Biomimetics 12
Patterns from Nature

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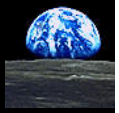
http://sinet.ca/patterns



Co-Authors

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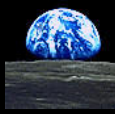
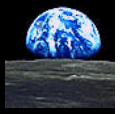
Overview

- Expectations and Objectives
- Biomimicry and knowledge transfer
- Patterns & Pattern Language
- ‘Patterns from Nature’ project
- Two ‘proto-patterns’
- Insights



Expectations

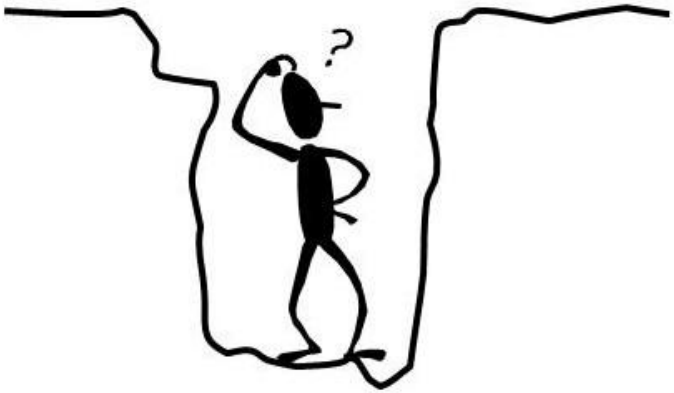
- Not (yet) a practical tool or methodology
- Concept or framework for managing and communicating knowledge
  - Structured: simple framework that makes sense of real-world complexity
  - Flexible: data-driven, bottoms-up approach
  - Extendable: in breadth and depth
- Work in progress



Objectives

- Linkage to the ‘big issues’ of the day
- Motivate students through relevant connections
- Facilitate innovation, especially across knowledge domains

Psychological Inertia (D. Mann)



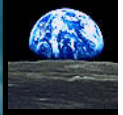
* Problem solving is like digging for treasure in a field
* If a hole already exists, our inclination is to dig it deeper
* The deeper the hole, the more difficult it is to see what's happening in other parts of the field
* If someone else comes along, we encourage them to jump in the hole with us
* The overall effect is called PSYCHOLOGICAL INERTIA

Patterns from Nature

Biomimicry

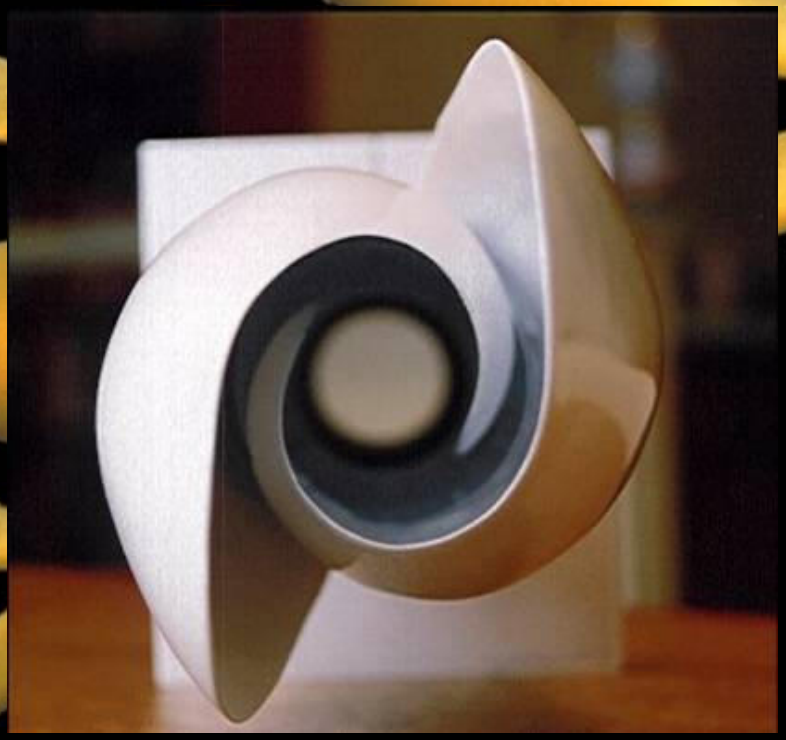
- A field of study about “the conscious emulation of nature’s genius”
- Knowledge transfer approaches:
  - Biology to Design (e.g. PAX Scientific)
  - Design to Biology (e.g. Bionic Concept Car)
  - Embedding Life’s Principles

