



Rules

The Tech Challenge 2021: Ultimate Upcycle

Scenario

One person's trash is another person's treasure. It's time to take that old cardboard box and upcycle it into something different.

Background

Cardboard is an amazing material. It's made of pressed paper pulp or pasted sheets of paper, and is incredibly strong. Cardboard is used to contain, protect and transport many goods. Why is that? What makes it strong? Examine some cardboard to investigate what makes some cardboard stronger than others. To solve this year's challenge, you will need to master the characteristics of this material and use it to skillfully build a solution.

Many items start off packed in small packages and are assembled into a larger product. In fact, most shipped devices are packed compactly to facilitate transportation. Many household devices can be folded up or taken apart in order to fit in limited spaces and be assembled when needed.

Challenge

The team will construct and assemble a useful life-size device of their choice out of cardboard. After initial assembly, they will change the device into something else. Unassembled parts must fit into a team-defined starting envelope. (See General Specifications section for details.) The challenge: Define a problem and develop success criteria; then design, document and build a solution. See NGSS core ideas of engineering in Appendix A.

Device 1:

- Define a problem that the team plans to solve with the first device.
- Define at least two or three success criteria to measure their device.
- Construct a device that solves the first problem and meets the success criteria using the engineering design process of brainstorming, prototyping, testing, revising, etc.

Device 2:

- Define a second problem that the team plans to solve by changing their first device.
- Define success criteria to measure their second device.
- Modify the first device into a new device that solves and meets the success criteria of the second problem.





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At the Showcase:

Assemble the first device so the judges can observe its assembly, and then change it into the second device.

Present the solution to judges during the Showcase. The team must demonstrate that the assembled and changed devices meet their success criteria.

Document the team's entire journey, including brainstorming, designing, prototyping, testing, etc. in their Engineering Journal.

Problem Definition

In previous Tech Challenges, the problem to solve was already defined. This year is different. The team will define the problem to solve. Teams will need to write a pair of problem statements that describe the real-world problems solved by their solution.

Teams should write their own problem statements in their own words and will be scored with students in their grade division.

It is not sufficient to just say the object that you are building. For example, "A bookcase" is not a sufficient problem statement. Instead, you should describe it as something like:

- Store and display 29 books.
- Easily retrieve one book at a time without disturbing other books.
- Fit in limited floor space available (only 17 inches available against wall).

The problem chosen should take into consideration the requirements listed in the General Specification section below, including cardboard as the material, starting envelope size and assembled size.

The problem statements must be documented in the Engineering Journal. Teams should also document any changes to their problem statement and explain why the changes were made.

Teams will need to submit their success criteria and problem statement when they sign up for their judging interview slot in April.

Success Criteria

The team will define their own success criteria. Meeting the success criteria demonstrates that the team solution solves their problem.

In our example, we are building a bookcase that can hold at least 29 books. Here is an example of success criteria that might be appropriate:

- Shelf is at least 10 inches deep, 16 inches wide and 10 inches between shelves.
- Shelf holds 10 pounds (lbs).
- Three shelves.
- Assembled dimensions = 10.5 x 17 x 40 inches (larger than starting envelope).

During their performance, the team will demonstrate that the solution meets their success criteria.



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Example:

- Use measuring tape to demonstrate dimensions of the shelf.
- Put 10 1-pound books on each shelf or put a 10-pound weight on each shelf.

Testing and results need to be documented in the journal. Changes to the success criteria or test procedures should be explained in the journal.

Teamwork

Due to physical distancing, all team members may not be in the same location to assemble the device. The challenge will be looking for teams to demonstrate cooperation, communication and planning even if they are physically separated. Teams will construct two copies of the device that assemble and function the same. The copies must be the same size. This shows that the teams are effectively working together, can follow their plans and ideas, and can duplicate their work within the team. All team members are expected to participate during performance and interview, whether it be through assembly, narration, etc. Different decorations and colors are allowed on your two copies. For example, if you build two bookshelves and one is pink and one is green, that is fine.

General Specifications (all measurements are nominal)

1. Allowable materials:
 - a. When constructing the parts that fit into the starting envelope, only cardboard and glue can be used. **Glue is allowed to bond pieces of cardboard together. Glue, in itself, should not be a building material.**
 - b. During assembly, only pieces from the starting envelope can be used. No additional materials, adhesives, fasteners, etc. may be used. We are looking for the team to creatively assemble the cardboard using folds, tabs, slots, inserts, friction, etc.
 - c. **Decorations are allowed; however, decorations should not help in solving the problem.**
2. The starting envelope must be defined and documented and must be within the limits listed below. All cardboard parts must fit in the starting envelope before assembly.
 - a. Minimum starting envelope = 12 x 12 x 2 inches.
See Figure 1.
 - b. Maximum starting envelope = 24 x 36 x 6 inches.
See Figure 2.

