Open for Innovation

Activity 4.1.1. A timed build against criteria you cannot argue with

The Unit 4 opener. You sort innovations into categories, rank nine real design briefs, then run a timed Instant Challenge: twenty five minutes to build a device that holds a simulated blood vessel open, against five stated criteria that either pass or fail.

WORTH 5 POINTS | HELPS ON THE WEBXAM, SOMEWHAT | HANDS ON. HOUSEHOLD MATERIALS | ABOUT 75 MINUTES

What this is and why it is worth doing

This is where the Unit 4 story starts. You have applied for an internship at PLTW Innovation, Inc., an incubator where physicians, scientists, engineers, entrepreneurs, computer scientists and artists work together on biomedical problems. The acceptance email is in your inbox.

The reason to do it is the Instant Challenge in the middle. Twenty five minutes, a fixed set of materials, and five criteria that are measured rather than judged. Either your device holds a 4.0 cm segment open or it does not. There is no partial credit from a nice explanation, which is unlike most school work and exactly like engineering.

DOES THIS HELP ON THE WEBXAM? SOMEWHAT, AND HERE IS THE HONEST LIMIT

It touches **Biotechnology Research and Experiments**, 46.07 percent of WebXam 072110, because you are running a build, test and redesign cycle against stated criteria. That is experimental thinking.

The limit is that **nothing in it is measured quantitatively** beyond a ruler check at the end. There is no data table, no repeated trial, no analysis. So it helps less than item 1 or item 2 and more than items 4 through 9. If you are picking purely on exam value, do 4.1.3 and 4.1.2 first.

How long it takes and what you need first

PART	HOW LONG	WHAT HAPPENS
Part A. Categories and briefs	About 30 minutes	List innovations, sort them into categories you invent, then read and rank nine real design briefs.
Part B. Instant Challenge	25 minutes, timed	Brainstorm 5, build 10, test 5, redesign 5. Run the clock honestly.
Part C. Design debrief	About 20 minutes	Read the design process, map what you actually did onto it, and write up.

WHAT YOU NEED FOR THE INSTANT CHALLENGE

- **A balloon.** This is your simulated blood vessel. Inflate it a little so it holds a tube shape, not fully.
- **A ruler, tape, and scissors.** The ruler and scissors are *tools only*. They are not allowed to be part of your device.
- **Everyday and recyclable materials.** Drinking straws, cardboard, paper clips, string, plastic packaging, bottle caps, pipe cleaners, rubber bands. Gather them *before* you start the timer.
- **A timer** you can see, and someone to run it if you have a partner.
- A partner or two makes this much better, and the activity is designed for a team of two or three. Doing it alone is allowed. Say which you did.

SAFETY

- **Latex allergy.** Many balloons are latex. If you have a latex allergy, or anyone in the room does, use a non-latex balloon or ask Mr. Mendoza for an alternative. Check before you start.
- **Uninflated balloons and balloon fragments are a choking hazard.** If small children are anywhere near where you are working, this item gets done at school instead.
- **Scissors.** Cut away from yourself, on a flat surface. Pass them handle first. Do not walk around holding open blades.
- If the balloon bursts during testing, that is a result. Note it and move on. Wear glasses or eye protection if you have any while you are compressing the device.
- Clear up every scrap. Small plastic fragments and rubber pieces are the ones that get swallowed by a pet or a toddler.

Part A. Categories and design briefs

1. **Two minutes on a timer.** List every innovation or invention you can think of that applies to human health. Be quick. Quantity, not quality.

   Done when: a list exists and the timer ran for two minutes, not five.

2. If you have a partner or a group, compare lists and combine them. If you are alone, go back and add five more now that the pressure is off.

3. **Invent your own categories** and sort the combined list into them. Name each category. There is no correct set. A toothbrush is a simple device that helps prevent disease, so it might go under devices, or it might go under prevention, depending on what your categories are for.

   Done when: every innovation on your list sits in a named category.

4. **Read all nine design briefs** in the activity. For each one, note the client, the target consumer, the problem statement, the justification, and the design requirements.

5. **Sort each brief into one of your categories.** Then note which briefs did not fit, and how you would change your categories to hold them. That second half is the interesting half.

   Done when: nine briefs are categorised and any misfits are named with a proposed fix.

6. **Rank all nine briefs** in the order you think Innovation, Inc. should address them. Most pressing to least pressing. Then write down the criteria you used to rank them.

   Done when: a ranked list of nine exists and the criteria you used are written above it.

