Bio-Inspired Design SBF Critter Cards

(beta)

NOTE: This document describes how to use the critter cards contained in the pdf *BID Critter Cards*. To use the cards, fold along the vertical axis so that one side has Environment (ocean, urban, etc) and the other shows the diagrams.

**Some Small Group Activities**

1. **Analyzing Animals**

through lenses of Structure, Behavior, and Function (SBF)

1. **Generating Design Solutions**

solving human problems using BID SBF

1. **Generating Human Problems to Solve**

using BID SBF as scaffold

1. **Researching and Designing Cards**

for other animals - using BID SBF Tall Cards as a model

Cards included in set are Bat, Crow, Elephant, Octopus, Shark, Yellow Jacket

* Fronts with illustration (S), name, biome, behavior questions (B), function category logos (F)
* Backs with annotated diagrams organized by function (F) to explain how problems are solved using SBF.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ACTIVITY 1**

**Analyzing Animals** – through lenses of Structure, Behavior, and Function (SBF)

*This activity gives students practice in describing animal adaptations and properties and in linking these properties to the environment.*

Students sit in small groups of 3-6. Each selects an animal card (or two).

Students familiarize themselves with their own card, its front and back. Then they put card on table facing up.

BIOME

L (Leader) says: With backs down, organize your cards by biome.

Q. How do you think that the specific environments of your animal affect their behaviors? Could an elephant, for example exist in an urban environment? Why or why not?

A: Environment affects animal in many ways, what they eat and how they eat, how they sleep, how they conserve energy, hunt and escape…

STRUCTURE

L: With backs down, organize your cards by animal **size** from smallest to biggest.

Q. How do you think each animal’s size affects its behavior in that environment?

L: Sort your cards by **color**.

Q. What role might color play in these animals’ behavior?

L: Look at animal illustrations.

Q. What **parts** do animals have in common? Sort them according to each part. Who has legs, mouths, eyes, skin…What parts are different? Who has wings, feathers, scales…

FUNCTION

L: Why might the animals have these parts that are similar and different? What functions does it help them perform to survive? Leader listens and helps to categorize these functions into these categories.

* All **sense** the environment, in different ways
* All have **efficient** systems of converting matter to energy and expelling waste, in different ways
* All have systems of **mobility**, that work differently
* All **cooperate** with their environment or with other animals, in different ways
* All **defend** themselves from danger, in different ways

Note that logos on card fronts help to categorize the function – or problem being solved

BEHAVIOR

L: Let’s look at how animals, with their unique structures, behave to solve these different types of problems. Let’s tackle, for example, the problem of SENSING. Align all the cards that solve problems of sensing – line up the sensing icons and their questions. Don’t turn them over yet.

 If you are the player with the first card in the set, read your card’s sensing question to the group.

 Other players at the table, talk together to hypothesize your answer. How is the animal behaving with its structures to perform this function?

 Propose a hypothesis: “I think the shark uses \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (S,B) to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (F).”

 The card owner should then flip over the card to allow the players to check their answers. Invite all to explore alternate answers as well.

This can continue with each function category, aligning cards, and hypothesizing to familiarize all players with how animals are designed to solve problems using the language of Structure, Behavior and Function.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ACTIVITY 2**

**Generating Design Solutions** –– solving human problems using BID SBF

*This activity helps students to understand animal adaptations are designed to address specific challenges (problems), which can then be used to solve human problems. The students have to understand the “function” of the adaptation and make analogies to similar human problems. The cards show different ways animals accomplish similar functions, helping students to compare and contrast.*

L: Let’s use our knowledge to solve human problem of COOPERATION, for example.

Look for the cooperation logo, and lineup card logos that solve problems using cooperation.

Hypothesize answers to the cooperation questions as a group, as you did in Activity 1.

Chart answers in this form to compare.

\_\_\_\_\_\_\_\_\_\_\_\_\_ (animal) uses \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(S) to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_ (animal) uses \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(S) to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_ (animal) uses \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(S) to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_ (animal) uses \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(S) to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

For example:

Bat uses blood and feeding system to share blood and improve health

Crow uses voice to call to other animals

 other sharp toothed animals to cut through thick skin’s prey

Elephant uses relationships with other animals to provide tools and skills for defense

Yellow Jacket uses experts, roles and mentoring to build community success

Now that we know how animals solve problems, let’s look at how they might suggest ideas for solving a specific problem of human cooperation.

