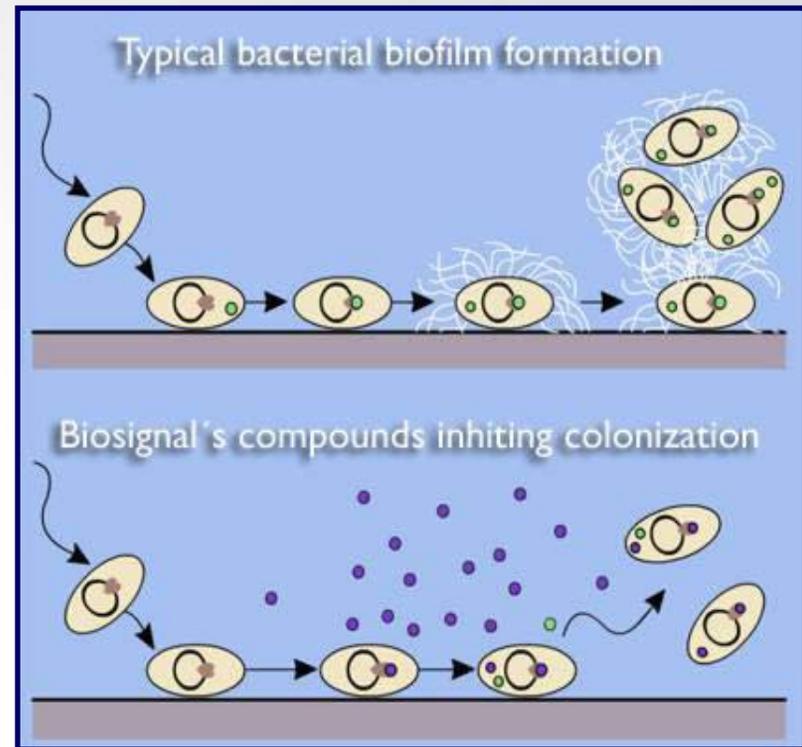


WhalePower

BUILDING THE ENERGY FUTURE ON A MILLION YEARS