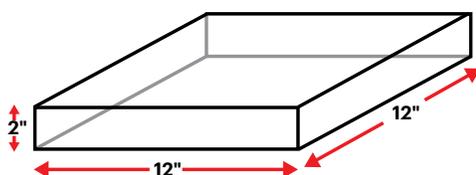


Figure 1. Minimum starting envelope

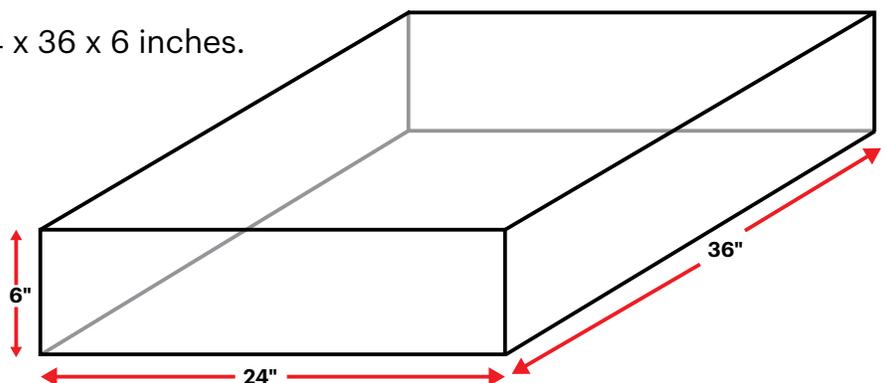


Figure 2. Maximum starting envelope



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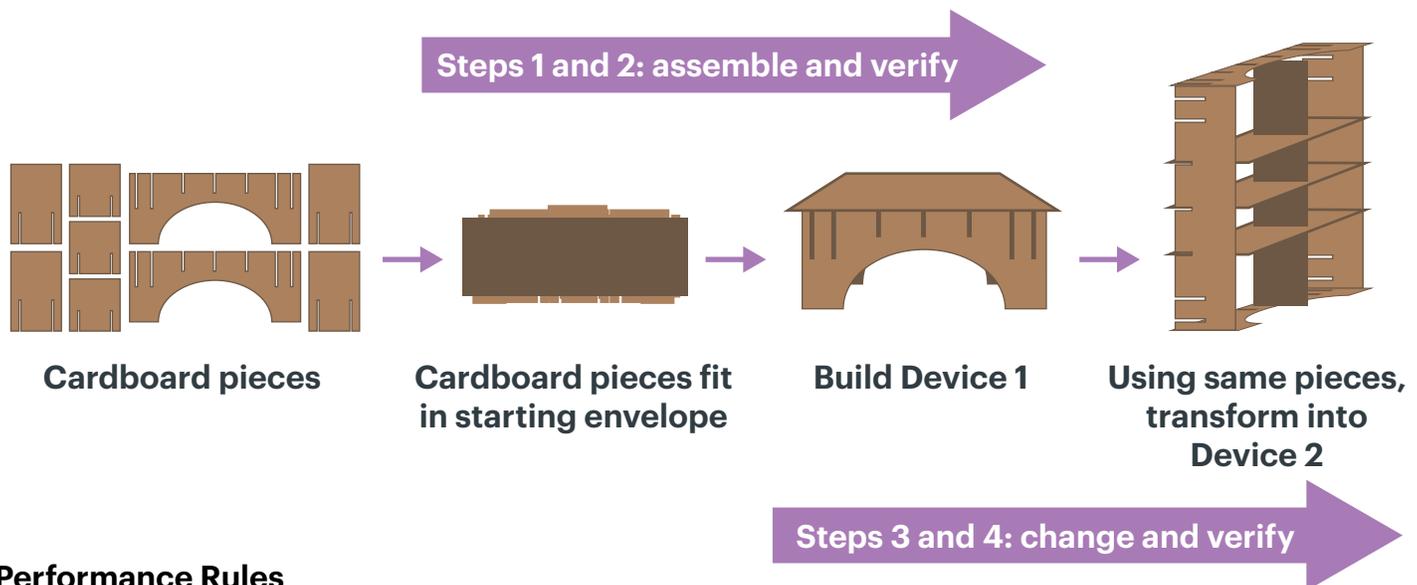
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3. The assembled device must be larger than the starting envelope. A device that starts small and assembles into something much larger is preferred over a device that only gets slightly bigger.
4. Teams must construct two copies of the final device for Showcase that assemble and function the same. The copies must be the same size.
5. The first assembly must use all pieces in the starting envelope.
6. The second assembly must use at least the following percentage of starting pieces and may not add additional pieces:
 - a. Grades 4 through 6: 50%
 - b. Grades 7 and 8: 75%
 - c. Grades 9 through 12: 100%
7. Each team must have their own devices. Teams may not share their devices or any portion of their devices with other teams.



