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Design Brief

Title
Biospire Insect Catcher

Description
The Biospire Insect Catcher is a bug catcher for kids that allows kids to take part in observing and participating nature without encouraging them to disrupt it.
It will help them capture, study, and release bugs safely and in a way that doesn't harm the insects.
It may or may not have electrical components. It should have a magnifying component so that kids can see the insects up close and personal.
It should come in a kit with accessories for different kinds of bugs or different kinds of situations.
The accessories should not be floating but should nest or attach to the main body of the insect catcher.
The insect catcher should be rugged enough to use and be left outside. It should be easy to clean, and all components that could possibly contain an insect should be completely see-through so that supervising adults can be sure that the catcher is empty before storing it away.

The company name and business
Biospire Toys

The purpose of the design
Help inspire future entomologists
Allow kids to study insects closely
Get kids outside
Keep kids (and insects) safe as they study insects

The aim or goals of the design (e.g. generate sales, modify behavior)
Allow kids to play with bugs in a way that doesn't teach children to harm the environment
Inspire the future leaders of entomology
Enable curious minds to study insects
Create an insect catcher that is good for the consumers and good for the planet
Keep kids safe
Keep bugs safe

The target consumer, user, or audience for the design
Ages 8-12, boy or girl
Their parents

Any values or messages you want the design to communicate

Insects are crazy cool!
They were here first, and they'll be here after we're gone. Study them, enjoy them, but respect them and their homes.
Sometimes insects are cool to look at, but sometimes it's better not to touch them
Anyone can study insects

The context or operating conditions within which your design will function

The design will need to be sturdy enough to survive the treatment of a 8-year old, and leaving it outside all night or all day.
It will also need to be able to contain live insects in a way that keeps the insects alive, but prevents them from escaping.

Examples of existing similar designs

Discovery Kids Outdoor Adventure Bug Collector

Weather Wiz Kids Bug Collector Kit

Chad Valley Insect Catcher Kit

Timeframe for completion

5 weeks

Any constraints or non-negotiables

Captures insects non-violently with low-to-no energy
Can't break easily
Can't kill the insects
Can't let insects escape on their own
Leaving the toy outside can't compromise the design.
Doesn't need to be waterproof, but getting it wet shouldn't break it
Easy to clean out

Design Process

Cycle 1

Identify:

What do we want it to do? We want it to suck up insects.

Translate:

How does nature capture small organisms? (Function #1)

Discover: Strategies available (3 strategies for function #1):

The Bladderwort

The bladderwort is a tiny underwater carnivorous plant that uses a vacuum action to suck its prey into its special leaves. The chamber-like leaves of the bladderwort are equipped with a special gland the pumps water out of the chamber, creating negative pressure inside. The door to the chamber is rigged with sensitive bristles. If a small creature disturbs these bristles, it misaligns the door, creating an opening through which water may rush into the chamber, equalizing the pressure, and sweeping the prey into the chamber with it. The bladderwort then excretes digestive enzymes to break down the prey.

Marsh pitcher

The marsh pitcher captures its prey passively. The leaves of the marsh pitcher curl to form a pitcher, which collects rainwater, with a small, nectar-producing hood above. The insects, inspecting the plant for more nectar, travel down into the plant pitcher where long, slippery hairs prevent the insect from climbing back up. As the insect slides down, it reaches a point in the plant pitcher where there are no hairs. Instead, the plant wall is slick and waxy. The insect can no longer climb out. It falls into the water where it drowns. Bacterial decay dissolves the insect into the water, and the pitcher absorbs the nutrients.

Blue whales

The blue whale, like many large whales, eats only tiny sea creatures called krill. The whale's mouth is equipped with baleen, sheets of horn, feathered at the end, that create a filter in the mouth of the whale. The whale sucks in a mouthful of water, bringing the krill in with it. The whale then pushes its tongue forward to expel the water and trap the krill in the baleen.