OF FIELD TESTS

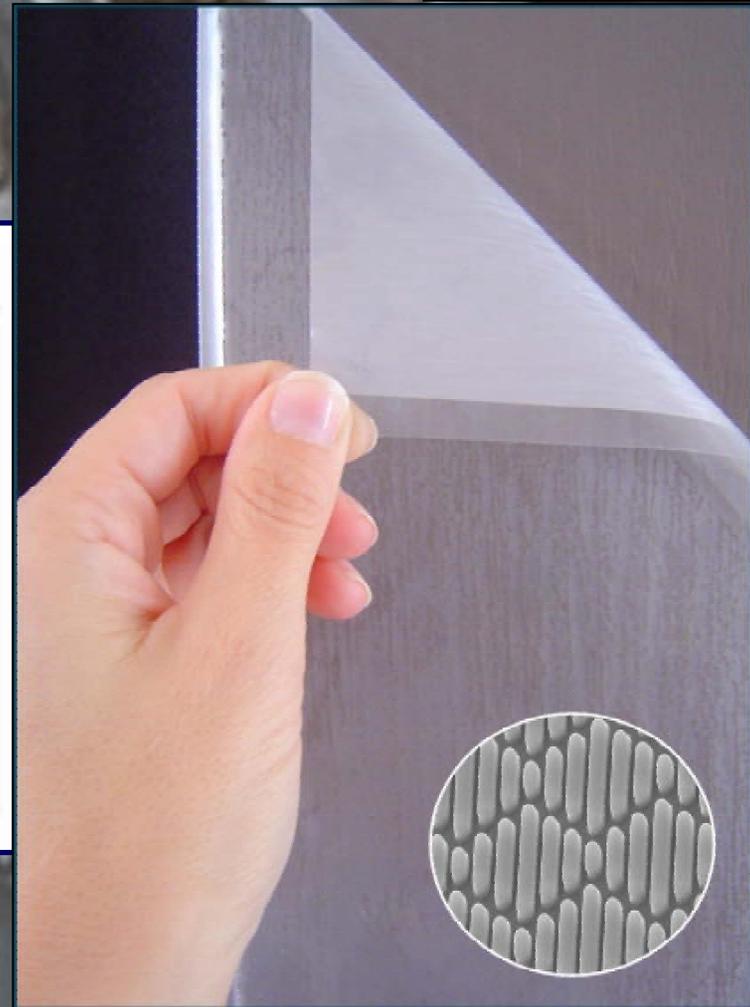
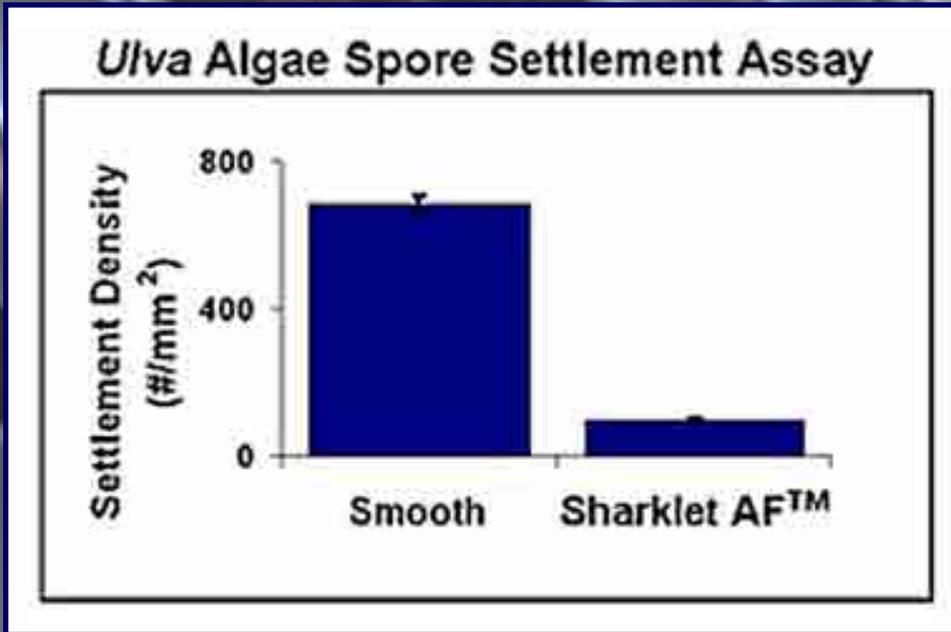