Patterns from Nature



Mimicking form

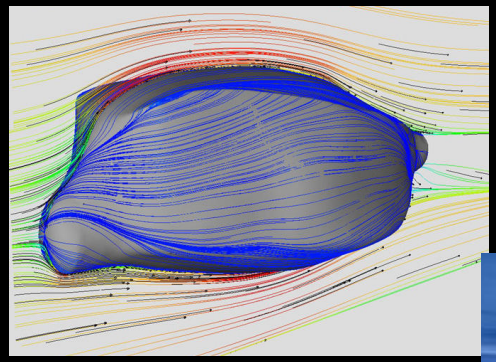
- Life Fits Form To Function
- Optimizes rather than maximizes
- Creates conditions conducive to life



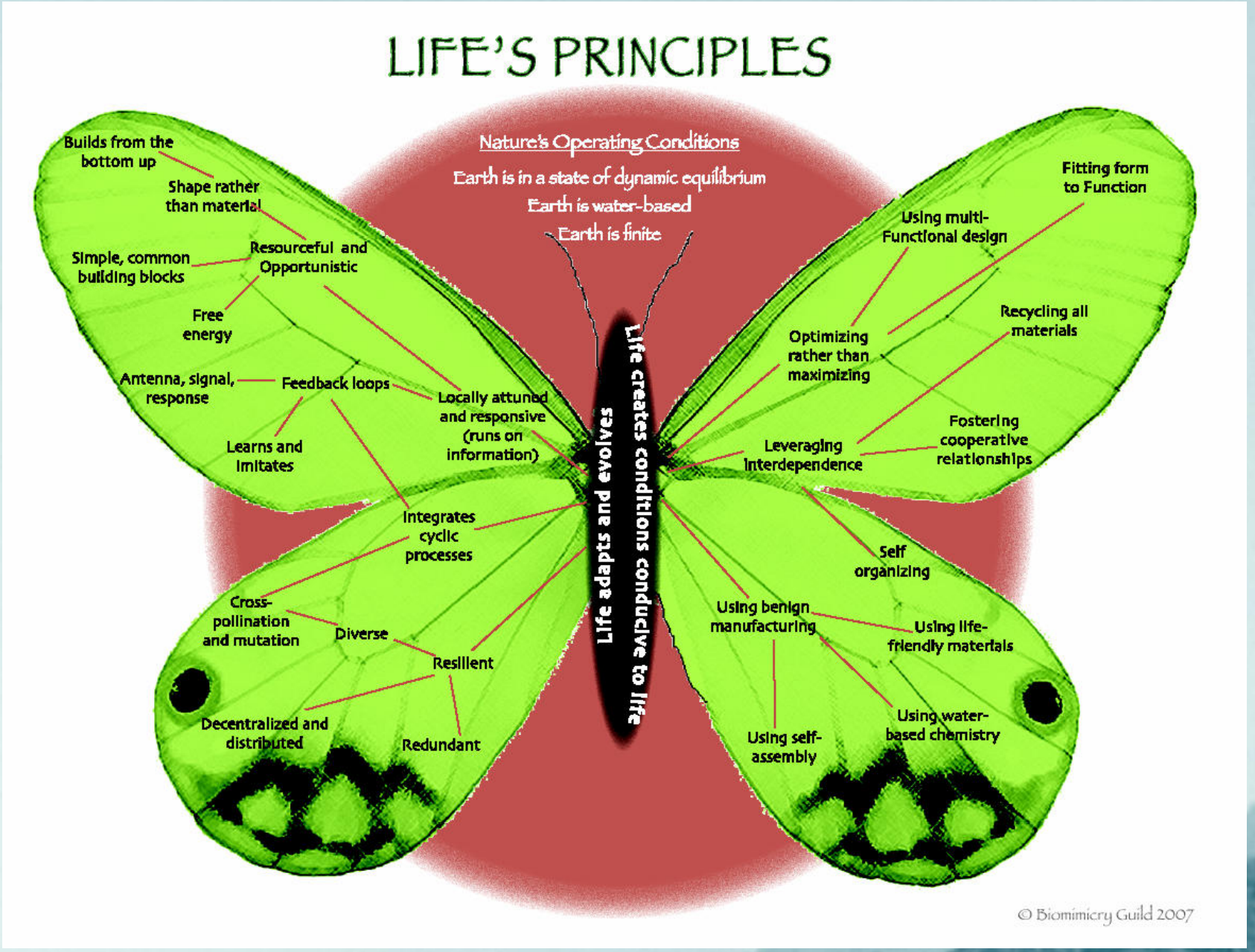
Pax Scientific

Mimicking form

- Life fits form to function
- Shape is cheaper than material
- Optimizes rather than maximizes

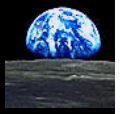


Mercedes-Benz
Bionic Concept Car



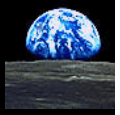
The Reality

- How do designers tap into biological information?
  - Different language & framework
- Is a bio-inspired solution necessarily sustainable?
- Do we have a repeatable process?
- Do humans have unique needs?



The Vision

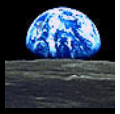
- An innovation methodology that:
  - Abstracts information
  - Structures information
  - Eliminates the jargon
  - Guides the innovative process
  - Encourages sustainable design
- TRIZ: Theory of Inventive Problem Solving
- Pattern Language (Alexander)



Structure of a Pattern

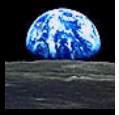
"*A pattern is a natural-language, context-dependent description of a solution to a class of problems, that is both generative and descriptive.*“ (Salustri)

- English
- Defined context
- Describes how to solve a problem
- Provides insights into the problem



Characteristics of a Pattern

- Solves a problem/challenge
- Describes a proven resolution
- Provides insight
- Describes relationship with other patterns
- "*Useful, usable, and used!*" (Appleton)



Watershed Services

THE PATTERNS OF A CONSERVATION ECONOMY

PATTERN:

Watershed Services

Virtually all watersheds have been modified or degraded by development, often resulting in the deterioration of water quality, damage to plant and animal communities, erosion, and other wounds. This reduction in the quality of ecosystem services may have significant economic and social implications as well.

