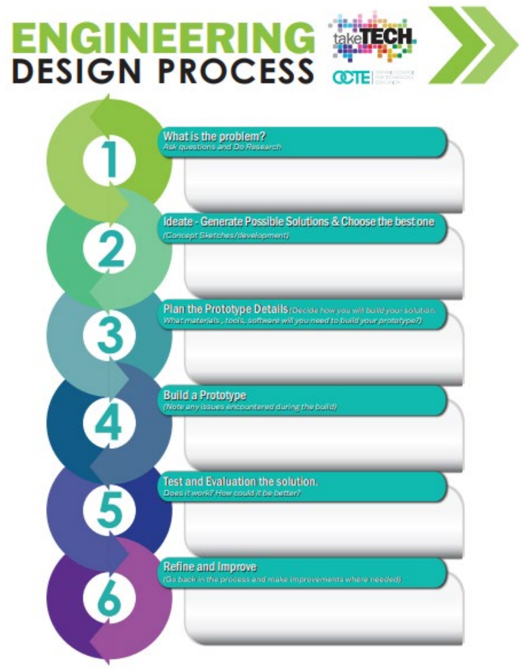
## Challenge Question or Problem to be Solved




**Design Challenge:**

Create a unique custom tensegrity structure.


**Considerations**

Students should be familiar with 3D CAD modelling and assembly structures. They should have prior knowledge of manufacturing practices either with a laser cutter or a 3d printer.

Students will gain understanding of how a tensegrity structure works by building an inexpensive prototype using popsicle sticks and string. Videos such as this one allow students to follow along while developing experience and understanding around the assembly process.

**Constraints**

**Size:**

The maximum size of the assembled tensegrity structure is 100 mm x 100 mm x 160 mm (height)

**Manufacturing:**

All parts will be made using the laser cutter or 3D printer. The appropriate file types are required for each.

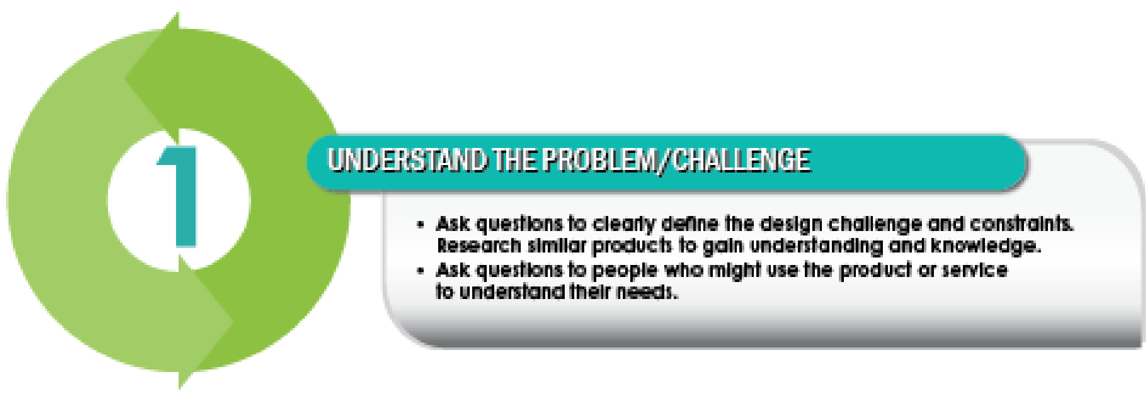
**Material:**

**Laser**

- Acrylic (various colours, as applicable) all 3 mm
- 3 mm Baltic birch plywood

**3D printer**

- PLA filament (various colours) - time permitting




Students will complete a prototype using popsicle sticks, they will develop a good understanding of the assembly challenges to better understand potential design criteria for success on their personal design.

- What are the design criteria you need to know?

Consider the joints that can be used to make a clean, strong structure

Consider an aesthetically pleasing way to conceal the knots on the string.

- What are the constraints your potential solutions must include? (Cost, material, size, safety etc)

Examples of constraints: Maximum overall size, maximum material thickness due to machine or machining time limitations.

- What fundamental concepts must you consider when developing solutions?