Bacteria-free w/o antibiotics



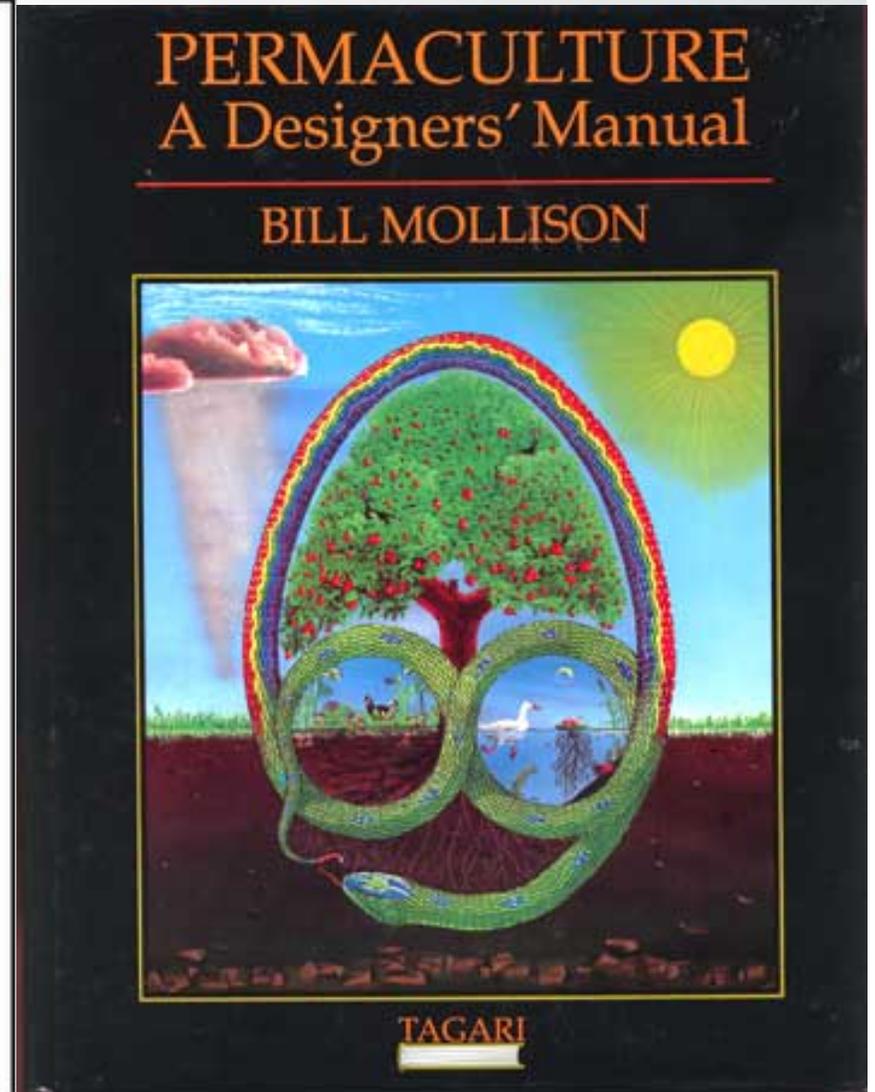