THE DESIGN BRIEF

Challenge: Classroom Management

You have a problem with an unruly class. Students have come in with diverse skills. Some are good at spelling, and boast loudly about their skills, for example, when others are just learning to write. Some students have a lot of resources at their disposal, others are struggling just to get to class each day. The principal shares that new resources just might be available soon, but he’s looking to you for suggestions to invest in for greatest impact – if your classroom can just be more cooperative!

Work towards a BID solution by looking at your chart and considering

1. What **behaviors** might you aspire to with your class? Think of all the possible stakeholders.
2. What **structures** might you design to bring these about? They could be furniture, wearables, apps, organization charts, mentorship systems; think broadly as you explore possibilities.

Work with your table group to design a variety of possible solutions to your classroom’s cooperation problem in the next 5 minutes. Use paper and pencils to describe your designs. Consider the use of quick annotated diagrams to explore possibilities while you work.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ACTIVITY 3**

**Generating Human Problems to Solve** - using BID SBF as scaffold

*This is the reverse of the activity above; using a human challenge and then understanding what animals might help solve the problem. But the learning objectives are more or less the same.*

This SBF BID structure can prove to be very helpful in generating new ideas to solve human problems as well. To explore this, let’s look at human problems categorically. What human problems result from a lack of SENSING, for example?

We’ll begin by looking at how our animal friends behave to sense the environments around them.

Line up the cards, read the SENSING questions, hypothesize and check answers as you did in Activity 1. Chart discoveries as you did in Activity 2. Example for leader:

Bat uses changing ear shapes to capture and filter sounds

Elephant uses feet and skull to make and ‘hear’ vibrations

Shark uses electroreceptors to detect visibly hidden objects

Yellow Jacket uses multiple data points to find way

Now, think about human situations where sensing becomes a problem, where perception, for example, might be impaired. Consider different environments, outside in the city, in the classroom, in a bar…. Make a list of SENSING problems to solve.

Example for Leader:

Possible SENSING Human Problems may include

* Traffic accidents – can’t see cars coming, can’t hear them, limited night vision
* Aging populations – losing sensory perception but want to age in place
* Microphones – capturing too many ambient sounds
* Blind populations – seeking mobility through public transportation in the city
* Bar conversations – miss hearing important information due to volume

Then to solve these, one can use previous processes.

1. What behaviors might help?
2. What structures?

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ACTIVITY 4**

**Researching and Designing Cards** for other animals - using BID SBF Critter Cards as a model.

*This is a great activity to extend, explore. Students can do basic research as well as practice visualizing/drawing. You can give students animals of different sizes, biomes, use different or related species to highlight comparisons and contrasts. We provide a template (Blank Critter Card) to help*.

What other animals solve similar problems in interesting ways? Think of ones that would contribute significantly to your BID conceptualizing. Do you want more solving problems of cooperation, mobility, efficiency, defense, or sensing?

Begin by researching animals and their behaviors. What problems are they solving that intrigue you?

Make a chart listing the animals, and the behaviors and structures they are using to solve particular types of problems. Make note of sources that prove helpful.

As you work, make your own original small diagrams that attempt to describe the points you are trying to make through images with only minimal words.

Propose your idea for cards by making a freehand rough draft.

Test out the use of your card with others in a small group.

Reflect: What worked and didn’t? Ask for feedback, and plan revisions.

Consider learning to use simple digital design software to fine tune your original descriptions and to allow your cards to be part of a sharable set!

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Additional Information**

Interested in staying connected regarding future BID Industrial Design work? Join our **TeachBID** Community at <http://teachbid.gatech.edu/> :the site for Bio-Inspired Design Teacher Resources.

The **Bio-Inspired Design SBF Tall Card Project** is under development by

Ann Gerondelis, Undergraduate Program Coordinator, School of Industrial Design at Georgia Tech and

Ken Kirtland, Undergraduate Research Assistant, School of Industrial Design at Georgia Tech

With support from

Marc Weissburg, Professor, School of Biology, and Co-Director Center for Biologically Inspired Design and

Michael Helms, Research Scientist, Center for Education Integrating Science, Mathematics and Computing