Innovation by Inspiration

Project 4.1.6. Biomimicry, a decision matrix, and a solution you will never build

You pick a global challenge, find an organism that already solved a version of it, and design something inspired by how it does that. Then you choose between your own ideas with a decision matrix instead of with a feeling.

WORTH 7 POINTS | DOES NOT HELP ON THE WEBXAM | RESEARCH, SKETCHING AND A PITCH | ABOUT 2 HOURS ACROSS TWO SITTINGS

What this is and why it is worth doing

Biomimicry is imitating nature's designs to solve complex problems. Not copying how something looks. Copying how something works.

HUMAN TECHNOLOGY	THE ORGANISM IT CAME FROM
Solar panel	Leaves, which collect sunlight to make energy for a plant.
Surgical glue that replaces sutures	Mussels, which make their own glue to hold onto rocks.
Search and rescue robots that squeeze through tight spaces	Spiders, and how they move through gaps.
Energy efficient skyscrapers that stay cool without power	Termite mound structure.
Antibacterial public surfaces such as bus grab handles	Cicada wings, which carry microscopic spikes that pierce and kill bacteria.
Less painful hypodermic needles	Porcupine quills.

DOES THIS HELP ON THE WEBXAM? NO, AND PLTW IS UNUSUALLY BLUNT ABOUT WHY

WebXam 072110 weighs handling, preparation, storage and disposal, and biotechnology research and experiments. This project states plainly that **no prototype is built** and that tests are only **proposed**, never run. Design without construction and without testing does not touch either weighted domain.

What it does teach, better than anything else in the pack, is choosing between your own ideas with a method instead of with a preference. That is what the decision matrix is for and it is harder and more useful than it sounds.

How long it takes and what you need first

- **About 2 hours, best split across two sittings.** The Instant Challenge and research in one, the design brief through the pitch in the other.

- **Sticky notes, chart paper or a whiteboard with markers.**
- **Coloured pencils** for the concept sketch. The sketch is a graded deliverable and it is meant to be in colour.
- **Access to research.** Current journal articles if you can reach them.
- The **Project 4.1.6 Rubric**, plus the Design Brief Template and the Decision Matrix Template from Mr. Mendoza. Read the rubric before you start, not after.
- A team is assumed. Alone is allowed. Say which.

Part one. The biomimicry Instant Challenge

You are out for a walk and you notice a hummingbird, a butterfly, a cactus, a bird hatching from an egg, and a turtle. Timed, in four blocks.

BLOCK	TIME	WHAT YOU DO
Brainstorm	5 min	Generate as many biologically inspired ideas as you can from those five organisms. What beneficial products or processes do they suggest? Record the list.
Evaluate	15 min	Before narrowing anything, decide what will drive your decision. List five to seven requirements your ideal product must meet. Is cost a concern? Is preserving the environment a priority? How many people might it help? Then cut that list to the three to five that matter most, assign scores so the most important factor carries the greatest score, and build a visual, like a rubric, showing the requirements and the ranking system.
Rank	5 min	Use your own system to score every idea on your list.
Decide	5 min	Record which idea scored best.

THE ORDER OF THAT MIDDLE BLOCK IS THE ENTIRE LESSON

You build the ranking system **before** you rank, and you build it without looking at which idea it will favour. Do it the other way round and you will unconsciously choose weights that make your favourite win, which turns the matrix into a decoration on a decision you had already made.

Afterwards, reflect honestly: did the requirements and weights you chose actually rank the ideas in the order you think is right? If they did not, that is worth writing about. Either your weights were wrong or your instinct was, and finding out which is the point.

Part two. The project

THE GLOBAL CHALLENGES

Pick one: provide all people with access to clean water, limit climate change, slow the aging process, protect human health, protect the environment, reduce hunger, or the wild card, which is any other global issue. **If you take the wild card, justify it with data showing the problem is worth solving, and get your choice approved before you go further.**

1. Choose a challenge and record the choice. Wild card gets approved first.

   Done when: a challenge is written down, and if it is the wild card, it has data attached and approval.

2. Review the Project 4.1.6 Rubric so you know what is being assessed before you invest time.

   Done when: you have read it.

3. Research the challenge. Find out who is affected and how, what different factors cause and sustain the problem, what has already been tried and how well it worked, and what criteria and constraints a solution has to satisfy. Use current sources and document them properly.

   Done when: notes exist on all four questions with sources recorded.

4. Write a **design brief** using the template. It needs a clear problem statement, a design statement saying what you will do, and **measurable** criteria and constraints.

   Done when: every criterion and constraint has a stated way of measuring it.

5. **Get your design brief approved before continuing.** Then attach the approved brief into your notebook.

   Done when: the brief has been read and approved.

6. Brainstorm solutions. Record everything and discard nothing at this stage. Then: pick which contributing factor you will address, list the essential functions your solution must perform, and go looking for organisms that have to perform the same function. **If you cannot find an organism, go back and change your contributing factor** rather than forcing a bad fit.

   Done when: a function has been named and at least one organism that performs it has been researched.

7. Build a **decision matrix** using the template. Ideas down the left. Criteria and constraints across the top. Create a rating scale, rate every idea against every criterion, and sum each row.

   Done when: every cell has a value, every row has a total, and the rating key is shown on the matrix.

8. Choose your solution by reflecting on the matrix. Attach it in your notebook.

   Done when: a solution is chosen and the matrix supports it.