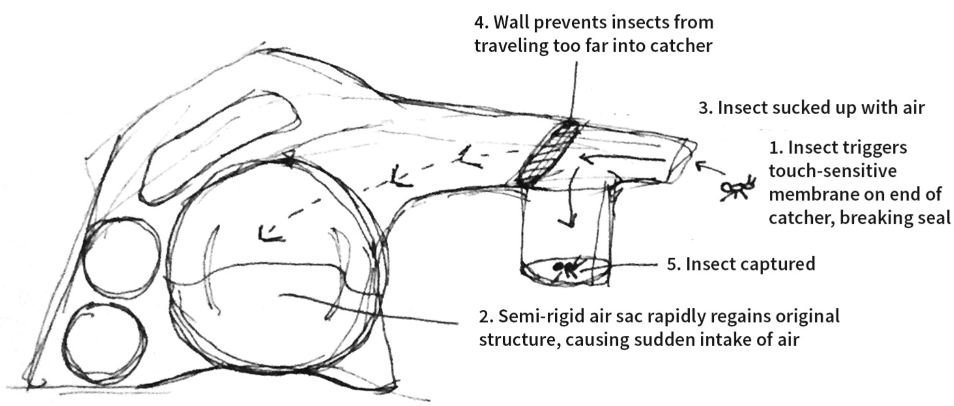
Strategy selected

Bladderwort

Abstract

Depress/deflate a spherical, semi-rigid air sac to forcefully expel air. The spherical walls of the air sac, once depressed, invert on themselves, leaving the air-sac in a state of tension, as the walls will want to re-invert on themselves to resume the original structure. The touch-sensitive membrane blocks the end of the product's tube, preventing air flow back into the air chamber. Touching an insect with the end of the product tube will dislodge the membrane, breaking the seal, and inducing the sudden intake of air.

Emulate



Evaluate

This first cycle resulted in only a slight adherence to Nature's Principles. While it does not fully meet any one of nature's principles, it does perform functions with minimal materials and energy by using the power of air pressure to capture the insects. Additionally, this air pressure equalization operates on a feedback loop by "inhaling" only as much air as would allow the air sac to regain its original form, and it responds to the feedback of an insect brushing up against the touch-sensitive membrane on the mouth of the chamber.

Cycle 2

Identify

What do we want it to do? We want it to capture living organisms in a different way (for variety and redundancy.)

Translate

How ELSE does nature capture small organisms?

Discover

The Marsh Pitcher

The marsh pitcher captures its prey passively. The leaves of the marsh pitcher curl to form a pitcher, which collects rainwater, with a small, nectar-producing hood above. The insects, inspecting the plant for more nectar, travel down into the plant pitcher where long, slippery hairs prevent the insect from climbing back up. As the insect slides down, it reaches a point in the plant pitcher where there are no hairs. Instead, the plant wall is slick and waxy. The insect can no longer climb out. It falls into the water where it drowns. Bacterial decay dissolves the insect into the water, and the pitcher absorbs the nutrients.

Ant lion sand pit

The ant lion digs a hole in lose sand and launches any excess sand out, leaving a crater that is just steep enough that any wandering ant will fall in with the tumbling sand.

Blue whale baleen plates

The blue whale, like many large whales, eats only tiny sea creatures called krill. The whale's mouth is equipped with baleen, sheets of horn, feathered at the end, that create a filter in the mouth of the whale. The whale sucks in a mouthful of water, bringing the krill in with it. The whale then pushes its tongue forward to expel the water and trap the krill in the baleen.

