



Materials are a critical element of hands-on engineering design. Being intentional about choice, placement and access to materials is important for promoting rapid prototyping and iteration and has the potential to turn everyday objects into novel tools. Careful materials selection can inspire student creativity and add layers of complexity to a challenge, but it is also key to having a manageable materials load for lesson facilitators.

SELECTING MATERIALS

- Offer a variety of materials
 - Everyday objects used in new ways, like paper clips, plastic spoons and cups.
 - Materials that are new to your learners, such as brads, corks and dowels.
 - Whimsical objects (to invite less STEM-confident students and inspire creativity). We recommend pom poms, googly eyes, and colorful paper.
 - Real science and building materials tools, like a drill and screws, a T-square or springs.
- Encourage learners to bring in materials or old toys from their homes that can be upcycled into their solutions.
- Use **alternatives to tape and glue** that facilitate reusability of materials and promote rapid prototyping and iteration. (e.g., rubber bands, binder clips, string, etc.)
- Have learners test out materials to see how they can be used and manipulated to create designs.
- Be flexible with materials and encourage flexibility and creativity with your learners. It is ok to add, takeaway (and even run out) of certain materials during a challenge, especially if that challenge takes place over multiple days.

MATERIALS LOGISTICS

- Have each group choose one team member to initially gather materials from the materials area. You can have each team rotate their designated material collector during the course of the design challenge.
- For challenges with fewer supplied materials, or if students are new to hands-on building, provide each team with a pre-stocked kit containing similar materials (new materials can be offered as teams start to think about what else they might need in their design).
- Have students deconstruct devices and help sort materials at the end of a design session. 64 hands are faster than two.
- For equitable access to materials, assign a value to every item (more desirable materials at a higher value) and specify a budget that teams need to stick to.

At The Tech, we've found that access to materials during brainstorming can help idea generation, creativity and create a level playing field by familiarizing all participants with the available materials.

FACILITATIVE QUESTIONS

Focus learners on the materials by using one or more of these questions during a brainstorm:

- How could we use this material in our design?
- What attributes do you notice about this material that would help your design? Drawbacks?
- If you were to pick only five materials for your team, what would they be and why?
- What types of materials are interesting to you in solving this problem?

Brainstorm debrief: Have each person select a different material and share one idea on how that material can be used to address the challenge.



FACILITATION STRATEGIES

- Allow for informal tinkering time with unfamiliar materials.
- Have learners think of new uses for everyday objects. (What are 25 new ways you can use a pencil? Can it be used for an electronic purpose? As a mechanism?)
- Allow time for more formal observations of individual materials with “tests” such as flexibility, stress or endurance tests. This helps engineers/designers assess the attributes of materials and plan how they might be used in a solution.
- For more experienced engineers/designers, have teams ask the question of whether they are making a component or a system of components (e.g., a pedal is a component, a bike is a system of components). Have teams discuss and break down their designs into components in order to optimize their material choices.

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