A watershed may be defined as the collection land surfaces draining to the same body of water. Smaller watersheds combine to form larger watersheds. The Columbia River watershed is composed of thousands of small stream-scale watersheds, ultimately draining parts of Oregon, Washington, Idaho, Montana, Wyoming, Nevada, Utah, and British Columbia.

Watersheds are functional units of ecosystems, and best treated as whole systems. They provide a wide range of Watershed Services, including air and water purification, flood control, habitat, and recreation. Degraded watersheds may show numerous symptoms, including erosion, loss of plant and animal species, decreased ability to hold water during storms (leading to more frequent and sever flooding), and habitat fragmentation.

IMAGE:

Student volunteers at Sea Resources in Chinook, Washington create a riparian debris structure for a salmon restoration project.
Image by Seth Zuckerman.

Watershed restoration is the process of restoring fully functional ecosystems at the watershed scale. This requires that the full complement of native plants and animals be reintroduced, perhaps over several decades. It is particularly important that large carnivores and "keystone" species, which each play a role in regulating food webs far out proportion to their numbers, be restored. Revegetation, particularly in riparian zones, can renew soil fertility and reduce erosion. Natural disturbances, including floods and fire may need to be re-established or effectively mimicked. Obstacles to species movement need to be addressed, thereby reconnecting isolated habitats.

Watershed restoration brings particularly significant economic benefits in an urban setting, where it enhances Ecosystem Services and directly impacts thousands of people. In , major economic uses of the land, including forestry, agriculture, and fisheries can directly contribute to watershed restoration as they shift towards sustainable forestry, agriculture, and fisheries. Restoration in a wildlands setting can establish and enhance Wildlife Corridors, improve the health of Buffer Zones, and play a role in establishing Core Reserves in disturbed areas. On a small scale, yards, gardens, landscaped grounds, and parks can all be planted with native species.