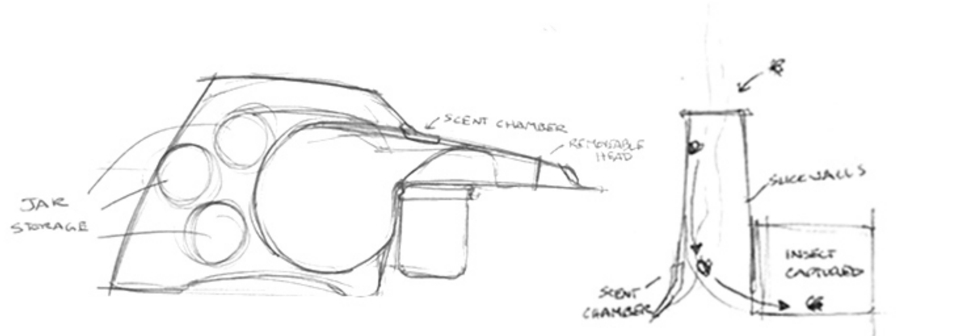
Strategy selected

Slippery edges of the Marsh Pitcher Plant

Abstract

Vertical chamber rigged with scented lure. Insects investigate lure. Climb further into vertical chamber. Further down the chamber, interior walls covered with slick wax that prevents climbing back up. Insect slides down into removable jar for inspection.

Emulate



Evaluate

This second iteration of the insect catcher helps enforce the reusability of the product, but the biggest change this addition makes is that the product functions are now redundant.

Cycle 3

Identify

What do we want it to do? We want it to stay clean.

Translate

How does nature repel dirt? How does nature clean itself? (Function #2)

Discover: Strategies available (3 strategies for function #2)

Gecko

The skin of the gecko is covered with tiny microstructures called spinules that collect water into larger droplets. The energy of the water being collected propels the drops of water off the gecko, keeping the gecko clean.

Lotus Leaf

The surface of the lotus leaf is covered in microstructures that cause the water to collect in beads as opposed to sticking to the surface of the leaf

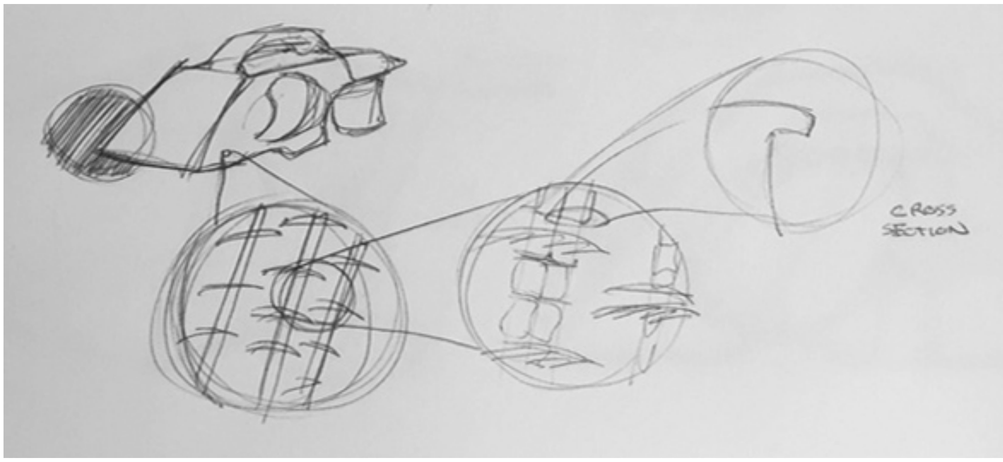
Springtail

The skin of the springtail has three layers of protection. First, the skin is covered in tiny bristles that create a layer of air around the skin. Second, the skin is covered in tiny bumps that prevent water from collecting. Finally, each bump has a microscopic overhang that prevents fluids from progressing.

Strategy selected

Springtail

Abstract
Surface covered in three-tiered defense system. First level, tiny bristles create air pockets that deflect larger particles, like water. Second level, geometric bumps prevent any contaminants from collecting. Finally, each bump has a small overhang, which prevents any fluids from progressing further

Emulate


Cycle 4

Identify
What do we want it to do? We want it to stay clean.

Translate
How else does nature stay clean?

Discover

Plant cuticles
Many blooming plants have a waxy layer of “skin” that protects the plant from losing moisture as well as from microbial infections.

Gecko skin
The skin of the gecko is covered with tiny microstructures called spinules that collect water into larger droplets. The energy of the water being collected propels the drops of water off the gecko, keeping the gecko clean.