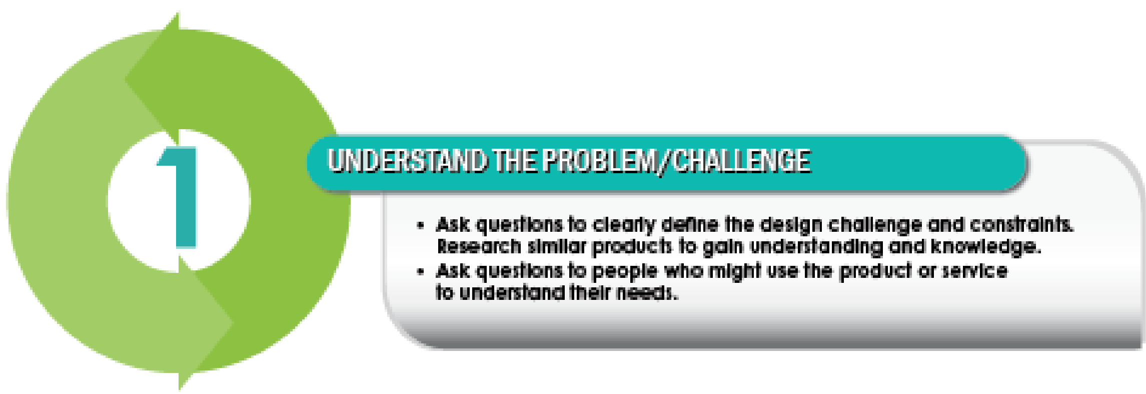
Example:

The structure in the CAD model must follow the assembly and manufacturing.

The Innovation will come from the personalization of the overall theme. This might show in the design of the arms of the structure or added features. The main geometry will likely be similar.

**Fundamental Concepts**

| | | | |
|---|---|---|---|
| **Aesthetics** | **Ergonomics** | **Material** | **Control** |
| **Safety** | **Creation** | **Mechanism** | **Structure** |
| **Environmental Sustainability** | **Function** | **Power & Energy** | **Systems** |
| | **Innovation** | | |




What are the end-users' needs?

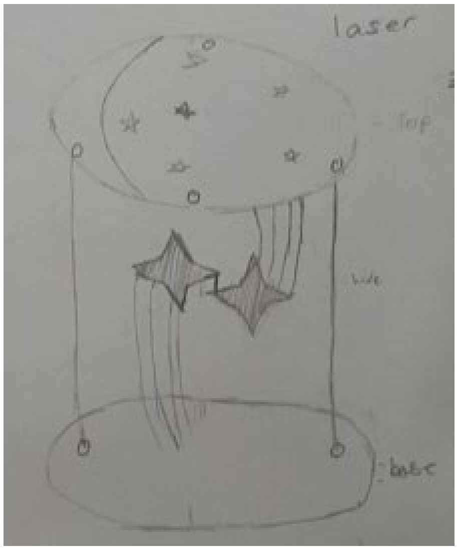
- The end user is you.
-

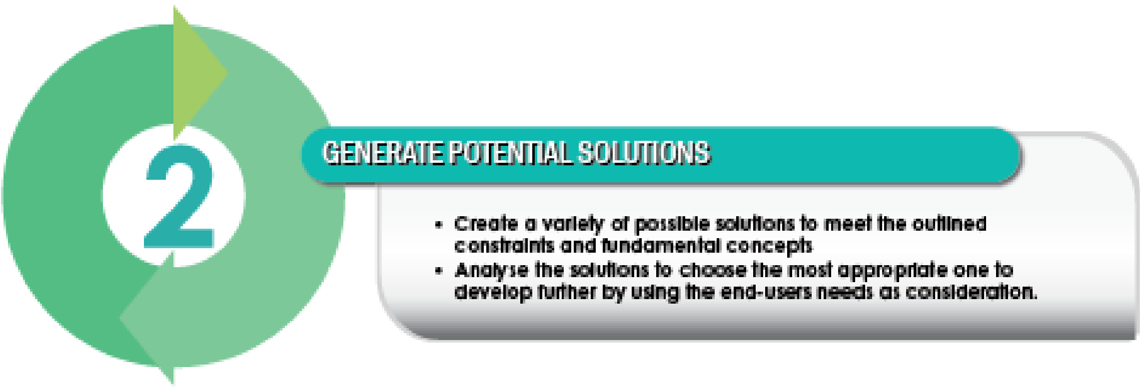
What products exist that can help guide your understanding for a solution? Use reverse engineering to help you develop potential solutions.

