Using Curiosity for Innovation Jacquelyn K. Nagel, Ph.D.



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Spot the Lie Game

 Using the Zoom polling feature, choose which of the three technologies is NOT inspired by nature....

- 1. Hook and loop fasteners
- 2. Photovoltaic solar cells
- 3. Color displays viewable in sunlight





practice Curiosity

Spot the Lie Game

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Learning Outcomes

Attendees will be able to...

- Articulate the fundamentals of bio-inspired design
- Identify and overcome common issues for applying biological inspiration during problem solving

4

• Recognize the potential for application of nature-inspired innovation in their industry







About Me

Jacquelyn K. Nagel, Ph.D.

- Engineering Faculty | Bio-inspired Design Researcher & Consultant
- My research focuses on bio-inspired design process & pedagogy

5

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What is bio-inspired design?

- The process of studying nature to solve human problems.
- The focus is not on what we can extract from the natural world, but what can we LEARN from nature.
 - Physical characteristics (form, structure, surface, material)
 - Non-physical characteristics (function, process, system)

7

 Leads to the discovery of unconventional solutions to problems that are often more efficient, economic and elegant.



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Chameleon tongue inspired gripper: adaptable to different shapes, no extra energy used for holding







Learning from Nature to Innovate



 Butterfly scale inspired low power color displays



 Sharkskin inspired antibacterial surface pattern for medical equipment

9





 Termite mound inspired sustainable building design









Bio-inspired Design Process









Achieving innovation is not without pitfalls, but there are approaches that can assist with overcoming them.

11

Common pitfalls:

- Using requirements to express the problem
- Endlessly searching for a perfect match
- Assuming the solution must look like the biological inspiration
- Getting lost in the process of bio-inspired design









Reframing Pitfall: Using requirements to express the problem

- Designers might give up too soon because it seems there are no relevant biological systems for the problem
- <u>To overcome the pitfall</u>: abstract the problem by expressing it in general language; develop questions to "ask nature"; think in opposites; come up with multiple phrases

How might you reframe this problem: Reduce the energy needed to mix liquids in tanks by 10%.

13





Reframing Pitfall: Using requirements to express the problem

14

Some answers might be:

- Low energy mixing
- + How does nature mix liquids?
- How does nature create fluid flow?
- Low energy vortex formation
- Does nature push or pull liquids in a vortex?
- Pulling liquids into a vortex



PAX Impeller: Pulls rather than pushes liquids, reduces energy usage up to 30%



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Identify Pitfall: Endlessly searching for the perfect match

- Designers can get stuck looking for the "right" biological system; one that is identical to the problem
- <u>To overcome the pitfall</u>: Recognize that a single biological system can inspired solutions to multiple different problems; Focus on connection making through analogies











Identify Pitfall: Endlessly searching for the perfect match

 Butterfly wing scale structural color properties have inspired solutions to problems dealing with light & superhydrophobic properties have inspired a self-cleaning surface solution





Using available sunlight to create vivid colors

Eliminating chemical dyes from colored fabrics



Improving silicon solar cell lightharvesting performance



Designing functional surfaces that are selfcleaning









Transfer/Apply Pitfall: Assuming the solution must look like the biological inspiration

- Designers can fixate on observable biological system characteristics and force them into the design
- <u>To overcome the pitfall</u>: Investigate a range of physical and non-physical biological system characteristics as form is coupled to function



19

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Considering the seven categories of biological information reduced fixation on physical forms







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Process Pitfall: Getting lost in the process of bio-inspired design

22

- Designers can get discouraged due to the iterative connection making; wondering "I'm I doing this right?"
- To overcome the pitfall: Use a visual guide based in design theory to structure thought processes allowing the focus to be on the discovery of biomimetic innovations





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Dr. Nagel, Dr. Pitaparti, Dr. Rose, Dr. Beverly © 2019





Using the BID Canvas has resulted in more realistic and feasible solutions than prior methods









More imitation

More inspiration







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Closing Remarks

- Bio-inspired design is a disruptive approach to innovation that thrives on curiosity.
- Reframing the problem using abstractions or opposites can help with identification of relevant biological inspiration.
- There is no "right" biological inspiration.
- Inspiration is derived from a diverse set of biological system physical and non-physical characteristics.
- Using a visual guide of the bio-inspired design mindset can improve connections between biology and engineering for problem solving.









Thank you for your time and attention!

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Please visit my website for access to some the resources mentioned in this presentation.

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Take the WE20 survey! Scan the QR code with your phone camera.







What questions do you have?

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