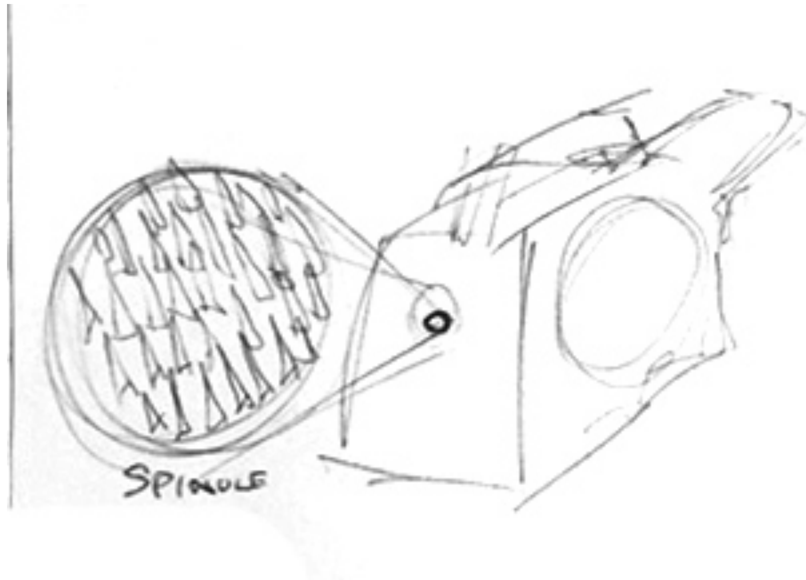
Blue Morpho Butterfly
The wings of the Blue Morpho Butterfly are covered in scales with tiny ridges that prevent water from sticking. As water collects in beads, the natural adhesion of the water picks up any loose dirt particles. Once the butterfly tilts their wings, the water rolls off, bringing the dirt with it.

Strategy Selected
Gecko skin

Abstract

Surface covered in tiny spires that prevent water from collecting. Water collects into little beads, which then easily roll off the surface, or "bounce" off the surface due to the energy of the water collecting.

Emulate



Evaluate

The fourth iteration of this design is really starting to capture more of nature's principles. This most recent addition helps to keep the product clean in more than one way. The difference could be between materials (for instance, the harder shell material could utilize one style of self-cleaning structure, where as the softer air sac material could use another)

Cycle 5

Identify

What do we want it to do? We want it to utilize local materials

Translate

How does nature leverage local materials? (Function #3)

Discover

Strategies Available (Strategies for function #3)
Hermit Crab: The Hermit Crab makes his home in a small shell. As the crab grows, it must move to a larger shell, meaning that the crab constantly upgrades from one discarded shell to another
Bird nests: Many birds construct their nest from the resources immediately available to them—anything from old newspapers to cassette tape to human hair
Hornet nests: Hornets chew up wood pulp and mix with their saliva to create a paper that they use to create the walls of their nests

Strategy Selected
Hermit Crab "moving in" to new, larger shells

Abstract
Use what's available. Allow for various kinds of jars to be used for capturing insects.

Emulate

Evaluate
This fifth iteration really drives home the life's principle focused on being locally attuned and responsive by allowing the product to use any kind of jar that the child might be able to find (and old peanut butter jar, or an old mason jar). This way, the jars can be reused, and they are already part of an existing recycling stream.

Team Evaluation
With the assistance of two colleagues, the product was evaluated more comprehensively against Life's Principles. The following features and suggested revisions were identified.

Cycle 6

Identify
To improve the BioSpire Insect Catcher, we will need to

Find a life-friendly material
Find a self-healing material
Design the product to disassemble/reassemble easily
Include app as local insect guide
Generate concepts for add-ons as well as an expanded product line

While many of these proposed improvements could be translated into biological functions for the sake of discovering a biomimetic solution, for the sake of brevity, one function will be selected for a fully biomimetic design cycle. The other cycles will be abbreviated and summarized in the conclusion.

Selected Function

Find a self-healing material

Translate

How does nature heal itself?

Discover

Bones

Bones respond to fracture by reabsorbing bone material and synthesizing a new matrix. The process takes about 4 months.