Using a design board to visual connect potential solutions with custom themes, colours and styles allows you to develop your ideas before concepting your own unique designs.

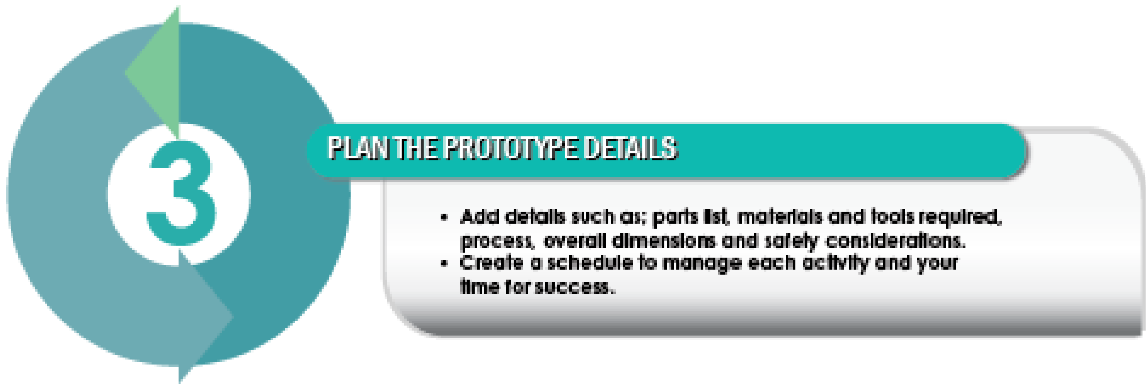

## GENERATE POTENTIAL SOLUTIONS

- Create a variety of possible solutions to meet the outlined constraints and fundamental concepts
- Analyse the solutions to choose the most appropriate one to develop further by using the end-users needs as consideration.

| | |
|---|---|
| Concept #1 - Example<br>Add material notes and laser details<br> | Concept #2 - Example<br> |
| Concept #3 | Concept #4 |




| **Concept 1 - Example 1** | | **Concept 2** | |
|---|---|---|---|
| **Pros** | **Cons** | **Pros** | **Cons** |
| Unique design | Simple | • | • |
| Strong Structure | Needs more colour | • | • |
| How will the arm connect to the base? | | • | • |
| | | • | • |

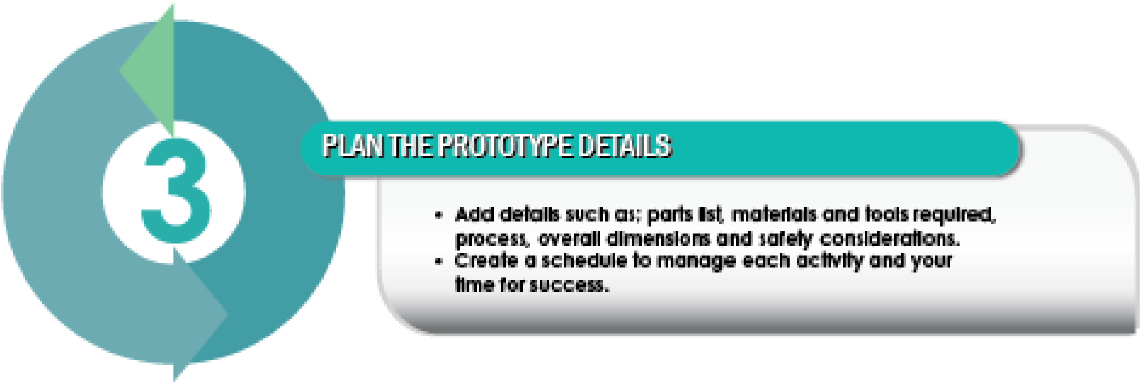



**Material Required or supplied**

| Material - Based on availability | Size |
|---|---|
| 1 popsicle sticks - -prototype | Rough dimensions 120 mm x 40 mm x 3 mm |
| 2 hot glue - prototype | |
| 3 string - prototype | |
| 4 PLA for 3D printing | |
| 5 birch plywood or acrylic for laser cut parts | |
| 6 fishing line | |