In the Pacific Northwest, restoration of Watershed Services is a major economic sector, with hundreds of millions of dollars allocated to salmon, wetlands, forest, and grasslands restoration. It remains an imprecise science, but holds enormous promise to eventually return the Natural Capital of the bioregion to ancient levels.

Treat watersheds as whole systems, seeking to restore a full complement of native plants and animals, re-establish natural disturbances, stabilize soil, and connect habitat with surrounding watersheds.

CASE STUDIES:

Examples of this pattern in action:

Watershed Research and Training Center
"The primary objectives and purposes of this corporation shall be the promotion of the sustainability of a healthy community economy in healthy forests through research, training, education and economic development." The By Laws

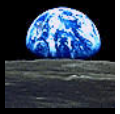
Johnson Creek Watershed Council

PATTERN INDEX ▼

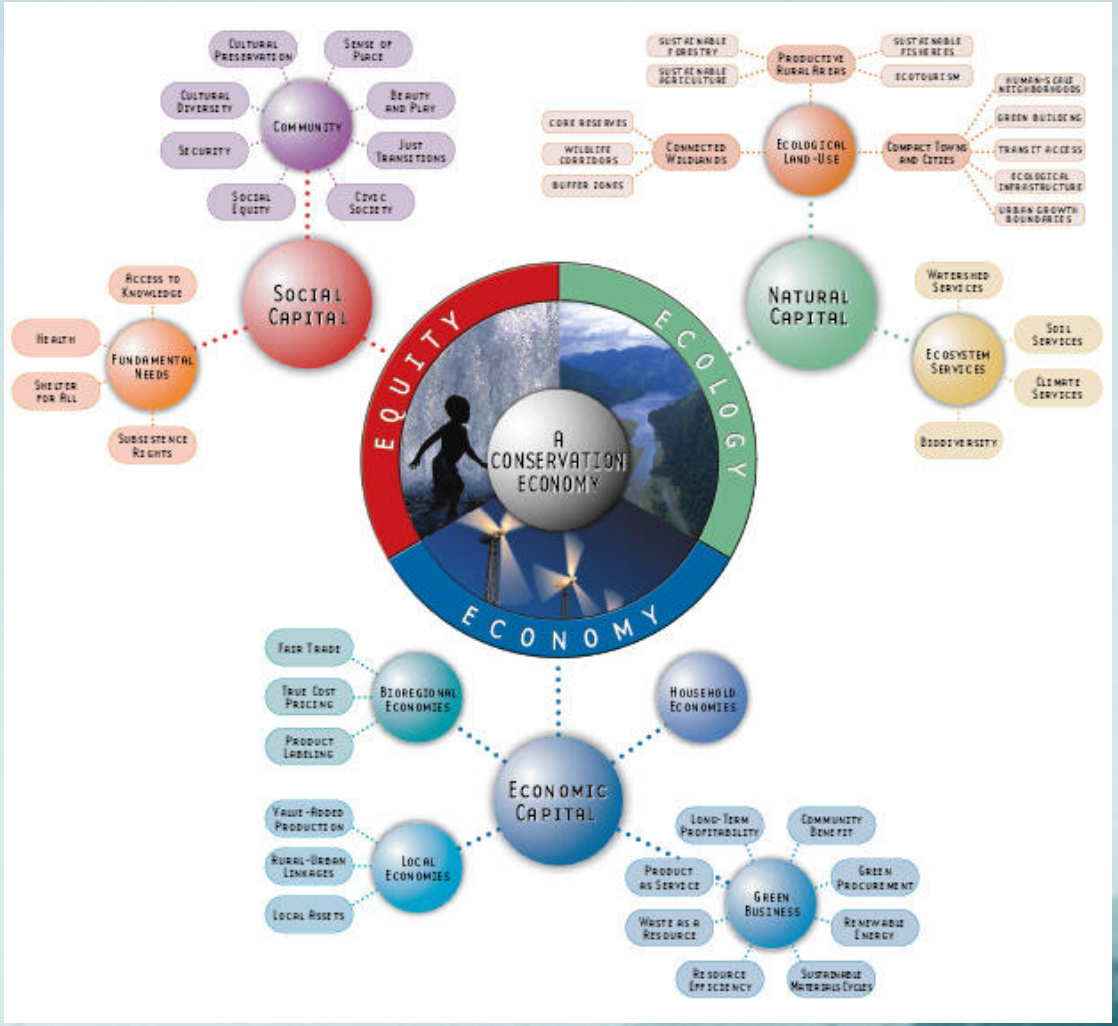
Patterns from Nature

Pattern Language

- A set of patterns covering a domain
- Linked by a ‘grammar’ that “… *reveals the inherent structures and relationships of its constituent parts”* (Appleton)
- “*A collective of … solutions which, at every level of scale, work together to resolve a complex problem…*” (Appleton)



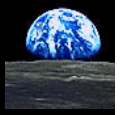
Conservation Economy Pattern Language



Patterns from Nature

‘Patterns from Nature’

- Volunteer effort, with members across North America, Europe and New Zealand
- Assumptions:
  - Solutions already exists (integration/translation)
  - It’s all about systems
  - Simplicity can lead to complex behaviour
- Started analysing ecosystem or Life’s Principles



Beetle vs. Candy Wrapper

Advertising
Moisture management
Adhesion
Tearability
Structure

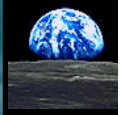