Starfish

The ossicles of starfish resist fracture as a result of microscopic holes in the structure. Should a fracture start in the material, the tear will immediately cease as soon as it encounters one of these holes. This allow the material to resist tearing, but also avoid the brittleness of more rigid materials.

Pipevines

Pipevine stems repair tears by surrounding cells that swell into the fissure to seal it.

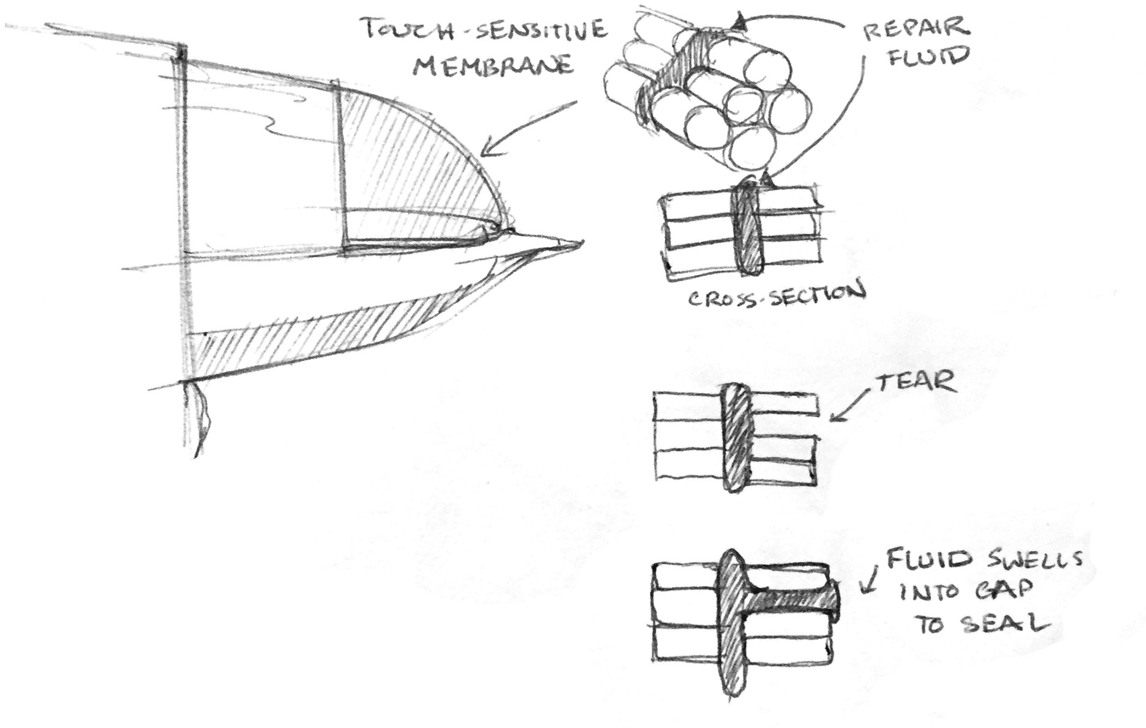
Strategy Selected

Pipevines stem repair

Abstract

Compose the membrane with tiny cells that swell and congeal upon rupture

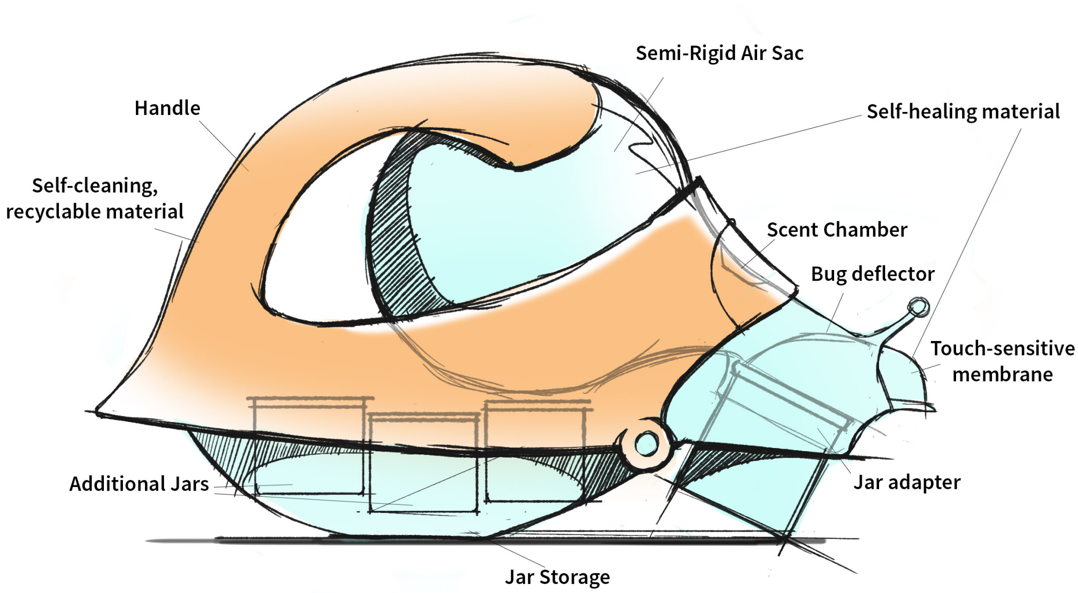
Emulate



Evaluate

Adding the self-healing feature to the semi-rigid membranes of the air sac as well as the front end of the insect catcher will help the product to meet some of the remaining Life's Principles.

Design Presentation



With that, I present the latest iteration of the Biospire Insect Catcher. Unlike many other insect catchers, the Biospire Insect Catcher doesn't use a motorized fan to suck the insect up into the device. Instead, the Biospire Insect Catcher uses the rigidity of a depressed spherical air sac to rapidly draw air into the device, capturing the insect in the process. This enables the user to capture the insects with little-to-no energy, and the process can be repeated without replacing batteries or electrical components.

Additionally, the Biospire Insect Catcher can be set up on end and used as an insect trap. Place a single drop of honey in the Insect Catcher's scent chamber, and the smell will attract insects into the vertical throat of the product. As they climb down, the insects will be unable to stick to the slick walls, and they will slide down into jar where they can be removed and investigated.

As for product flexibility, the Biospire Insect Catcher comes with three jars for catching insects, but it also comes with a size-adjusting mouth, meaning that jars of just about any size can be used to capture and study insects. Finally, the surfaces of the Biospire Insect Catcher have been designed for self-cleaning using the microstructure strategies of the Springtail and Gecko, so dirt and grime should slide right off with a quick rinse.