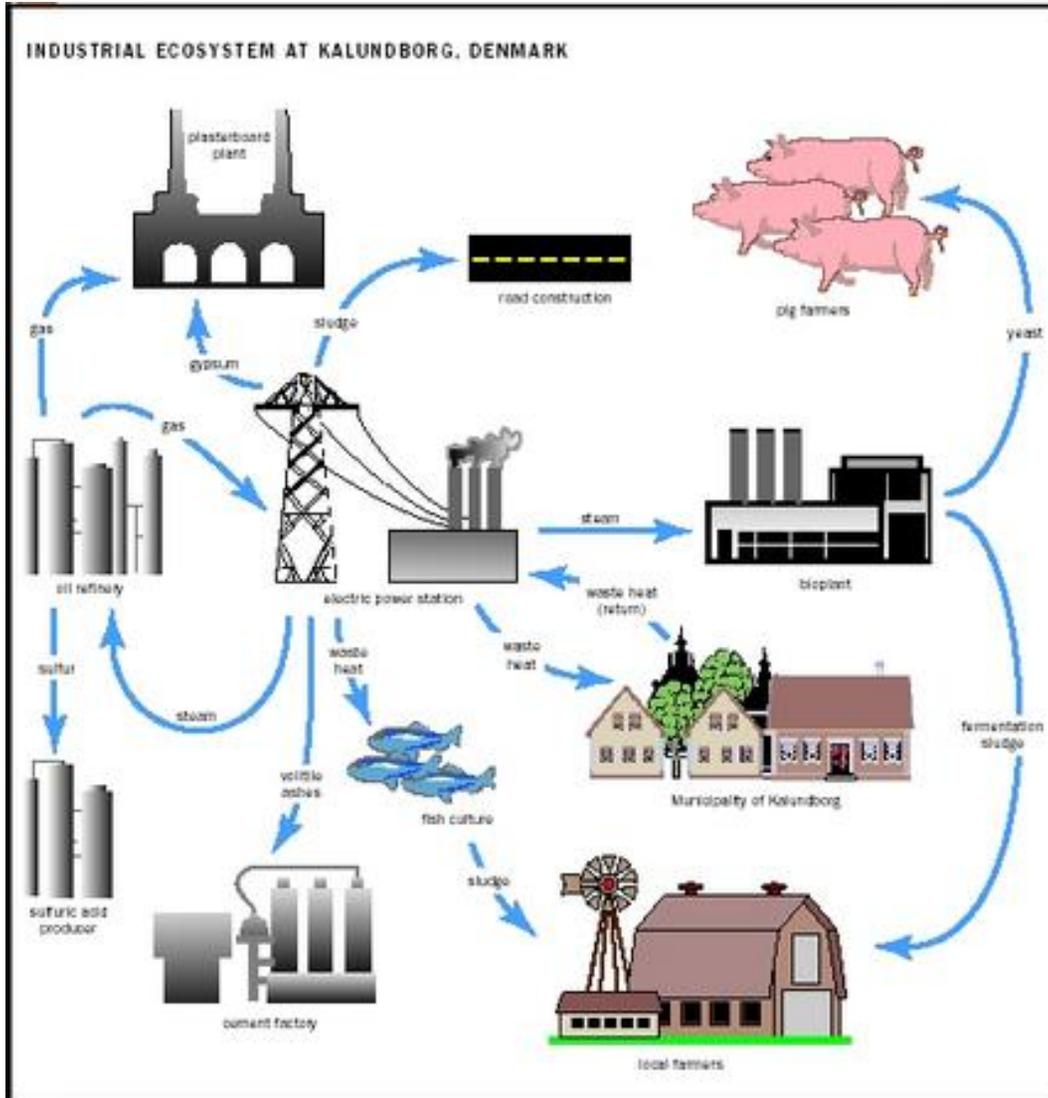
Peter Steinberg BIOSIGNAL Ltd