"a composite of polysaccharides whose functions are achieved by altering the shape of the polymers, their alignment, and how they are bonded together"

"75-gauge polypropylene/ink/adhesive /60 gauge metallized-oriented laminate"

Patterns from Nature

Multi-Functional Materials

- **Problem:** Why do living systems structure common materials to meet a broad range of requirements, while we rely on chemistry?
- **Drivers:** Energy may be the most constrained resource in natural systems.
  - "*… in technology, the manipulation of energy can account for up to 70% of the solutions to technical problems, whereas in biology energy never figures more than 5% of the time.*" (Vincent, May 1/2007)



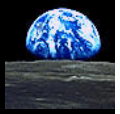
Multi-Functional Materials …

- **Therefore:** We should emphasise information over energy, utilising inherent structure
  - "*In technology we are outside the system. We destroy the information in the material (e.g. by processing, melting etc) then impose a new set of information (flow, moulding, casting) in order to end up with a product. … In biology we are inside the system … and the general scheme is to USE the information to generate the shapes / functions.*" (Vincent, May 1/2007)
- **But:** Our benign manufacturing skills are limited, and we lack tools to analyse the quality of material and information flows

Patterns from Nature

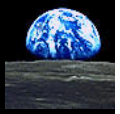
“Conducive to Life”

- **Problem:** Healthy ecosystems evolve into balanced, rich, diverse and vibrant communities of species, often displaying interdependent, cooperative or symbiotic behaviours, *in spite* of natural selection.
- **Drivers:**
  - Natural selection works on organisms (no generally accepted theory at the ecosystem level)
  - “Survival of the fit” suggests competition, not cooperation/interdependency