The Biospire Insect Catcher is about half-way to being able to emulate each of Life's Principles. Right now it is locally attuned and responsive in the way that it allows the option of using local materials (jars) and responds to feedback (in refilling the air sac as well as in triggering the touch sensitive membrane). It also optimizes rather than maximizes in that the processes take minimal energy, it integrates multiple functions, and it can use recyclable materials. It can also integrate cyclical processes in its reusability as well as it's ability to utilize jars of any kind again and again. However, it needs further development before it can completely emulate the remaining principles.

The Biospire Insect Catcher is the first step towards fostering a sustainable entomological spark in today's children. With its powerless insect catching and its chemical-free cleaning and jar reusing abilities, the Biospire Insect Catcher provides a dynamic, exciting, and sustainable alternative to other insect catchers on the market today.

Design Proposal

The basic functions of the product have been explored. However, based on the progress of the project so far as well as the evaluation against Life's Principles, suggested next steps include investigating environmentally-friendly, locally available, and recyclable materials for manufacturing the product, including a downloadable field e-guide based on user location, and extending the product line to include other means for users to capture insects (nets, traps, etc). Additionally, the product could be designed so that users could upgrade or repair individual components of the product (larger, quicker, or newer air sac, or a mounting system for larger or more jars). This would provide the user with additional value and extended product life.

Should Biospire choose to continue pursuing this project, the proposed timeline would be as follows:

2 weeks: draft concepts for extended product line

1 week: revise Biospire Insect Catcher for modularity and upgradability
>4 weeks: create downloadable field guide (possibly an app) for users to identify insects