Sharklet SafeTouch™



www.sharklet.com

Industrial ecology & permaculture = Biomimicry = Systems thinking



Bioteams follow rules not orders



The Bumble Bee

Ken Thompson's shared know-how on team dynamics, virtual collaboration and bioteaming.

LEADERSHIP: Treat every team member as a leader

- **RULE 1: Stop Controlling** Communicate information — not orders.
- **RULE 2: Team Intelligence** Mobilize everyone to look for and manage team threats and opportunities.
- **RULE 3: Permission Granted** Achieve accountability through transparency not permission

www.bioteams.org

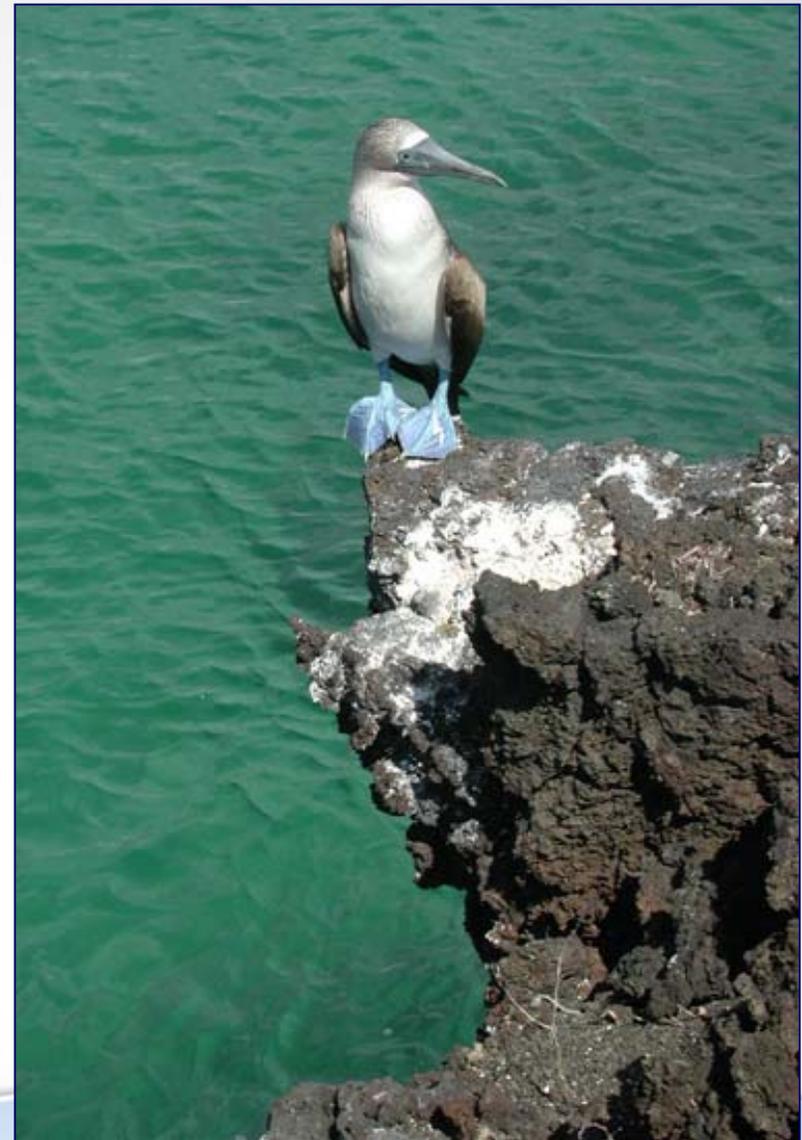
How do we *do* biomimicry?

