Governor's Summer STEM Challenge 2021
Week 1: July 5 - July 9
3D Infill Challenge: Individual

Background Information

In the United States, there are over forty thousand hand or arm amputees. However, traditional functional prosthetics are often very expensive and heavy. Yale e-NABLE is an organization that 3D prints prosthetics as a lightweight and inexpensive alternative. When 3D-printing parts, we are often considering how the interior infill pattern affects the strength of the printed part (see image below).

Challenge Objective

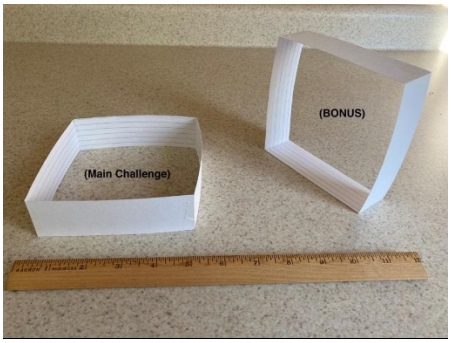
First, build a 5" x 5" x 1.5" box out of flashcards. Demonstrate your skills by designing the most effective infill design within this 5" x 5" box using the materials below. To measure the infill's strength, place weights (ex. books) on top of your box. The more weight your box can hold, the more successful your design.

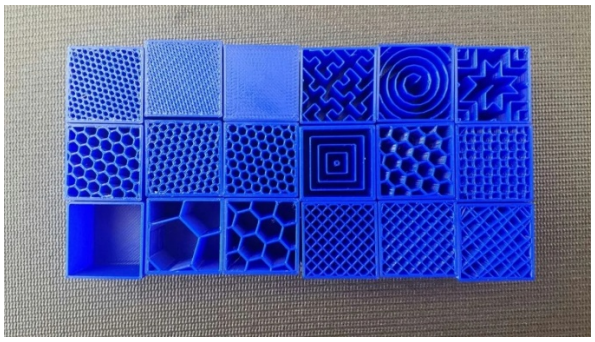
Materials Allowed

- Six 3" x 5" flashcards. Two of these flashcards will be used for the exterior box; four of these flashcards may be used for the infill.
- 1' of Scotch tape

Set-up Instructions

- Cut two flashcards in half lengthwise so that you have four 5" x 1.5" flashcards.
- Tape all the ends of four flashcard pieces together to form a 5" x 5" x 1.5" box.
- Use the rest of the four remaining flashcards to create your infill design.





Examples of Infill Designs

Rules

- All structural support must be contained within the 5” x 5” box.
- Infills must be touching at least one edge of the box (i.e. cannot have “islands” floating in the middle of box)
- During the testing stage (placing weights on the box), the box may be taped down to the surface with whatever left tape is left over.
- In the documentation process and in the video, be as honest and accurate as possible in estimating weight that your box can hold (if no scale is available)
    - If a scale is available, show the scale’s reading in the video.

Bonus

- For bonus points, design either a replica of the original design or a new design using *only* the same materials as before.
- This time, flip the box sideways such that it is standing 5” tall and 1.5” wide and design the strongest infill.
- Balance as many flashcards/other objects on the surface until it crumbles or until objects fall off.

Content Required for Submissions

- Required – Documentation of the design process.
    - Describe in detail the final infill design, the approach you took to come up with ideas, any prototype designs, and how you selected the final design.
    - Documentation should be in English or in your native language with an English translation.
- Required – Describe your final infill design.
    - Include how much weight it held *before* the box crumpled (use a scale or give your best guess).
- Required – Photo of the final infill design (aerial view).
- Required – Video of testing the infill’s strength.
    - Begin with your box on a flat surface, with the infill facing up.
    - Next, stack weights on the box (ideally flat objects such as textbooks).
    - Be sure to show the side view to show when the box crumples.
- Optional – Photos or videos of the design and build process.
- Bonus (optional) – Video of testing the infill’s strength for bonus challenge
    - Begin with your box on a flat surface, with the infill facing you.
    - Next, stack as many flashcards/other objects on the box until the box crumples/ or object falls off.
- Bonus (optional) – Documentation of bonus design process
    - Describe in detail why you either kept the same infill design or changed the design. Describe which design held more weight and why.

3D Infill Challenge Rubric					
Score Value	**Follows the Rules**	**Testing Infill Strength**	**Design Process**	**Final Design Review**	**Bonus**
4	The challenge is completed with only allowed materials, all outlined rules are followed, and required materials are submitted.	Infill design can withstand approximately > 20 lbs of weight.	Design process and thinking is documented in full detail, with descriptions of previous interations.	Documents how they arrive at final infill design and what could have been done for future improvements. Explains why infill strength is important to 3D printing.	Bonus is attempted, design process is documented, infill design can hold the weight of more than two pencils.
3	The challenge is completed with only allowed materials, all outlined rules are followed, and not all required materials are submitted.	Infill design can withstand approximately 10-20 lbs of weight.	Design process and thinking is documented in some detail.	Documents how they arrive at final infill design and what could have been done for future improvements.	Bonus is attempted, design process is documented, infill design can hold the weight of two pencils.
2		Infill design can withstand approximately 3-10 lbs of weight.	Design process and thinking is documented in little detail.	Documents why the final infill design was chosen.	Bonus is attempted, design process is documented, infill design can hold the weight of one pencil.
1	The challenge is completed with more materials than allowed or some of the design rules are not followed.	Infill design can withstand 0-3 lbs of weight.	Design process and thinking is not documented.	Does not compare final design with previous design ideas	Bonus is attempted and design process is documented.

TOTAL: _____