“Conducive to Life” …

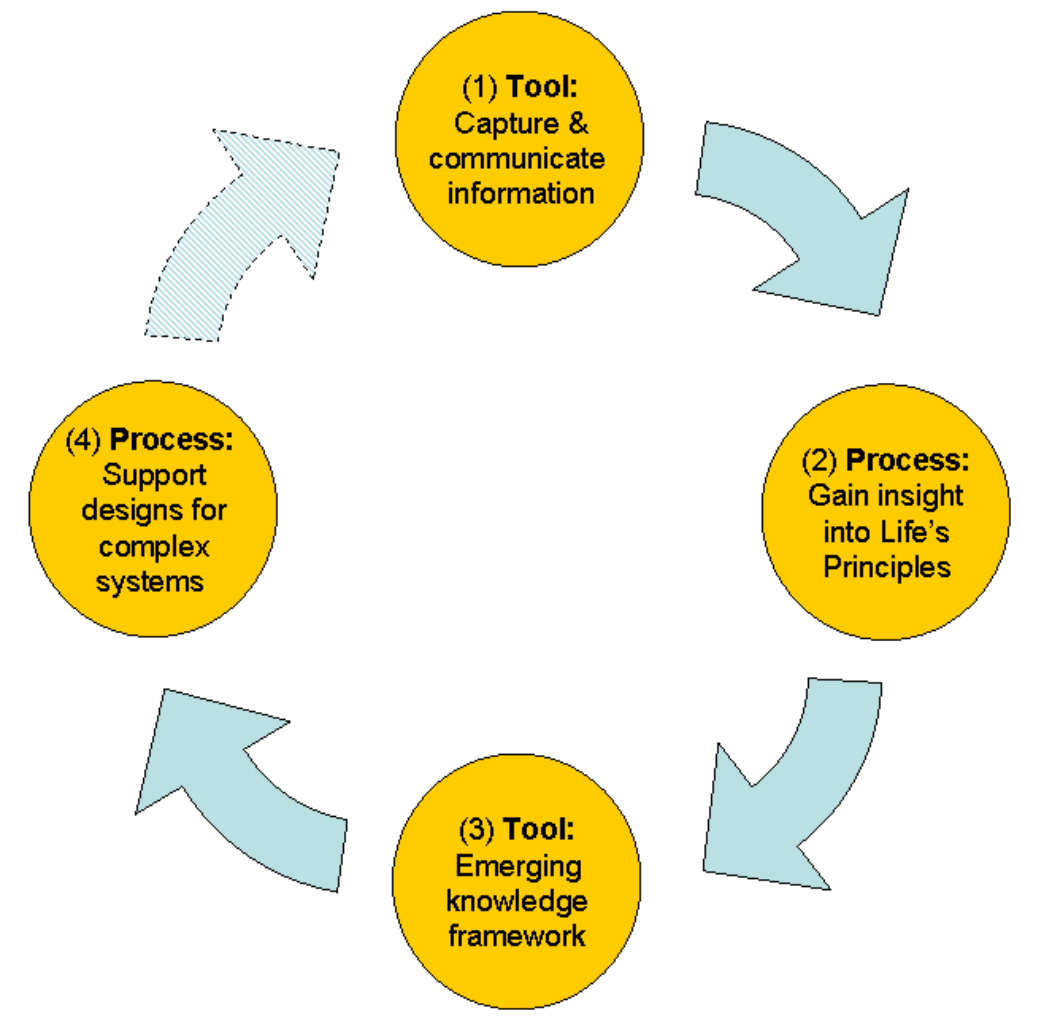
- **Therefore:** Explore non-equilibrium thermodynamics and self-organising systems to identify the principles and enablers of complex, emergent systems.
- **But:** The mechanics of how systems self-organize is unclear, and we lack the tools to analyse complex systems.



Are There Limits to Energy?

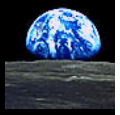
- "*… in technology, the manipulation of energy can account for up to 70% of the solutions to technical problems, whereas in biology energy never figures more than 5% of the time*." (Vincent, May 1/2007)
- Increasing energy flows can push system past criticality into a chaotic or turbulent state
- Has our use of energy pushed our systems into a chaotic state, requiring ever more stringent controls to enforce stability?

Insights



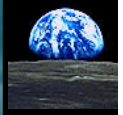
Pattern Language Can Provide…

- A way of thinking about:
  - **Problems** (rather than solutions)
  - Problems/solutions in a **systems context**
- A way to facilitate inter-disciplinary collaboration.
- A future framework for innovation that can extend from basic principles to a rich set of implementation examples.



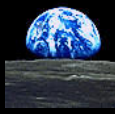
Acknowledgements

- Psychological Inertia:
  - © D. Mann: Hands-On Systematic Innovation
- PAX, Bionic Concept Car & Life's Principles:
  - D. DeLuca, © Biomimicry Guild
- Structure of a Pattern:
  - F. Salustri, Using Pattern Languages in Design Engineering"
- Pattern Language:
  - B. Appleton, Patterns and Software: Essential Concepts and Terminology



Acknowledgements …

- The Conservation Economy:
  - © Ecotrust, http://conservationeconomy.net
- Julian Vincent quote:
  - Biomimetics Listserver post
- beetle: © Igor Gorelchenkov – FOTOLIA
- candy bar: © Marc Dietrich – FOTOLIA
- Jack Goldstone quote:
  - J. Diamond, Guns, Germs, and Steel



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