Quiet human cleverness

*"In the beginner's mind
there are many
possibilities*

*While in the expert's
mind there are few."*

- Suzuki



Listen to Life's Genius



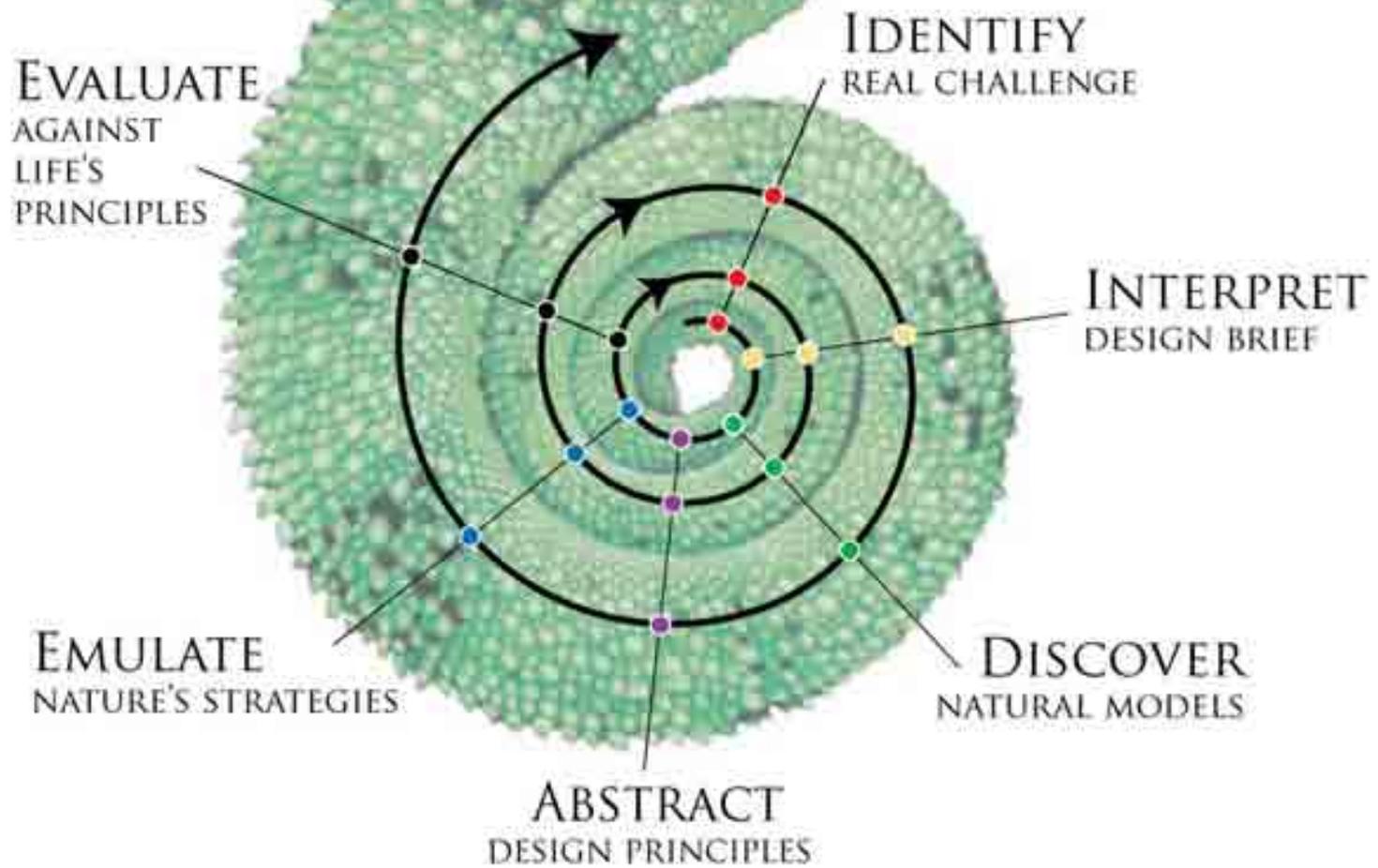
Echo What We Learn



Photograph by József L. Szentpéteri

Dragonflies
National Geographic, April 2006
© 2006 National Geographic Society. All rights reserved.

CHALLENGE TO BIOLOGY



Biomimicry in action at COD Ranch

Design Challenge:

Low and intermittent water availability requires effective water collection and storage

Biologize the Question:

How does nature collect and store water?

How does nature collect water... *here?*

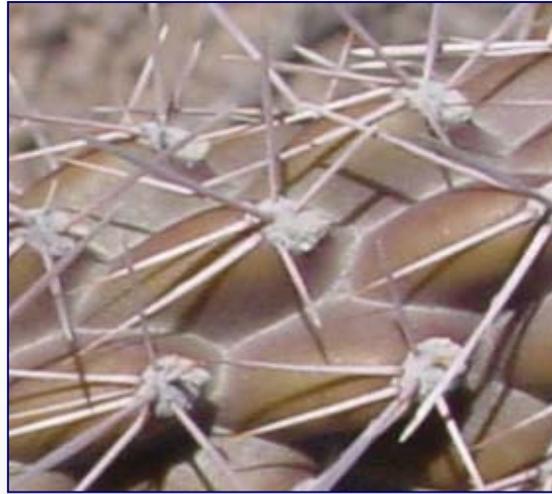
Deep Principle:
Rosette shape
maximizes water
capture

Design Idea:
Rainwater catchment (for
any given footprint,
This shape collects more
water than a flat surface)



Erin Leitch

How does nature store water... *here?*



Erin Leitch

Deep Principles:

Diverse and redundant strategies makes a system resilient to water loss

White starlet structure manages temperature (reduce heat gain & maximize heat loss), thereby reducing water loss