9. Read the Concept Sketching resource, then draw a concept sketch of your solution in coloured pencil. Simple and clear beats detailed and unreadable.

   Done when: a coloured sketch exists that someone else can understand without you talking.

10. **You will not build a prototype.** Instead, propose the tests the Biomimicry Lab should run on your product if they select it. Be specific about what each test would find out.

    Done when: each proposed test names what it measures and what result would count as a pass.

11. Prepare Part I, a three minute oral presentation, and Part II, a one page document.

    Done when: both exist and the talk runs three minutes when spoken aloud.

12. Present the talk and the one page document to at least two people, and ask them for feedback using the Providing Peer Feedback resource. Then iterate: change your design based on what you heard, or write down why you decided not to. Either counts, refusing to do one of them does not.

    Done when: feedback was collected in writing from at least two people, and a change or a written refusal to change exists for each substantive comment.

WHAT THE TWO DELIVERABLES HAVE TO CONTAIN

Part I, the three minute talk: a summary of the challenge you chose, your approach to solving it, which contributing factor you addressed and how your solution addresses it, an explanation of how your solution was inspired by nature, and a picture of how lives change if it is selected.

Part II, the one page document: the design brief, the decision matrix, the concept sketch, and the suggested experimental design test requirements. All four, on one page.

WORKED EXAMPLE OF MEASURABLE CRITERIA AND CONSTRAINTS. INVENTED, AND NOT A CHALLENGE ON THE LIST

> Two categories, and people confuse them constantly. A **criterion** is something the design has to do to succeed. A **constraint** is a limitation on the design: time, money, resources, expertise. Both must be measurable, and measurable means you can say *how* you would measure.
>
> **Criterion.** Does not consume energy. *Measured by:* whether the product requires electricity or a battery to operate. Yes or no.
>
> **Criterion.** Works without training. *Measured by:* the fraction of ten first-time users who complete the task correctly with no instruction beyond what is printed on the device. Target above eight out of ten.
>
> **Constraint.** Costs less than 100 dollars. *Measured by:* the total cost of all materials needed to produce one unit.
>
> **Constraint.** Assembled by one person in under an hour. *Measured by:* timing one assembly, start to finish, by a person who did not design it.
>
> **Not measurable, so rewrite it:** *should be user friendly*, *should be sustainable*, *should be innovative*. None of those name anything anybody could check. Each one is a good instinct hiding inside a sentence that cannot be evaluated.

Where people get stuck

Criteria that cannot be measured.
User friendly, sustainable and innovative are the three that show up every time. If you cannot say how you would measure it, rewrite it until you can.

Building the rating system after seeing which idea it favours.
The weights get bent toward the answer you already wanted and the matrix becomes theatre. Build the system first, then apply it.

A decision matrix where every option scores nearly the same.
That usually means your criteria do not actually distinguish the options. Either your ideas are all the same idea, or your criteria are too general. Both are worth fixing.

Picking a favourite organism first, then hunting for a problem it fits.
The procedure runs the other way: name the function your solution has to perform, then find organisms that perform it. Backwards, you end up with an interesting animal and a weak solution.

Confusing criteria with constraints.
Criteria are what it must do. Constraints are the limits you work inside. Put each one in the right column.

Forgetting that no prototype is built.

You are proposing tests, not running them. Spending your time trying to build the thing means the test proposals, which are graded, end up thin.

Vague proposed tests.

"Test if it works" is not a test. Say what would be measured, on what, and what result counts as a pass.

A concept sketch nobody can read without you explaining it.

The sketch has to communicate on its own. Label it. Show scale. Use colour to separate parts, not to decorate.

A talk that runs five minutes.

Three minutes. Time it out loud, twice.

How to submit and how it is credited

THIS ITEM IS WORTH 7 POINTS

The Instant Challenge record, an approved design brief, a decision matrix, a coloured concept sketch, proposed tests, and the two presentation deliverables. About two hours across two sittings puts it above the single session items. Remember the 20 point per semester cap across all extra credit.

- **Where it goes.** The same place as everything else. Your class form on the portal, or handed to Mr. Mendoza in person. Nothing about extra credit needs a different route.
- **What to hand in.** Photographs of your work where the handout asks for them, plus your written pages. Photographs of handwritten pages are fine. A photograph you cannot read is not.
- **Put your name and period on every page and every photograph filename.** Unlabelled work cannot be credited and it is the single most common way points get lost.
- **When.** Any day after the pack opens, right up to the last week of the semester. There is no deadline inside that window and no penalty for going slowly.
- **Feedback.** You get it back with a note. If a piece is short of full credit you may fix the named thing and resubmit once.

Words this activity uses

Biomimicry

Imitating nature's designs to solve complex problems.

Design brief

A document defining the problem, what you will do about it, and the measurable criteria and constraints a solution has to satisfy.

Problem statement

A concise statement of the problem that leaves room for multiple solutions and does not imply one.

Criteria

What a design has to do to be successful. Each one measurable.

Constraint

A limitation on the design: time, money, resources, expertise, equipment.

Decision matrix

A table that evaluates several design choices against the same criteria and produces an overall rating for each, so a choice can be justified with evidence.

Rating scale

The scheme you use to score options in the matrix. A one to four rank scale and a yes or no scale are two common ones, and you may build your own.

Concept sketch

A simple drawing that communicates design intent and detail quickly, without needing the designer present.

Prototype

A working model built to be tested. This project does not build one.

Iterate

Rework a design based on feedback and go round the cycle again.