THE RANKING IS NOT THE POINT. THE CRITERIA ARE

Any ordering of those nine is defensible. What is being assessed is whether you can say what you were optimising for. Number of people affected? Severity? Cost to solve? How long people have been waiting? Whether anyone else is working on it? Two people who rank differently but both state their criteria have both done the task. A ranking with no stated criteria has not.

The nine briefs cover: early detection of bacterial infection and antibiotic resistance; medication compliance for elderly patients; the transplant organ shortage; disrupted circadian rhythm in spaceflight; teaching braille to young children; ACL injury in athletes; workplace ergonomic injury at a delivery company; the time physicians spend on electronic records instead of on patients; and stigma around seeking mental health care.

WORTH A LOOK WHILE YOU ARE HERE

The National Academy of Engineering has published 14 **Grand Challenges** for improving life on the planet, and many of them are health problems. Read the list, then answer two questions in your notebook: which do you think are highest priority for a company like Innovation, Inc., and which matter most to you personally, and why. The second answer is the one worth writing properly.

Part B. The Instant Challenge

THE BRIEF, AND THE FIVE CRITERIA

The problem. The device team is investigating ways to open blood vessels for patients with vascular problems. Vessels may be narrowed by cholesterol buildup or weakened by stress and high blood pressure. Your device should hold these vessels open so blood flows evenly and consistently to organs and tissues.

Your goal. Use the everyday and recyclable materials in front of you to design and build something that opens the simulated blood vessel. Your device must:

- Hold open a **4.0 cm segment minimum** of the simulated vessel.
- Maintain an opening **1.0 to 2.0 cm in diameter**.
- **Not pierce or damage** the vessel.
- Hold the vessel open **evenly** and keep its cylindrical shape.
- Be **strong enough to withstand moderate pressure** when compressed.

Five criteria, all of them checkable with a ruler and your fingers. Nothing here is a matter of opinion.

1. **Gather your materials and set your timer before you start.** The clock is part of the challenge and hunting for a bottle cap mid-build is not.

2. **Brainstorm. 5 minutes.** As a team, generate as many device ideas as you can. One person records everything. You may handle and inspect the materials, but you may **not** alter or connect any of them during this phase. Scissors and rulers are tools, never elements of your design. At the end of the five minutes, pick one idea.

   Done when: a written list of ideas exists and one of them is circled.

3. **Build. 10 minutes.** Build the device. Change your original idea as you go if you need to. Note what you changed.

   Done when: a physical device exists.

4. **Test. 5 minutes.** Put the device inside your vessel. Measure the segment it holds open with the ruler. Measure the diameter of the opening. Check the vessel for punctures. Look at whether the opening is even along its length or bulging in one place. Then pinch the device between two fingers. Does it collapse?

   Done when: you have a written pass or fail against all five criteria, with the two measurements written as numbers.

5. **Redesign. 5 minutes.** Revise the device based on what the test showed. Then retest and record the second set of results.

   Done when: second results are recorded next to the first, so the change is visible.

6. Show your final device to somebody: your group, your class, or a person at home. Explain what it does and why you built it that way.

7. Decide, as a class or with your partner, how you would choose between two devices that both passed all five criteria. That question is harder than it sounds and it is worth writing an answer to.

   Done when: a written tie-break rule exists.

Part C. Design debrief

Innovation, Inc. uses a six-step design process. You almost certainly followed most of it without being told to. Read the Design Process resource, summarise each step in your own words, then map what your team actually did onto it.

- Which steps did you use?
- Which did you skip, and why did you skip them? Time pressure is a legitimate answer if you say what it cost you.
- What were the **constraints** on the device you designed? A constraint is a limitation: time, materials, the rule about scissors, the size of the balloon.
- If you had more time, what would you do next?

What finished looks like

Your submission is these six things.

1. Your categorised innovation list, with your category names.
2. Your ranking of the nine design briefs, with the criteria you ranked by written above it, and a note on any brief that did not fit your categories.
3. Your brainstorm list from the Instant Challenge, including the ideas you did not build.
4. Photographs of your device, plus your test results against all five criteria, first build and after redesign.
5. Your summary of the six design process steps and which ones you actually used, with your constraints listed.
6. A short reflection: why did your team pursue the idea you chose, how did you reach agreement, and what is one thing you would improve about how you worked together.