**Life's
Principles
provide
guidance on
what works**

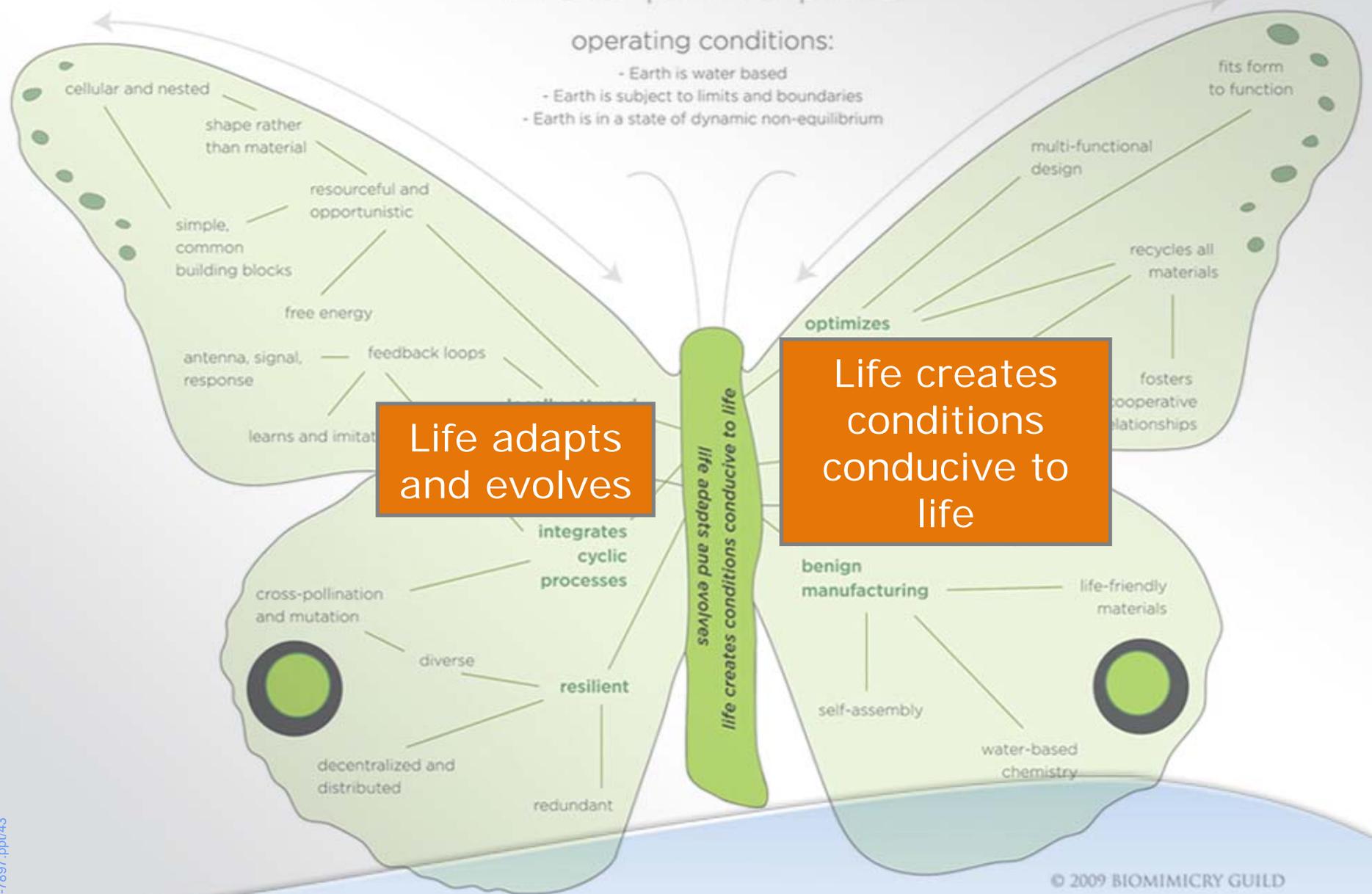


http://commons.wikimedia.org/wiki/File:Northern_Spotted_owl.JPG

life's principles

operating conditions:

- Earth is water based
- Earth is subject to limits and boundaries
- Earth is in a state of dynamic non-equilibrium



Life adapts and evolves

Life creates conditions conducive to life

life adapts and evolves
life creates conditions conducive to life

Life creates conditions conducive to life

Optimizes rather than maximizes

Uses benign manufacturing



Leverages interdependence



Ostara struvite recovery

- Multi-functional design
 - Reduces P & N in effluent
 - Reduces struvite buildup
 - Creates 'food' from waste
 - Generates revenue
- Recycles all materials



Ostara



Optimizes rather
than maximizes

Life adapts and evolves

Locally attuned and responsive



Integrates cyclic processes

Resilient

Genius of Place: Prairie dogs guide development in Colorado



Locally attuned strategies adopted by local organisms





Biomimicry Resources

Biomimicry Guild & Institute

Education



www.asknature.org

www.biomimicryinstitute.org

Consulting



www.biomimicryguild.com

[Sign In](#) · [Join](#)

Ask Nature BETA

A project of THE BIOMIMICRY INSTITUTE

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How would Nature...



How would Nature solve green building challenges?



[CONSERVING MATERIALS >](#)



[GATHERING WATER >](#)



[CAPTURING ENERGY >](#)

Nature's elegant solutions to building challenges include the Scots pine's adaptive growth, the thorny devil's passive water collection, and a leaf's on-site energy production. AskNature can help you solve *your* design challenges. [Learn more>](#)



WHAT IS BIOMIMICRY?

It's amazing what a 3.8-billion-year head start can do when it comes to problem solving.