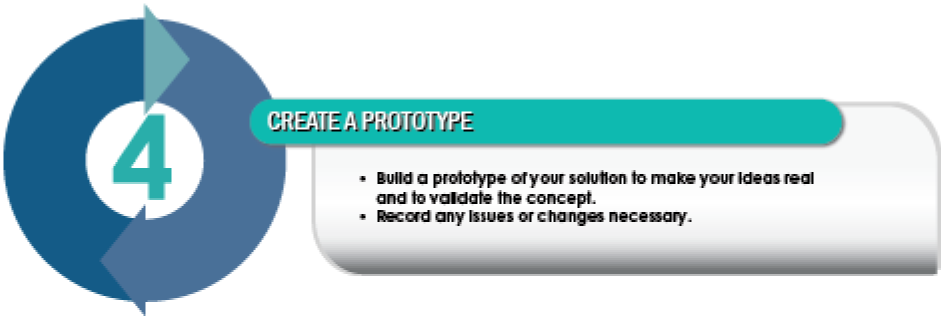
**Tools Required or Supplied**

| | |
|---|---|
| 1 3D printer | 6 Hot Glue Gun |
| 2 3D modelling software | 7 |
| 3 CO2 Laser | 8 |
| 4 Drill - Prototype | 9 |
| 5 Pliers | 10 |




List all **safety** and other **fundamental concepts** that need to be considered when working with the tools, chemicals or other materials for this project

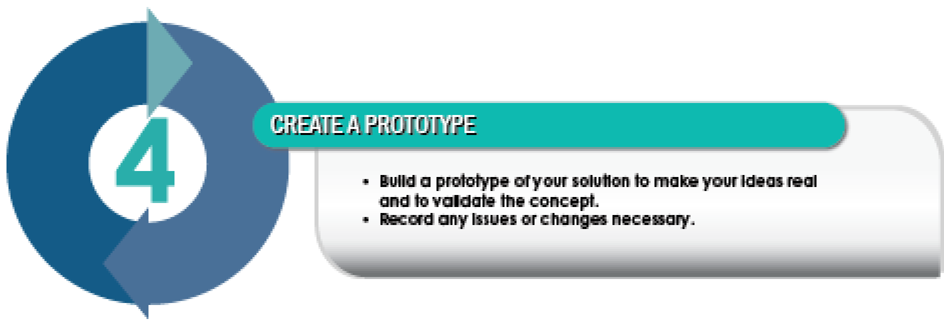
| Tool / Chemical | Safety Consideration: | Fundamental concepts - how are they considered? |
|---|---|---|
| 1 3D printer | See OCTE safety docs | 3D modelling using CAD<br>Slicing the 3D model to create G-Code |
| 2 CO2 Laser | See OCTE safety docs | |
| 3 Drill for prototype | See OCTE safety docs | |
| 4 Pliers or exacto knife for prototype | See OCTE safety docs | |
| 5 | | |




Plan the Prototype Details

List all safety considerations that need to be considered when working with the tools, chemicals or other materials for this project.

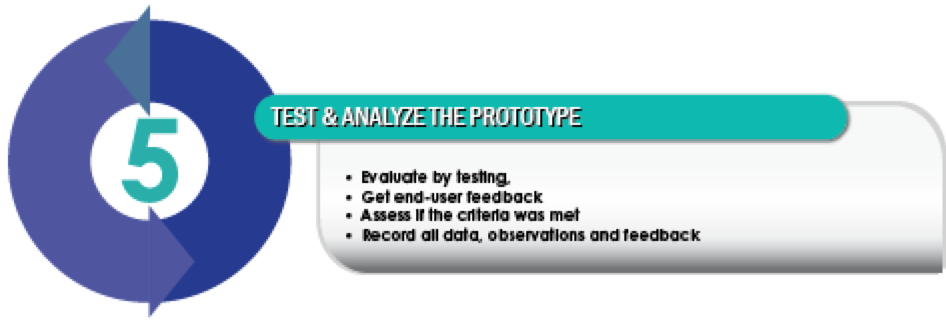
| Tool / Chemical | Safety Consideration: |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |




Create a physical/computer model of the chosen design solution to verify the functionality and feasibility of the concept. Consider which type of prototype will work best for your project?