Performance Rules

1. Teams must build two copies of the device that assemble and function the same. The copies must be the same size. These two copies will be presented by different team members during judging.
2. Step 1: Assemble - Team member starts with pieces in the starting envelope and assembles their first device while another team member narrates. Team will have a maximum of 5 minutes for this step.
3. Step 2: Verify - Team member demonstrates that device meets success criteria.
4. Step 3: Change - A different team member starts with the second copy of device 1 pre-assembled and then changes it into their second solution. Team will have a maximum of 3 minutes for this step.
5. Step 4: Verify - Team member demonstrates that the second device meets success criteria.



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Engineering Journal

1. How the team works together to research, brainstorm, build, test, evaluate, document, revise and repeat (iterate) is as important as the solution itself. The Engineering Journal is a record of this process. Start the journal at the beginning of the team's involvement in the Challenge.
2. At the Showcase, each team must submit only one PDF file for their Engineering Journal.
3. Organized records should be kept of all team activities. The team's Engineering Journal is a living document. More information on Engineering Journal requirements can be found on The Tech Challenge website in the [Team Guide \(https://www.thetech.org/thetechchallenge/teamguide\)](https://www.thetech.org/thetechchallenge/teamguide).
4. Display boards (like those used for science fairs) and digital presentations are not a substitute for an Engineering Journal.
5. Journals may be typed or handwritten. Legibility and organization are important.
6. Include problem statements and success criteria.
7. Include measurements, or other evidence, that assembled devices are larger than the starting envelope, are solutions to the problems stated, and meet the success criteria.

Safety

1. Safety is the top priority during the entire Tech Challenge.
2. Teams will be judged on safe design and implementation.
3. Judges have full authority to stop any activity they view as unsafe. The judges' word is final.
4. Each team will identify a team Safety Officer who will ensure safety from design through implementation. All team members are responsible for safety.
5. Safety gear must be worn during use of tools, device assembly, etc. as appropriate.
 - a. When eye protection is needed, teams should use ANSI-approved eye protection (e.g., glasses, goggles, mask). Regular eyeglasses do not provide the necessary level of eye protection and are not an acceptable substitute for ANSI-approved eye protection.
6. Team members must be cautious while using sharp knives or blades when cutting cardboard. Consider using alternative cutters (example: Canary Cutter).
7. Closed-toe shoes are highly recommended.
8. For more information on safety, see The Tech Challenge Resources Page (<https://www.thetech.org/thetechchallenge/resources>) and refer to the California Department of Education Science Safety Handbook 2014 (<https://www.cde.ca.gov/pd/ca/sc/documents/scisafebook2014.pdf>).



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Adviser

1. Teams must have an adult adviser. Team solutions must be designed, built and tested by team members, not the adviser.
2. The adviser role is to guide, facilitate and mentor.
3. The adviser may not be a Tech Challenge judge.
4. An adviser may work with more than one team. However, it is important that advisers ensure each team receives the necessary level of attention.
5. See the Adviser Guide (<https://www.thetech.org/thetechchallenge/adviserguide>).

Spirit of the Challenge

The Tech Challenge emphasizes the importance of developing engineering solutions that would be practical in real life, otherwise known as the Spirit of the Challenge. For this challenge, teams should develop and document real-life solutions. They will need to demonstrate their assembled devices for the judges. Judges will also look to a team's engineering journal for evidence of real-world application of the team's solution.

Store-bought solutions are prohibited and not in the Spirit of the Challenge. Teams are encouraged to design and build devices using their own ideas and creativity. Use of existing plans for reference and inspiration is allowed. All plans, and the source of those plans, must be documented in the team Engineering Journal.

Important Note Regarding the Rules

Clarifications and additions to the rules may be made due to lessons learned during Test Trials. When changes occur, registered Tech Challenge teams will be alerted by email. Changes will be noted in the rules on The Tech Challenge website in **red** type. Teams are encouraged to monitor the website for changes.

The website also includes answers to frequently asked questions (FAQs) which are posted and updated periodically.



Appendix A

Core Ideas of Engineering Design

Per Next Generation Science Standards (NGSS) (NRC, 2012, p. 71), the core idea of engineering design includes three component ideas:

- A. Defining and delimiting engineering problems involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits.
- B. Designing solutions to engineering problems begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.
- C. Optimizing the design solution involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important.

It is important to point out that these component ideas do not always follow in order, any more than do the “steps” of scientific inquiry. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that just isn’t working out.