WORKED EXAMPLE OF THE FORMAT

PRACTICE EXAMPLE PRACTICE-IC-1. AN INVENTED DEVICE, INVENTED RESULTS

> **Idea chosen and why.** Three ideas made the shortlist: a rolled cardboard tube, a spiral of pipe cleaner, and a cage of drinking straws taped into a ring. We chose the straw cage because it was the only one that stayed open when squeezed, and criterion five is about compression.
>
> **First test.** Segment held open: 3.2 cm. **Fail**, needs 4.0. Opening diameter: 1.6 cm. Pass. Punctures: none. Pass. Even along its length: no, it bulged where the tape ring sat and narrowed at both ends. **Fail.** Compression: sprang back. Pass. Three of five.
>
> **What we changed.** Cut longer straws so the cage ran 4.5 cm, and moved from one tape ring in the middle to three rings evenly spaced, to stop the bulge.
>
> **Second test.** Segment: 4.3 cm. Pass. Diameter: 1.4 cm, narrower than before because the extra rings pulled it in, still inside 1.0 to 2.0. Pass. Punctures: none, though one straw end was sharp and we blunted it with tape before testing. Even: yes. Pass. Compression: sprang back. Pass. Five of five.
>
> **Constraints we were working under.** 25 minutes total. Only the materials on the table. Scissors and ruler as tools only. The balloon's own size limited how wide the opening could go.
>
> **Tie-break rule we agreed.** If two devices both pass all five, we would prefer the one that uses less material, because a real stent has to fit through a vessel to get where it is going, and smaller is easier to deliver. We would rather have that rule than pick on which one looks better.
>
> **One thing to improve about how we worked.** We spent seven minutes brainstorming when the rule said five, and lost that time from building. Next time somebody who is not talking runs the clock.

WHAT THAT EXAMPLE DOES THAT YOU SHOULD COPY

- It reports the failures in the first test rather than only the final passing device.
- Both measurements are numbers, not *about right*.
- It notices a change it did not intend: the extra rings narrowed the opening. That is what testing is for.
- It mentions blunting a sharp straw end before testing, which is a criterion-four risk they caught early.
- The tie-break rule is justified by the real medical situation, not by taste.
- The reflection names a specific process failure and a specific fix.

Where people get stuck

Building during the brainstorm.

The rule says handle and inspect, do not alter or connect. Breaking it means you commit to your first idea before you have had the second one, which is the whole failure mode the phase exists to prevent.

Using the scissors or ruler as part of the device.

Tools only. It is an explicit constraint and it is the one people break without noticing.

Testing by looking instead of measuring.

Criteria one and two are numbers. Get the ruler on it. A device that looks like it holds 4 cm open and holds 3.2 cm has failed, and only a measurement tells you that.

Skipping the redesign because the first build passed.

The redesign phase is graded. If everything passed, use the five minutes to make it better on some axis you choose, and say what axis and why.

Forgetting criterion four.

Holding the vessel open *evenly* is the one people miss. A device that props one spot open and lets the rest sag has failed, and it looks fine from one end.

Not writing down the ideas you rejected.

The brainstorm list is a graded deliverable and the rejected ideas are the evidence you generated more than one.

Ranking the design briefs without stating criteria.

The ranking is unmarkable without them. Write the criteria first, then rank.

Running the challenge without a timer.

The time limits are the constraint that makes it an Instant Challenge. Without them it is just a craft project and the design debrief has nothing to talk about.

How to submit and how it is credited

THIS ITEM IS WORTH 5 POINTS

Three parts, a physical build with photographs, and a written debrief. 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

Innovation

A new idea, method or device. Not necessarily a new object.

Incubator

An organisation set up to develop new ideas and companies.

Client

A person, company, organisation or group that needs a design team to develop a solution for them.

Design brief

A document on file for a project, naming the client, the target consumer, the problem statement, the justification, and the design requirements.

Problem statement

A concise statement of exactly what problem is being solved.

Design requirement

Something a solution has to do or has to be.

Criteria

The standards a design is judged against. Each one should be measurable.

Constraint

A limitation on the design. Time, money, materials, or a rule you have to work inside.

Design process

A systematic strategy for solving problems. Innovation, Inc. uses a six-step version. It is iterative, meaning you go round it more than once on purpose.

Iterative

Repeating a cycle, improving each time round, rather than going straight through once.

User centred design

Starting from the needs of the people who will use the thing: asking questions, watching them in a real setting, and holding back your own judgement.

Instant Challenge

A short, timed, team problem-solving task with fixed materials and rules.

Vascular

Relating to blood vessels.

NAE Grand Challenges

Fourteen challenges proposed by the National Academy of Engineering for improving life on Earth. Many of them are health problems.