- ❑ A 3D CAD model
- ❑ Process sheets
- ❑ Videos to show techniques
- ❑ Home / classroom / workshop landscape layouts
- ❑ A marketing campaign or information session
- ❑ A hairstyle, arrangement, or product
- ❑ A 3D printed part
- ❑ Cardboard model (low cost popsicle sticks)
- ❑ A Storyboard/ website or photograph
- ❑ A robot / schematic / get specifics from specialists
- ❑ Plants / an indoor grow kit

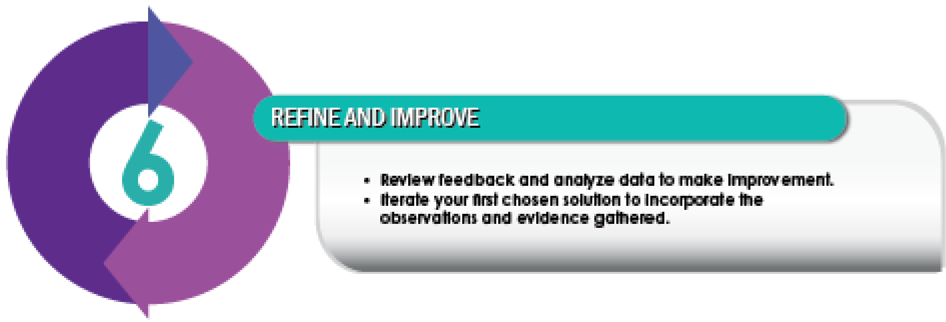
The prototype will be made using low cost materials.  The final product will be designed in 3D CAD, the product can be made on the 3D printer or laser




### Assess your working prototype in one of the following ways:

1. Test and collect data.
2. Assess if the prototype meets the specified criteria from step 1
3. Get user feedback. Ask Questions like:
   - Does it work like it is supposed to?
   - Does it meet the end-users needs?
   - Is it safe to use?
   - What would you change? Why?
   - What might you add or take away?
   - What other thoughts do you have now?

For the assessment of the final design, students will ensure that all components are assembled properly and the completed structure floats as required.




How can you improve your design?
Use testing, feedback, conversations and observations to guide iterative improvements.
Here is an example of how you can document changes.

Duplicate as needed

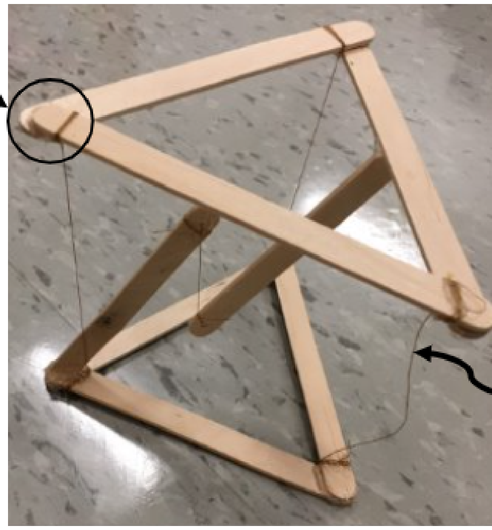
| | |
|---|---|
| Design issue:<br><br><br>Details of possible improvements: | Add image or sketch of potential improvement: |

Example or prototype

# Prototype Build Issue

**Issue:** A lot of hot glue was required to fully tighten the strings.

**Possible solution:**
Add holes for string to pass through,
to tighten string and add knot



**Issue:** During the build, it was hard to keep the strings tight and all the same length,

**Possible solution:**
Use blocks to space the top and bottom equally during assembly.
Work with a partner to assist in keeping the spacing equal.

**Issue:** Thread used does not keep its tension.

**Possible Solution:** Use stronger, more durable/strong string such as fishing line or rope.

**Student work exemplars:**

**Additional Resources:**

**Video:**
Reconfigurable Tensegrity Structure - Architecture
Prototype of a Tensegrity Structure using popsicle sticks
Tensegrity Chair build instructions

**Article:**
Tensegrity Structures: What They Are and What They Can Be

How do Tensegrity Structures Defy Gravity? Explained with 10 Examples