[Learn more >](#)



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Autodesk®

Many universities have biomimicry academic programs

Georgia Tech



UC Berkeley



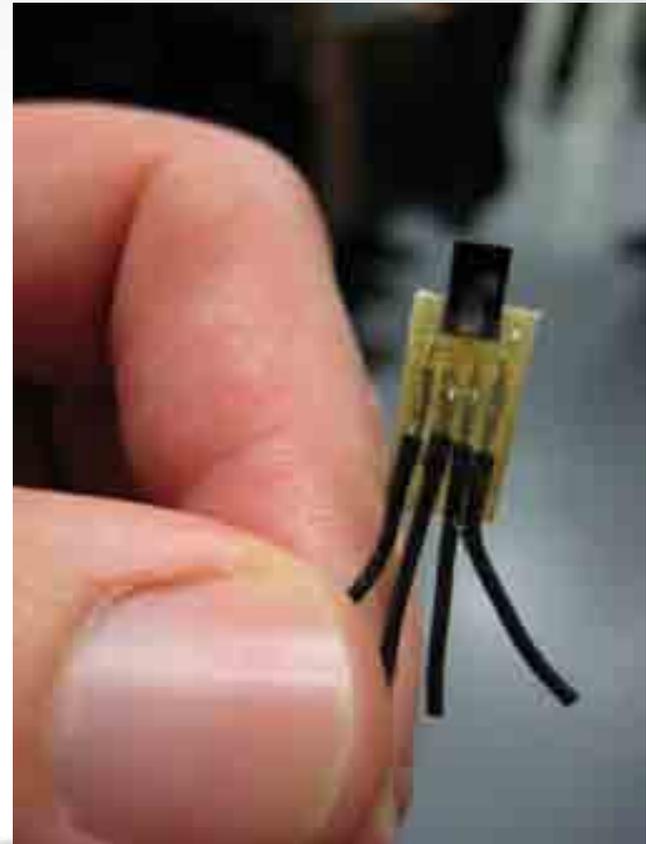
Aizenberg Biomineralization and Biomimetics Lab



Janet Kubler

Georgia Tech

Center for Biologically Inspired Design



Social Biomimicry: Insect Society and Human Design Conference



February 18-20, 2010

ASU School of Life Sciences

<http://sols.asu.edu/frontiers/index.php>

Biomimicry Opportunities

- Training
 - 1 week Workshop
 - Two-Year Certificate
- AskNature Curator & Community



<http://www.itsnature.org/endangered/moderately/hyacinth-macaws/>

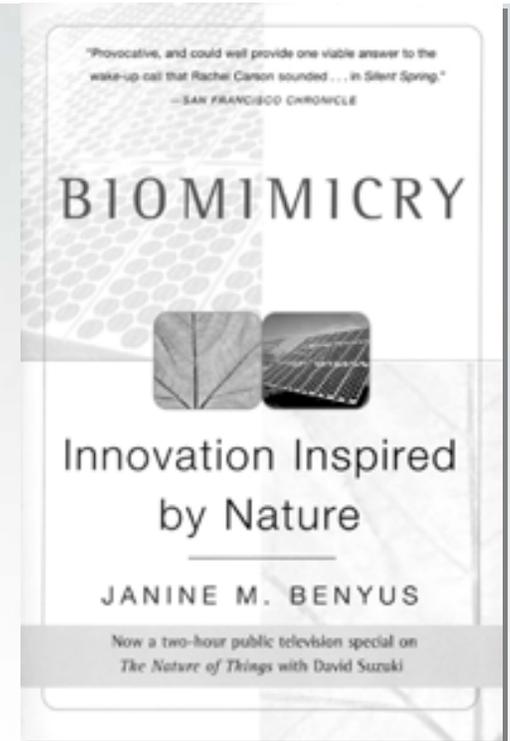
Biomimicry Resources

Books

- Biomimicry, by Janine Benyus
- The Way Nature Works, edited by Robin Rees
- Cats' Paws and Catapults, by Steven Vogel

Networks

- Ask Nature: www.asknature.org
- BIONIS:
<http://www.extra.rdg.ac.uk/eng/BIONIS/>
- BioInspired newsletter:
www.biomimicryinstitute.org



Giving Thanks



We are a young species ...



... living in an incredibly competent Universe



Ocotillo is my mentor



**The more our world functions
like the natural world, the
more likely we are to endure
on this home, which is ours,
but not ours alone**

- Janine Benyus



Questions?

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Mhansel@carollo.com



Aquatic ecosystems perform many functions

