**Challenge to Biology Methodology**

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| SCOPING | IDENTIFY | **Identify the real challenge:**  Don’t ask “what do you want to design?” (for example, design a plastic drink bottle recycling program for the Park) but ask “what do you want your design to do?” (you want to reduce the amount of waste that goes to the landfill).  Ask WHY multiple times (challenge: visitors use a lot of plastic bottles and throw them away)   * *Why do they use plastic bottles?* Because they need to hydrate. * *What do they need to hydrate?* Because they exert themselves in a dry, warm climate. * *Why do they exert themselves?* Visitors want to climb the sand dunes and need to carry a beverage with them. * *Why do they need to carry a beverage?* Because the sand dunes are a distance away from the water fountains.   So you want a design that will provide portable hydration to visitors without creating a waste. |
| Identifying the real challenge is just good design practice, independent of turning to Nature and is worth learning how to do well. By asking what you want your design to do (identifying the function), your potential solutions space broadens significantly. |
| DEFINE | *Develop a Design Brief for the Needed Function* |
| Define Operating Parameters (define the context for your design)   * “Climate” conditions (e.g., wet dry, cold, hot, high/low) pressure, highly variable, high/low UV, etc…) * “Nutrient” conditions (e.g., nutrient poor or rich, lots of $ or small budget) * “Social” conditions (e.g., competitive, cooperative) * “Temporal” conditions (e.g., dynamic, static, growing, aging) |
| *Integrate Life’s Principles into the Design Brief*  Before you begin designing, it’s important to not only determine up front what functions and context the solution must reside in, but to make a sustainable design commitment by also incorporating each of life’s principles into the design brief. By deciding up front that each of these is important, subsequent efforts are more likely to result in sustainable solutions.   * Evolve to survive * Be resource (material and energy) efficient * Adapt to changing conditions * Integrate development with growth * Be locally attuned and responsive * Use life-friendly chemistry |

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| DISCOVERING | BIOLOGIZE | Biologize the question   * Identify functions (i.e., purpose, role, or use) *Provide portable hydration.* * How does nature do that function? *How does nature provide portable hydration?* * How does nature not do that function? *How does nature eliminate the need for hydration?* * After defining operating parameter (context) ask “How does nature do that function HERE. In these conditions? *How does nature provide portable hydration in the San Luis Valley?* * Reframe with additional keywords. | | |
| DISCOVER | Find the best natural models   * Go for a walk outside   + Find organisms/ecosystems that are doing what you want to do   + Observe closely, and note all the strategies you can find and where you found them   + Practice the art of listening and discovering rather than hunting and searching. Sometimes life reveals itself when you least expect it. * Think about your biological lens as you search. Different lenses will have different values depending upon your question, how you are discovering biological strategies and which iteration of the methodology that you are on. If one lens does not work, try another. * Consider both literal and metaphorical models. While it may appear that nature doesn’t do exactly what you want your design to do, it probably has much to offer if you consider the function and the context metaphorically. Consult the taxonomy at Asknature.org for ideas if you get stuck. * Comb the literature   + Find champion adaptors by asking “who’s survival depends upon going what I want to do?”   + Look for the truly challenged: find organisms that are most challenged by the problem you are trying to solve, but remain unfazed by it. (i.e., find the organisms that has developed a unique strategy to reduce the need for hydration in the semi-arid climate of the San Luis Valley).   + Look in extreme habitats (at both ends of the spectrum, e.g., desert and rain forests)   + Turn the problem inside out and on its head (e.g., if looking for a way to provide portable hydration don’t only look at organisms that survive in desert areas, look also at organisms than live in climates that have too much water and must dehydrate their surroundings to survive)   + Read popular natural history literature, textbooks, and internet sites to get a cross-taxa “amoeba-through-zebra” perspective. * Brainstorm with biologists   + Find naturalists and biologists at your local university, natural history museums, zoos, botanical gardens, nature centers, land management agencies.   + Consult the AskNature.org data base created by biologists for designers and engineers. | | |
| ABSTRACT | *Identify the core design concept* used by each of your natural models to accomplish a function. Try to describe the concept without using biological terms. Imagine needing to define the strategy your model uses to your design team, without revealing your model as the source. If abstracted well, a designer should be able to emulate that concept within another design. E.g., a design concept for the function of providing portable hydration, in non- biological terms may be “maintain physical integrity and protect from abiotic factors that affect the loss of liquids.” | | |
| *Create a taxonomy.* Specific to your desired function and context, what does each strategy have in common? How are they different? Play with different forms of clustering until you find the combination most relevant. | | |
| CREATING | EMULATE | Play and design   * Brainstorm with multiple solutions (have fun, be creative, and filter later) * Refer back to the discover phase for more details as needed * Have a deep conversation with your natural teacher; how does it address the challenge? | | |
| Deepen the conversation | | |
| Are you mimicking form?   * Find out the details of the morphology * Consider scale effects * In what context does the form function? | Can you mimic the process?   * Find out the details of the biological process * Consider scale effects * In what context does the process function? | Can you mimic the ecosystem?   * Find out the details of the ecosystem conditions * Consider scale effects * In what context does the ecosystem function? |

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| EVALUATING | EVALUATE | Spot check your design with Life’s Principles (i.e., practice deep or holistic biomimicry)  Continue to question your solution; identify further ways to improve your design and develop new questions to explore; move around the design methodology again with your new questions. |
| Is the design **locally attuned and responsive**?   * By using readily available materials and energy? * By cultivating cooperative relationships? * By leveraging cyclic processes? * By using feedback loops?   Is the design **resource (material and energy) efficient**?   * By recycling all materials? * By fitting form to function? * By using multi-functional design? * By using low-energy processes?   Does the design us **life friendly chemistry**?   * By doing chemistry in water? * By building selectively with a small subset of elements? * By breaking down products into benign constituents?   Does the design **integrate development with growth**?   * Does it combine modular and nested components? * Does it build from the bottom up? * Does it self-organize?   Does the design **adapt to changing conditions**?   * Does it embody resilience through variation, redundancy, and decentralization? * Does it incorporate diversity? * Does it maintain integrity through self-renewal?   Does the design **evolve to survive**?   * Does it replicate strategies that work? * Does it reshuffle information? * Does it integrate the unexpected? |
| ***THANK NATURE FOR THE INSPIRATION!*** | | |